BEYOND COPING IN INFORMAL SETTLEMENTS:
THE FACTORS INFLUENCING FLOOD RISK ADAPTATION INTENTIONS

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Disaster Management.

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DEDICATION

This work is dedicated to my parents, Tasantab and Bulatob. Dad, thank you for supporting me with everything you had. Mom, I wish you were alive to see your son, Chati, become the great man that you always thought he would be.

ABSTRACT

Flooding is a nightmare in many parts of the world, with the poor and vulnerable usually the worst affected. Extensive flood risks are a significant concern in many countries, including Ghana, where localised annual flooding is common in urban areas. There is concern that climate change will increase the intensity of precipitation, with resultant flooding affecting vulnerable populations, especially those in informal settlements in developing countries.

Households in the informal settlements have habitually adopted coping measures to deal with the existing flood risks. Coping measures are reactive, short-term measures, and are unable to ensure resilience. Although coping measures are a critical part of building flood resilience, adaptation measures ensure proactive and long-term adjustments to existing and future flooding risk that increases resilience. Nevertheless, adaptation measures that can build the resilience of households are not adopted currently in Ghana, and this is placing lives at risk.

Only a few empirical studies have focused on the flood risk adaptation intentions of informal settlements in the Ghanaian context. This research, therefore, investigates the informal settlements' flood risk adaptation intentions, with a view to understanding how flood experience, fear, coping experience and cognitive appraisals affect those intentions. The conceptual position of this research is underpinned by the protection motivation theory (PMT). The application of PMT to the study of the flood risk adaptation intentions of households in informal settlements is novel. Therefore, a new conceptual model was developed, based on PMT, to examine how flood experience, fear, coping experience and cognitive appraisals influence flood risk adaptation intention.

The study employed a convergent mixed methods design, comprising a concurrent quantitative and qualitative data collection approach. The research focused on Glefe, an informal settlement in Accra, Ghana, as a case study. The quantitative data was collected using a household survey, resulting in 392 responses. The qualitative data was collected from interviews with nineteen key informants, comprising seventeen community members and two National Disaster Management Organisation (NADMO) officials. The quantitative data was then analysed using Structural Equation Modelling (SEM) analysis with the support of Statistical Package for the Social Sciences (SPSS) and WarpPLS, while the qualitative data was analysed with thematic analysis with the aid of NVivo.

The quantitative results showed that there exist statistically significant relationships between the aforementioned independent variables and flood risk adaptation intentions. With few exceptions, the hypothesised relationships in the conceptual model were generally supported by the results. The adaptation appraisal had a substantial positive influence on adaptation intention, explaining 68% of the variance. The qualitative findings also showed that the residents were fearful and anxious about current and future flooding risks. The households in the informal settlement also perceived that adaptation actions could be effective in reducing flooding risks and impacts.

The qualitative results concurred with the quantitative results, underlining that household experiences and appraisals are vital in households' flood risk adaptation intentions. The results revealed that there was a general willingness and intention to undertake adaptation measures against flooding. Crucially, the results indicated that flood experience and coping experience positively influenced the flood risk adaptation intentions of households in the informal settlement. The research results also found that informal settlement households place a greater emphasis on the response efficacy of adaptation measures than the cost or their self-efficacy. The findings of the research have, therefore, underscored the relevance of household experiences and appraisals to flood risk adaptation intentions in informal settlements, which may be crucial to aid transition, beyond coping, to adaptation to the impacts of climate change.

Keywords: Adaptation Intention, Flood Risk Appraisal, Flood Experience, Coping Experience, Informal Settlements, Protection Motivation Theory, Ghana

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LIST OF ABBREVIATIONS

AA	Adaptation Appraisal
AI	Adaptation Intention
AMA	Accra Metropolitan Assembly
CBDRM	Community-Based Disaster Risk Management
DRM	Disaster risk management
DRR	Disaster Risk Reduction
EM-DAT	Emergency Events Database
ER	Extrinsic Rewards
FEMA	Federal Emergency Mannagement Agency
FRA	Flood Risk Appraisal (Perception)
FW	Fear and Worry
GAMA	Greater Accra Metropolitan Area
GCA	Global Commission on Adaptation
GFDRR	Global Facility for Disaster Reduction and Recovery
GOF	Goodness of Fit
GSS	Ghana Statistical Service
HBM	Health Belief Model
HCM	Hierarchical Component Model
HOC	High-Order Construct
IPCC	Intergovernmental Panel on Climate Change
IR	Intrinsic Rewards
LOC	Lower-Order Construct
LV	Latent Variable
MPPACC	Model of Private Proactive Adaptation to Climate Change
NADMO	National Disaster Management Organisation
NGOs	Non-Governmental Organisations
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PAC	Perceived Adaptation Cost
PC	Previous Coping Experience

PE	Previous Flooding Experience
PLS-SEM	Partial Least Squares Structural Equation Modelling
PMT	Protection Motivation Theory
PS	Perceived Severity
PV	Perceived Vulnerability
RE	Response Efficacy
SCT	Social-Cognitive Theory
SE	Self-Efficacy
SEM	Structural Equation Modelling
SPSS	Statistical Package for the Social Sciences
TPB	Theory of planned behaviour
TRA	Theory of Reasoned Action
UN	United Nations
UNDP	United Nations Development Program
UNDRR	United Nations Office for Disaster Risk Reduction
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Program
UN-HABITAT	United Nations Human Settlement Program
UNISDR	United Nations International Strategy for Disaster Reduction
VIF	Variance Inflation Factor
WMO	World Meteorological Organisation

CHAPTER 1: INTRODUCTION

1.1. Background

In cities of developing countries, adaptation to extreme hazards such as flooding, is a rising concern, and there is a growing recogntion that climate change could exacerbate the intensity, frequency and unpredictability of these natural hazards (Ngo et al., 2019; Ogunbode et al., 2019; Panda & Amaratunga, 2019; Thayaparan et al., 2014). Globally, flooding hazards have destroyed the lives of people, homes and livelihoods, and the toll is escalating in an alarming way (Jordhus-Lier et al., 2019; Ngo et al., 2019; Ogunbode et al., 2019). For instance, it has been estimated that during the period from 1980 to 2013, direct economic lossess attributed to flooding exceeded US$1 trillion (2013 values) and in excess of 220,000 people died (Winsemius et al., 2015). Flooding was further culpable for about 43% of disasters betweeen 1994 to 2013 (CRED, 2015).

Flooding risk is acute, particularly for the urban poor, who inhabit highly exposed lands (de Coninck et al., 2018; Jordhus-Lier et al., 2019; Panda & Amaratunga, 2019). These poor and vulnerable urban dwellers can be found in informal settlements of varying sizes (Amoako, 2012; Archer, 2016; Ishiwatari, 2015). Informal settlements refer to urban settlements that by their nature and formation do not conform to the formal regulations of the state in terms of land ownership, settlement planning, and building construction (Dovey, 2015; Satterthwaite et al., 2020). It has been predicted that climate change will excessively increase the vulnerability of these urban residents in comparison with other groups of urban dwellers (Jabeen et al., 2009). With an estimated one billion urban residents (29 percent of the urban population) living in informal settlements in developing countries (Satterthwaite et al., 2020; Smart et al., 2020) and a 10% yearly increase (Williams et al., 2019), flood risk adaptation is urgently needed to save people's lives, properties and livelihoods.

Individuals prone to flood risk in developing countries have habitually employed coping strategies as the means to reduce the flood impacts (Chatterjee, 2010; Fenton et al., 2017). These strategies have ranged from temporary protection from floods (Bird et al., 2013), accommodation of floods (Wilby & Keenan, 2012), or temporary retreat (Bird et al., 2013). However, these approaches are often short term, reactive, and unable to provide resilience against extreme events (Lavell et al., 2012; Porter et al., 2014). Adaptation offers a proactive alternative to that reactive and short-term culture by advocating protective measures in anticipation of adverse flooding hazards and impacts (UNISDR, 2009). Despite the advantage

that adaptation measures offer over reactive and short-sighted coping measures, research has noted that people prone to flood risk continue to rely on their coping strategies (Amoako, 2017).

Research suggests that creating an enabling environment for adaptation is imperative for transitioning from coping to adaptation (Wilby & Keenan, 2012). The enabling environment for adaptation may be facilitated by placing a strong focus on people (UN, 2015) and recognising that their decisions on how to handle risks may be influenced by past experiences, perceptions, concerns and values (Amaratunga et al., 2018; IRGC, 2017). Also crucial is the understanding and knowledge of people's perceptions about vulnerability, capacity, exposure and hazard characteristics, and their impacts, and leveraging that information for pre-disaster risk assessment, production and dissemination of flood risk information and the implementation of policies, plans, and strategies to reduce flooding risk (UN, 2015; UNDRR, 2019a; Wilby & Keenan, 2012).

Extant research underscores the importance of evidence-based and practical information about risk adaptation (Abunyewah et al., 2019; Volenzo & Odiyo, 2019). It has also been identified that risks can be reduced where data exists to support planning processes (Pelling et al., 2018). However, several factors may contribute to whether people in flood-prone areas undertake adaptation to flooding risk (Birkholz, 2014; Bubeck et al., 2018; Poussin et al., 2014). Some extant literature has identified that previous experience of floods influences protective behaviour (Boamah et al., 2015). Others found cognitive (and affective) appraisals as the defining influence on protective motivation (Koerth, Vafeidis, et al., 2013; Loewenstein et al., 2001; Rogers, 1975, 1983). The implementation of proactive, prospective, and corrective measures against flooding to save lives and livelihoods in poor and exposed urban settlements may also depend on how adaptation intentions are understood and leveraged (Lechowska, 2018; UNDRR, 2017). However, how household experiences and appraisals influence adaptation intention in informal settlements is not well understood (Boamah et al., 2015).

With an emphasis on informal settlements, this study investigated how household experiences and appraisals influence flood risk adaptation intentions within the context of Ghana. This is important because research has underscored that an understanding of people's perceptions and protective intentions may improve the effectiveness of flood risk management (Bubeck et al., 2018; Koerth, Vafeidis, et al., 2013; Lechowska, 2018; Weyrich et al., 2020). The findings of this research may, therefore, contribute to an understanding of, and incorporation of, local flood risk knowledge into policies and programmes that seek to encourage households in flood-prone communities to adapt and to reduce flooding risk.

Flood risk, as the term is used in this research, is the combination of the probability of a flood event and its negative consequences (Palliyaguru et al., 2014; UNISDR, 2009). Conversely, cognitive appraisals are people's assessment of perceived risk and their perceived adaptive capacity to eliminate or reduce those risks or their harmful impacts (Bubeck et al., 2018; Zaalberg et al., 2009).

1.2. Contextualising the Research Problem

In Ghana, the incidence of flooding is widespread, causing considerable damage to lives and properties (Addo, 2013; Rain et al., 2011). Between 2000 and 2015, more than ten major flooding events have occurred, with the June 2015 event leading to the loss of more than 150 lives in a single day (Mensah & Ahadzie, 2020; Poku-Boansi et al., 2020). Furthermore, the international disasters database (EM-DAT) reveals that about one million people were affected by flooding in Ghana between 1968 and 2018 (Guha-Sapir, 2018; Tasantab et al., 2018). Asumadu-Sarkodie et al. (2015) further estimated that between 1968 and 2014 flooding in Ghana caused economic losses exceeding US$780 million (2014 values). The impacts are pronounced in informal settlements, which mostly occur in the flood-prone locations in the cities (Abeka, 2014; Tasantab et al., 2018). More than 30% of poor households had not recovered two years after the June 2015 flooding disaster (Erman et al., 2018). Without any proactive adaptation, this trend is likely to continue or even worsen (Rain et al., 2011).

One third (38.4%) of the population of Ghana's capital city, Accra, live in informal settlements (Okyere et al., 2018; UN-HABITAT & AMA, 2011). The literature also shows that about 40% of Accra is within a high, flood-prone zone (Okyere et al., 2012; Tasantab et al., 2018), while about 90% of informal settlements in Accra are located within a 10-year flood zone (a flood with a 10% probability of occurring in any given year) (Amoako & Inkoom, 2017; Rain et al., 2011).

Nevertheless, only a few studies exist in the Ghanaian context of households' responses to flooding risk (Abeka, 2014; Ahadzie et al., 2016; Amoako, 2017; Amoako et al., 2019; Tasantab, 2019; Twum & Abubakari, 2019). These studies have variously relayed the causes of flooding and the coping measures adopted by households to respond to the recurring annual events (Abeka et al., 2019; Amoako, 2017; Danso & Addo, 2017; Mensah & Ahadzie, 2020; Owusu-Ansah et al., 2018; Tasantab, 2019). Others have critiqued the contrasting and contradictory flood risk management regimes and stakeholders in Ghana (Abeka et al., 2019; Amoako et al., 2019). Beyond that, there is a scarcity of empirical research analysing how

households will, in future, deal with the predicted rise in severity of flooding events, the factors that will hinder the ability of households to adapt to flood risk, and how experiences and appraisals can be leveraged to position households to become resilient. In addition, there is limited literature on people's perceptions of flooding risk and their perceived capacity and intentions to eliminate or reduce the risks. Specifically, there is a gap in research on informal settlements' flood risk adaptation intentions. Research on these issues is important because it is needed to enable understanding of the capacity and resources required to build the resilience of households against flooding in the changing climate (Haigh & Amaratunga, 2015). Against the backdrop of studies that have revealed progressive increases in flood damage and losses to households in Accra (Abeka, 2014), this study is crucial.

Generally, it is anticipated that climate change will worsen flood hazards (Bird et al., 2013; Panda & Amaratunga, 2019; Qin et al., 2015). Also, monsoon precipitation in Ghana is projected to become heavier between 2010 and 2050, worsening the plight of people in exposed locations (Tasantab et al., 2018; World Bank & GFDRR, 2011). Adaptation to the heightened risk is therefore much needed. This research investigates the factors that influence households' flood risk adaptation intentions. Also relevant is how these factors interact with each other (Appleby-Arnold et al., 2018; Bagagnan et al., 2019; Zheng & Dallimer, 2016).

Existing research has shown that cognitive appraisals (Koerth, Vafeidis, et al., 2013; Zheng & Dallimer, 2016) and flood experience (Boamah et al., 2015) have a notable influence on flood risk adaptation. That is because cognitive appraisals may influence the decisions of people who previously experienced severe floods to adapt (Boamah et al., 2015). Research has shown that people making decisions that involve uncertain information may rely on heuristics, biases, affective influences, and appraisals (Elrick-Barr et al., 2017; Kellens et al., 2011; Wang, 2016). Prior experience, socio-economic and demographic factors, and emotions such as fear have also been mentioned as factors that may influence how people perceive and appraise their risk (Bradford et al., 2012; Kortenkamp & Moore, 2011; Slovic et al., 2004). However, there is little empirical evidence (if any) that correlates these factors with flood risk adaptation intention in Ghana from both a practical and theoretical point of view.

Nevertheless, in order to encourage adaptation, there is a need to understand flood risk, vulnerability, exposure, hazard characteristics and impacts, and decision-making responsibilities from the perspective of the people (UN, 2015). This will enable the formulation and implementation of policies and programmes, such as media campaigns and community

mobilisation that consider people's perceptions, views and needs, to encourage flood risk adaptation.

Research applying the protection motivation theory (PMT) has shown that attempts to encourage private protective behaviour must incorporate information on the probability of the threat and its potential consequences, and the possibility, effectiveness and cost of adaptation measures (Bamberg et al., 2017; Grothmann & Reusswig, 2006; Poussin et al., 2014; Weyrich et al., 2020). Such information may help people to make informed judgements and decisions about the risks they face, the adaptation capacity available to them, and their ability to implement those adaptation actions to reduce or eliminate risk. Therefore, empirical data on these variables are vital.

Detailed local data that address the local context for risk are crucial for enabling local flood risk adaptation (Tonmoy et al., 2019; UNDRR, 2019a). Ghana is quite different from the western world, where most of the studies of factors that influence private adaptation have been conducted (Bamberg et al., 2017; Bubeck et al., 2013; Grothmann & Reusswig, 2006; Koerth, Vafeidis, et al., 2013). Empirical data is, therefore, needed before one can reliably identify the factors that influence flood risk adaptation intentions in the Ghanaian context. Besides, informal settlements are characteristically unique compared to other settlements. What motivates adaptive behaviour in informal settlements may, therefore, differ from other contexts. The study, therefore, adopts a mixed-methods case study strategy to investigate how household experience and appraisals (cognitive and affective) influence flood risk adaptation intentions, using a study of an informal settlement in Accra, Ghana.

1.3. Theoretical Lens of the Research

The research was based on a framework derived from a modification of the Protection Motivation Theory (PMT). The theory was first proposed by Rogers (1975) to explain how appeals to fear influenced protective behaviour. The theory explained that factors such as the severity of threats, the probability of threat occurrence, and the efficacy of the coping response could influence protection motivation that encourages, sustains, and directs individual protective behaviour against the threats. Rogers (1983) and Maddux and Rogers (1983) expanded the components of the theory to include factors such as self-efficacy, coping cost, information sources (environmental and intrapersonal variables), and maladaptive responses. Protection motivation theory (PMT) has been applied widely in research. Of salience is its

recent application in research on disaster risk and climate change adaptation, as exemplified by the work of Grothmann and Patt (2005).

PMT has proven to be a versatile theory that explains how risk perception and perceived adaptive capacity influence people's motivation to adopt protective measures against disaster risk (Birkholz, 2014; Koerth, Vafeidis, et al., 2013). In the current research, the theory was modified to incorporate the flood experience and coping experiences of informal settlements. The purpose was to establish the influence of these factors on flood risk perceptions and perceived adaptive capacity, and how these factors collectively influence flood risk adaptation intention. It was necessary to incorporate coping experience, as the PMT did not anticipate the impacts of prior protective actions on protection motivation. This modification sets this research apart from previous research applying the protection motivation theory. The use of PMT in the current research is also novel, as there is a gap in research applying the theory to study flood risk adaptation intentions in the context of Ghana. Furthermore, there is limited research applying PMT to the study of adaptation intentions in informal settlements.

1.4. Research Question

The question that underpinned the study was.

- How do household experience and appraisals influence flood risk adaptation intentions in informal settlements?

1.5. Research Objectives

The study sought to accomplish the following objectives:

1. Establish a theoretical model supported with hypotheses relating to factors influencing flood risk adaptation intentions.
2. Test hypotheses about the relationship between the constructs representing household experience and appraisals and the flood risk adaptation intentions using quantitative data.
3. Examine the factors relating to household experience and appraisals influencing flood risk adaptation intentions using qualitative data.
4. Synthesise the quantitative and qualitative results to explain how household experience and appraisals influence flood risk adaptation intentions.

1.6. Philosophical and Methodological Underpinning of the Research

The philosophical worldview underpinning this research design is pragmatism (Creswell, 2009; Kitchenham, 2010), as it tends to be outcome-oriented and allows researchers to use design components that are suitable for answering the research question in the best way possible (Johnson & Onwuegbuzie, 2004). This research was based on a mixed-methods single case study strategy. Mixed methods research design mixes both quantitative and qualitative strategies of inquiry to arrive at a well-integrated study (Creswell, 2009).

The study adopted a concurrent mixed methods strategy, which ensured that both quantitative and qualitative components of the research where executed concurrently (Onwuegbuzie & Collins, 2007). Primary data, which was both quantitative and qualitative, were collected to investigate the research problem. A survey utilising a questionnaire was used to collect the quantitative data, while the qualitative data were obtained through semi-structured interviews. The results from the two components were then merged by comparing and contrasting during the synthesis and discussion of the results. That enabled comparison and validation, confirmation or corroboration of the quantitative results with qualitative findings (Creswell & Plano Clark, 2011; Onwuegbuzie & Collins, 2007).

The research was also novel from a methodological point of view, as many studies underpinned by the protection motivation theory have adopted mainly quantitative techniques. The few exceptions included the work of Birkholz (2014). The adoption of the mixed methods design is, therefore, a unique departure from common practice and very important to a holistic understanding of the factors influencing households' flood risk adaptation intentions.

1.7. Profile of Case Study Location

The research site, Glefe, is a small coastal community in Accra, the capital and largest urban centre in Ghana. One-third of the population in Accra lives in informal settlements, known to be prone to flooding (Abeka, 2014; Aboagye, 2012; Aboagye, 2008; Addo & Adeyemi, 2013; Amoako, 2015; Dacosta, 2012; World Bank Group, 2017).

Glefe's most prominent informal characteristic is its contravention of planning provisions concerning housing construction and land use. The Accra Metropolitan Assembly (AMA) classifies Glefe as a mature informal settlement, meaning its tenure status is secure (UN-HABITAT & AMA, 2011). The ownership of the land is, therefore, not in dispute. There are

78 informal settlements in Accra and 82% of these informal settlements are classified as mature (UN-HABITAT & AMA, 2011). As of 2010, Glefe was inhabited by 8,738 people (approximately 2,368 households) (GSS, 2012a). The number of houses was also estimated to be 1074 (GSS, 2012a). Figure 1 shows the location of Glefe in the context of Greater Accra region and Ghana.

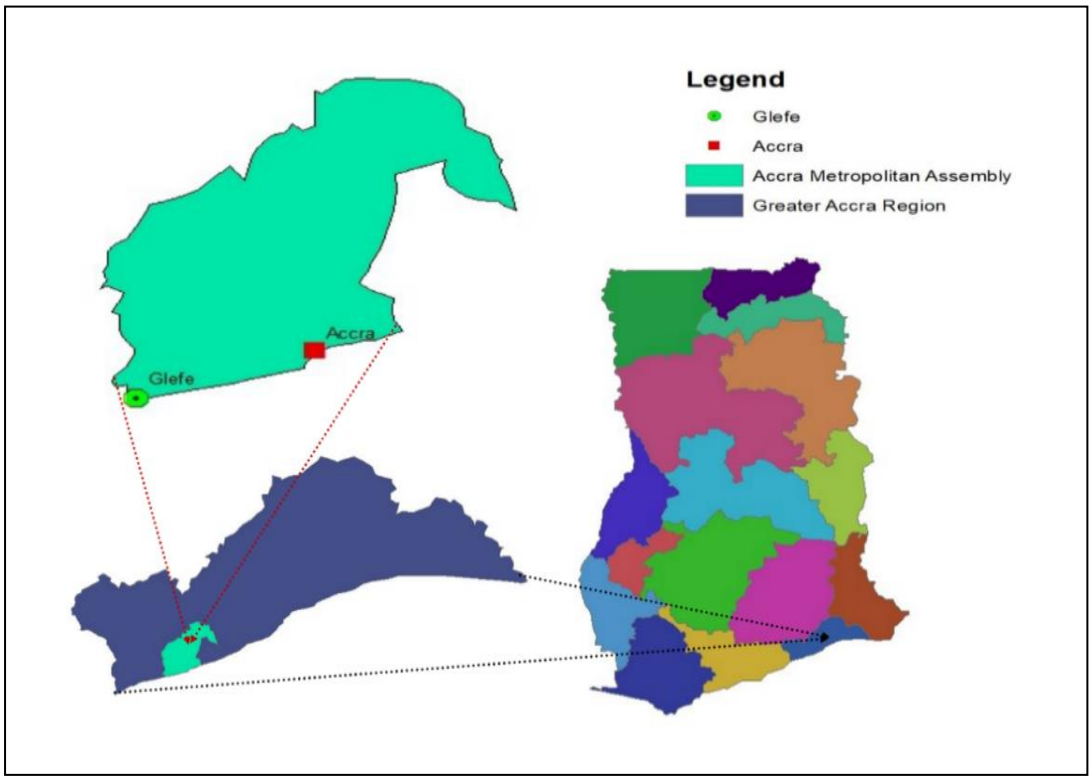

Figure 1: Location of Glefe in Accra, Ghana
Source: (Tasantab et al., 2020)

Glefe emerged as an informal fishing village situated on a sandbar between two lagoons, Gbugbe and Gyatakpo (Amoako, 2016). It is one of the settlements located in the Densu delta, known for its vulnerability to annual flooding (Amoako, 2017). The community is faced with flood hazards from both coastal and pluvial sources due to the continued development of wetlands without adequate provision for drainage and sanitation infrastructure (Frick-Trzebitzky & Bruns, 2019). Glefe's situation was earlier captured in an article by Bokpe (2014) who opined that the settlement has been "invaded by filth and a violent sea." The author further narrated that the beginning of the rainy season is a moment the residents dread due to the flooding of homes and destruction of their valuables (Bokpe, 2014). The residents, therefore,

adopted coping responses such as relocating from the community or accommodating the impacts of floods hazards as much as they can (Bokpe, 2014). In the face of these conditions of vulnerability and exposure to flooding, the need for proactive flood risk adaptation is urgent. However, research has revealed (Amoako, 2017; Frick-Trzebitzky & Bruns, 2019; Owusu-Ansah et al., 2018; Twum & Abubakari, 2019) that the measures that have been adopted to respond to flooding are reactive and spur of the moment.

The discussions in the current section have underscored the importance of understanding the perception of the vulnerable Glefe community about adaptation to future flood risk. That will provide robust data and narratives for plans and programmes to enable flood adaptation in the same or similar settings.

1.8. Definitions of Key Terms

The current chapter and subsequent chapters use various key terms that need detailed definitions. Table 1 shows the key terms and their definitions.

Table 1: Definitions of Key Terms

TERMS	DEFINITIONS
Adaptation	Adaptation refers to the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that moderates harm or exploits beneficial opportunities (UNISDR, 2009).
Appraisals	According to the Cambridge dictionary (online) "appraisal" is "the act of examining someone or something in order to judge their qualities, success, or needs." Thus "appraisals," as used in this research, refers to the act of examing (assessing) the nature of flood risk and adaptive capacity.
Capacity	The array of resources, strengths and abilities present within a community or society to manage and reduce disaster risks and enhance resilience (UNDRR, 2017).
Cognitive Appraisals	Cognitive appraisals are people's assessment of perceived risk and their perceived adaptive capacity (Bubeck et al., 2018; Grothmann & Patt, 2005; Zaalberg et al., 2009).
Community	A community refers to a group of people living in the same area (geographic community) (Kelly, 2000 cited in Boon et al., 2012).

Coping	Denotes strategies to protect lives and or properties during or immediately after flooding events. Coping is short-term, reactive, and focused on surviving the immediate threat (Lavell et al., 2012; Twum & Abubakari, 2019).
Hazard	A hazard is a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (UNISDR, 2009).
Disaster	The UNDRR (2017) defines a disaster as "a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability, and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts."
Disaster Risk Reduction (DRR)	DRR is the development and application of policies, strategies, and practices to minimise vulnerabilities and disaster risk through prevention, mitigation, and preparedness (Twigg, 2004). The purpose of DRR is to prevent new disaster risk and reduce existing disaster risk to strengthen the resilience of communities or systems (UNDRR, 2017).
Exposure	Exposure denotes that people, assets, livelihoods, and infrastructure are located in hazard-prone zones (Oliver-Smith et al., 2016).
Experience	According to the Cambridge dictionary (online) "experience" is "the process of getting knowledge or skill that is obtained from doing, seeing, or feeling things, or something that happens which has an effect on you." In this research, experience refers to flood experience and coping experience.
Flood Experience	Refers to the experience gained through exposure to, observation, or awareness of a flood event. It may be direct or indirect.
Coping Experience	Experience gained through the implementation of coping strategies to respond to flooding risks (Amoako, 2017; Balgah et al., 2019).
Household	The Ghana Statistical Service defines a household as "a person or a group of persons, who lived together in the same house or compound and share the same house-keeping arrangements" (GSS, 2012b).
Informal Settlement	Informal settlements are urban settlements that do not conform to the formal codes of the state in terms of land tenure, urban planning, and construction (Dovey, 2015).

Resilience	The ability of individuals or a community exposed to a hazard to resist, accommodate, absorb, adapt to, transform and recover from the impacts of the event in a timely and competent way (UNDRR, 2017).
Vulnerability	Vulnerability refers to the characteristics that expose people to harm and limit their ability to anticipate, cope with, and recover from harm (Wisner, 2016).

1.9. Significance of the Research

Context is crucial in disaster risk management and adaptation. It is for that reason that the 2019 Global Assessment Report (GAR) emphasised the importance of contextual understanding of risk (UNDRR, 2019a). It is salient that the report advances the need for research and policy formulation that seeks integrated, innovative, and people-centred ways, tailored to the context, to reduce disaster risk. It stresses that contextual and trans-contextual research should provide robust data and statistics about local knowledge, wisdom, culture, sensitivities, and experience of risk, enabling the advancement of solutions that are effective and relevant. For Ghana to formulate policies that encourage flood risk adaptation at the property-level, context-specific research that investigates local risk perception and protection intentions is imperative. The current research, therefore, provides much-needed insights into the flood risk adaptation intentions of informal settlements. This research is thus novel because:

- It contributes to the broader literature of risk perception and perceived adaptive capacity, and how it influences flooding risk adaptation intention.
- It is one of the first research endeavours to explore the flood risk adaptation intentions of informal settlements in Ghana.
- It is one of the first studies to quantitatively test the association between flooding experience, coping experience and formation of flood risk adaptation intentions in the context of Ghana.
- It is one of the few studies to employ a mixed methods methodology together with protection motivation theory.

1.10. Summary of the Thesis Chapters

The thesis has been organised into seven (7) chapters. Below are the summaries of the content of each chapter.

- **Chapter 1** introduces the study, discussing, among other things, the research problem, justification of the study, the research question, objectives of the study and the definitions of key terms.

- **Chapter 2** is a literature review, and discusses the concepts of flood risk, coping, adaptation, adaptive capacity, vulnerability, and resilience. It also explains disaster risk perception and how it influences flood risk adaptation intention and behaviour. The chapter concludes with a conceptual framework, based on the protection motivation theory that underpins the study.

- **Chapter 3,** on the other hand, explains the research methodology, the sampling procedures and data collection processes. It further explains the data analysis procedures and ethical considerations for the research.

- The analysis of the survey (quantitative) and interview (qualitative data) are presented in **Chapters 4 and 5**. **Chapter 4** presents the descriptive statistics for the survey data. It also presents the results of the structural equation modelling (SEM) to test the hypothesised relationships in the specified model. **Chapter 5** presents the results of the interview data. It shows the perceptions of the respondents regarding the causes and impacts of flooding in the study area, vulnerability of the population, risk perception and adaptation intention of the households.

- **Chapter 6** presents the synthesis and discussion of the quantitative and qualitative findings from Chapters 4 and 5. The discussion and synthesis are done in accord with the formulated conceptual model and hypothesis. The significance of the path relationships in the structural model are discussed. The interview results are then used to confirm, collaborate, and emphasise the findings.

- **Chapter 7** is the concluding chapter of the thesis. It, therefore, discusses the theoretical and practical implications of the findings. Conclusions and recommendations are then made based on the findings. It further provides recommendations for further study to address the gaps that were revealed in the findings.

1.11. Summary of Chapter 1

Chapter 1 provided insights into the research problem and acknowledged the huge financial and human toll of flooding. It further emphasised that urban areas in Ghana, particularly

informal settlements such as Glefe, are subject to such risks. The chapter underscored the necessity for households in flood-prone communities to adopt adaptation measures that build resilience, rather than coping measures that are reactive and unable to provide resilience in the changing climate, thus making the study of households' flood risk adaptation intentions crucial.

Also, within Chapter 1, the research questions, objectives, research scope and the theoretical and methodological underpinnings of the thesis were outlined. The chapter further outlined the novelty of the research and explained the key terms used in the thesis. Chapter 2 will discuss the literature and the theory underpinning the research.

CHAPTER 2: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

Climate change is hidden in common natural hazards such as flooding, and is often not discernible as a risk factor because it cannot be directly experienced (Reser & Swim, 2011; Whitmarsh, 2008). However, changes in the frequency and intensity of natural hazards, such as floods, heatwaves, wildfires and hurricanes, call for adaptation (GCA, 2019). This literature review examines the concepts of coping and adaptation to flooding risk in the context of disaster risk reduction (DRR). By addressing flooding risk from the perspective of disaster risk reduction, this research invariably contributes to climate change adaptation (Dias et al., 2017). Moreover, disaster risk reduction is linked to and dictates adaptation to climate change (WMO, 2017).

The chapter, therefore, explains the concepts of risks, hazards and disasters, especially concerning flooding. It unpacks these concepts and how they relate to each other in section 2.2. The chapter further examines the vulnerabilities that make informal settlements prone to flood risk in section 2.3. Resilience is also discussed in section 2.4. The discussion centres on what the concept means, its relationship with the concept of vulnerability, and why resilience-oriented strategies are desirable. The chapter then proceeds to discuss measures for reducing flood risk in section 2.5, while coping and adaptation strategies are covered in section 2.6. Section 2.7 discusses risk perception as it relates to flood risk adaptation. The conceptual framework of the study is discussed in section 2.8. The next section, therefore, discusses hazards, risks and disasters.

2.2 Hazards, Risks and Disasters

The world is at a time in human history in which people and their valuables face unprecedented risks (Balgah et al., 2019; Smith, 2013). The factors affecting exposure and vulnerability to hazards, risks and disasters have become so pervasive that they require attention to reduce existing and new disaster risks and build resilience, with the aim of reducing the loss of life (GCA, 2019; Jha et al., 2012; Tran & Few, 2006; Wisner et al., 2004). This section discusses hazards, risks and disasters and their linkages.

2.2.1 Hazards

A hazard is “a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services,

social and economic disruption, or environmental damage" (UNDRR, 2017; UNISDR, 2009), for example, flood hazard, fire hazard, and storm hazard, among others. According to Ribot (2014), hazards are probable events, which are expected but cannot be locally manipulated. It is suggested that hazards are prompted by "specific natural forces" out of the control of their victims (Wisner et al., 2012). However, Smith (2013) and Wisner et al. (2012) argue that hazards may also be influenced by human actions or inactions, whether inadvertent or deliberate. Smith (2013) further suggests that environmental hazards have the following characteristics:

- The origin of the event is known and produces known threats to human life or well-being (a rainstorm produces a flood that causes death by drowning).
- The warning time usually is short (the events are often rapid onset).
- Most of the direct losses, whether to life or property, occur shortly after the event.
- Human exposure to hazards is commonly involuntary, typically due to the location of people in a hazardous area (Smith, 2013, p. 11).

The likelihood of a hazard at a particular location does not necessarily imply that there is a risk (Maier et al., 2017). Hazards become risks when people and or their valuables are exposed (Maier et al., 2017; Siriwardena et al., 2013). Exposure denotes that people, their assets and livelihoods, and infrastructure are located in hazard-prone zones (Oliver-Smith et al., 2016). In terms of flood hazards, exposure relates to who or what is getting inundated (Maier et al., 2017).

According to UNDRR (2017), exposure is measured by the number of people or types of assets in the hazard-prone location. They further suggest that the origin of a hazard may be natural, anthropogenic or socio-natural. While natural hazards are associated with natural phenomena and processes, anthropogenic hazards are induced by human choices and activities. Some hazards may also be caused by the interplay of natural and human factors, such as environmental degradation and climate change, making them socio-natural hazards.

Vojinovic (2015) also notes that the International Disaster Database (EM-DAT) estimates that floods have grown faster relative to other hazards. Furthermore, the Intergovernmental Panel on Climate Change (IPCC) projections show that precipitation is likely to increase in the medium to long term (Christensen et al., 2013; Collins et al., 2013; IPCC, 2012; Kirtman et al., 2013). Precipitation extremes associated with monsoon seasons are very likely to increase around the globe in the future (Christensen et al., 2013). Also, short-term duration precipitation events are likely to shift to more intense individual occurrences. Both near-term and long-term

climate projections have suggested similar increases in extreme precipitation (Collins et al., 2013; IPCC, 2012; Kirtman et al., 2013). Other estimates show that extreme precipitation may increase markedly more than average precipitation volumes (Kirtman et al., 2013).

The projected increases in extreme precipitation are likely to result in increased flooding (including both inland and coastal flooding) bringing negative impacts to people, their livelihoods, and assets (Revi et al., 2014). Hazards and risks are intricately related. The relationship between a hazard and its probability can, therefore, be used to estimate the overall level of risk a population would face (Smith, 2013).

2.2.2 Risks

The term 'risk' refers to the likelihood of losses to lives, health status, livelihoods, assets, or services occurring in a community (Niekerk, 2011) due to the combination of hazards and vulnerabilities or adaptation capacities of exposed populations (Romero-Lankao et al., 2014). Risks may also be described as the combination of the probability of an event and its adverse effects (Romero-Lankao et al., 2014; UNISDR, 2009). Risk is often expressed as the product of hazards and vulnerability (that is R=H x V) (Wamsler & Brink, 2014; Wisner et al., 2004). Several variables may also be considered in the determination of risk, including severity, probability of occurrence, frequency of occurrence, rapidity of onset and spatial extent of a potentially harmful hazard (Wisner et al., 2012). Though risks may sometimes be seen as synonymous with hazards, they represent a quantifiable estimate of the frequency with which a harmful hazard event is experienced (Smith, 2013).

Also, risks are indications that vulnerable people (including their valuables, settlements and livelihoods) are exposed to hazards (Shaw et al., 2015). Risk, therefore, is a cross-cutting combination of vulnerability, exposure, hazards and capacity (UNDRR, 2017; Wisner et al., 2004). The trends in risk have been increasing over time. Even worse, climate change is bringing new risks for human societies (Dias et al., 2017; Shaw et al., 2015). In some places, extensive disaster risks are a great concern. These are low-severity, high-frequency harmful events that are usually, but not exclusively, linked to very localised hazards (UNDRR, 2017). An example of extensive risk is localised annual flooding in Ghana. While the impacts might not be extreme enough to demand international assistance, the repeated occurrence erodes the population's capacity to respond and exacerbates conditions of vulnerability and poverty (Erman et al., 2018; UNDRR, 2017).

The existence of risk (specific physical and social conditions) directly influences the occurrence of disasters (Lavell et al., 2012). Disaster risks are an indication of unfavourable

conditions in a society or community (UNDRR, 2017). Understanding of the broader social, economic, environmental and physical processes shaping risk is therefore essential (Romero-Lankao et al., 2014). It is also crucial to understand that people may not hold the same perceptions of risk (UNDRR, 2017).

The conditions (particularly social drivers) that create risks continue all over the world, especially in developing countries (Wisner et al., 2004). These conditions include growing inequalities, which prolong existing risks or generate new risks (Oliver-Smith et al., 2016). More people in urban locales are forced to accept and domicile in high-risk areas due to poverty (Oliver-Smith et al., 2016; Wisner et al., 2004).

2.2.2.1 Flooding Risks

Long-term data on disasters show that flood hazards and wind storms (which frequently lead to flooding) are the most typical causes of nature-induced disasters worldwide (Panda & Amaratunga, 2019; Tran & Few, 2006). This is consistent with the assertion by Wilby and Keenan (2012) that flooding is the commonest, and one of the most devastating, natural hazards globally.

The term flooding refers to the inundation of land that is usually dry (Few, 2006; Jha et al., 2012). Vojinovic (2015) also defines flooding as the overflow of water onto naturally dry land surfaces, which may cause losses and destruction. While a flood hazard is any flood event that has the probability of causing impacts on human beings and their assets (Few, 2006), flood risk is the interconnection of a flood hazard, the exposure to the flood hazard, and the vulnerability of the exposed population (Jha et al., 2012).

Heavy rainfall of long duration or high intensity is one of the leading causes of flooding. The surface water then builds up in areas of low elevation (Few, 2006). Sudden onset but severe flash floods may also occur due to extreme rainfall from rainstorms and cyclones (Few, 2006; Limthongsakul et al., 2017). Flooding may also result from sea-level rise, glacial melt, snowmelt or ground infiltration (Limthongsakul et al., 2017). Flooding can also occur as a result of the breakdown of dams, reservoirs and pumping systems (Jha et al., 2012). Urban flooding may be regular waterlogging of localised areas after rainfall (Few, 2003; Houston et al., 2011). Localised flooding may result in harmful impacts to human populations, including their health, livelihoods and assets (Limthongsakul et al., 2017).

Flooding in itself is not a problem, especially in cultivated arable land where it is needed to enhance soil fertility for agricultural production (Campion & Venzke, 2013; Schmuck, 2012).

Rather, the impacts of flooding are felt when it interacts with natural and human-made environments in a negative sense, causing damage, death and disruption (Siriwardena et al., 2013). Flooding is usually severe in urban areas due to topography, plant cover and vegetation loss, inappropriate land use and obstruction of natural water channels, fast-growing and uncontrolled housing development, inadequate and inefficient drain networks and reduction in permeability of ground surfaces due to urban development (Abebe et al., 2018; Douglas et al., 2008; Gyekye, 2011). The current study deals with flooding in urban areas caused by heavy rainfall. These kinds of flooding (both pluvial and fluvial) overwhelm drainage channels, causing deadly overflow (Gyekye, 2011). It may also affect land at low elevation or relatively flat areas, and may thus be localised. As extreme precipitation increases over the medium to long term (Christensen et al., 2013; Collins et al., 2013; IPCC, 2012; Kirtman et al., 2013), urban flooding is estimated to increase in severity (Jiang et al., 2018).

There have been rapid increases in the factors affecting exposure and vulnerability to flooding in urban settlements, especially in developing countries (Jha et al., 2012; Jordhus-Lier et al., 2019). Conditions of informality put more people and their assets at risk of flooding (Satterthwaite et al., 2020; Williams et al., 2019). This is particularly troubling in sub-Saharan Africa, where about 70% of urban dwellers live in informal settlements (Campion & Venzke, 2013; Simiyu et al., 2018). Informal settlements, often in central city or peripheral locations, are very vulnerable to flood risk (Jha et al., 2012).

Observed trends show that urbanisation, environmental change and climate change could worsen the vulnerability of urban areas to flood risks (Rana et al., 2020; Romero-Lankao et al., 2014). Research shows that between 1995 and 2015, 47% of climate-related disasters were flooding events (Gran Castro & Ramos De Robles, 2019). The impacts of flooding are far-reaching, including environmental, physical and psychological impacts (Mensah & Ahadzie, 2020; Ogunbode et al., 2019). Table 2 shows some of the direct and indirect impacts of flooding.

Table 2: Types of Flood Impacts

Direct impacts (immediate)
Tangible: physical property damage, restoration, and rebuilding costs
Intangible: ill-health of flood victims (including mental trauma)
Indirect impacts (delayed and long-lasting)
Tangible: economic and social disruption (lost industrial and agricultural production, damage to transport infrastructure and the retail sector)
Intangible: increased vulnerability of impacted people, exacerbating poverty, planning blight and out-migration

Source: Hellman (2015)

However, these impacts will be disproportionate, with the urban poor suffering the most compared to the more affluent population (Houston et al., 2011; Jabeen et al., 2009). Despite evidence to the contrary, Schmuck (2012) is uncertain whether flooding has increased over the last few hundred years. Schmuck is, however, confident that flooding affects a large number of people due to the increased populations now living in or near flood-prone areas.

The global debate on climate change is drawing the awareness of governments and citizens to the worsening nature of floods (Hellman, 2015). Nevertheless, the level of understanding and knowledge of flooding risks is directly associated with people's perceptions about the risks and their decisions to either adjust to such risks or ignore them altogether (Vojinovic, 2015).

2.2.2.2 Flooding Risk in Ghana

Floods are a common theme in African cities during the wet seasons of the year (Douglas et al., 2008; Gyekye, 2011). Floods can occur multiple times a month in many African countries, most often as a result of heavy rainfall (Douglas, 2017). In addition to the challenges of economic growth and social development, floods have become a critical developmental challenge, especially for these countries (Amoako, 2016).

This risk is worsened by multiple stresses, such as poverty, governance failures, limited access to capital, complex humanitarian crises and livelihood fragility (Amoako, 2016; Rain et al., 2011). It has been projected that urban dwellers will exceed the rural population in Africa by 2030 (Rain et al., 2011). An increased urban population suggests that the population of vulnerable people may also increase, since most of this growth is projected to take place in informal settlements (Amoako & Inkoom, 2017; Satterthwaite et al., 2020). The situation is already dire as the social system has been unable to limit the growth in vulnerabilities and flooding risks (Gyekye, 2011; Williams et al., 2019).

Flooding risk in Ghana is by no means different from other African countries or most developing countries (Amoako & Inkoom, 2017). Pluvial and fluvial flooding is the most common in the urban areas of Ghana, particularly Accra (Mensah & Ahadzie, 2020; UNEP/OCHA, 2011). The impacts of these flooding events have been severe, in some instances resulting in disasters.

The International Disaster Database (EM-DAT), covering the period 1968 to 2017, shows that 4.9 million people in Ghana were affected by flood events, resulting in about 640 deaths (Guha-Sapir, 2018) and economic damage of US$780.5 million (Asumadu-Sarkodie et al., 2015). In the past two decades, seven major flood disasters have occurred in Ghana (UNDP, 2017). The floods of 2007 in Northern Ghana affected 350,000 people, with 49 people dying (Asumadu-Sarkodie et al., 2015; UNDP, 2017). The devastating floods of November 2010 also displaced about 700,000 people, destroyed 3234 houses and 23,588 acres of farmland in 55 communities (Mensah & Ahadzie, 2020). Another severe flooding disaster with enormous casualties occurred on June 3, 2015 when a flood and fire hazard in Accra resulted in the deaths of about 200 people and injured several others (Amoako & Inkoom, 2017; Asumadu-Sarkodie et al., 2015).

Accra seems to be the most flood-prone urban area in Ghana (Mensah & Ahadzie, 2020; UNEP/OCHA, 2011). This is not surprising, since the city is the capital, most populous, and significant economic and administrative centre of Ghana (UN-HABITAT & AMA, 2011). This also makes it the primary recipient of urban migrants, the most densely populated urban centre and home to most informal settlements (Amoako, 2016; Amoako & Inkoom, 2017; Schaupp, 2013). These are the same conditions that create vulnerability to floods, as elucidated in preceding discussions. When existing flood hazards interact with these natural and social conditions, it multiples the risk of flooding disasters (Amoako & Inkoom, 2017; Douglas, 2017).

The influence of climate change on precipitation and flooding in Ghana is marked. While overall precipitation is projected to decrease by 1.1%, and 20.5% in 2020 and 2080, respectively (World Bank & GFDRR, 2011), the total proportion of heavy rainfall in July-August is predicted to increase over the period 2010-2050. Thus, the wet seasons are projected to get wetter (World Bank & GFDRR, 2011). For instance, Mensah and Ahadzie (2020) found that average monthly precipitation in Accra has increased from 160mm between 1991-2010 to 200mm from 2011-2020. That is an indication that pluvial and fluvial floods are likely to become more severe in the foreseeable future.

The places most affected by flood events in the past were informal settlements (Amoako & Inkoom, 2017; Douglas et al., 2008). Without any proactive adaptation, the trend is very likely to continue or even worsen (Rain et al., 2011). Indeed, about 90% of informal settlements in Accra are located within a 10-year (a flood with 10% probability of occurring in any given year) flood zone (Amoako & Inkoom, 2017; Rain et al., 2011), making proactive flood risk adaptation all the more crucial.

2.2.3 Disasters

The previous sections discussed hazards and risks. However, it is essential to be aware that unmitigated hazards and risk result in disasters. A disaster occurs when a hazard event results in serious disruption to the lives of exposed human populations, such that they suffer severe loss and impacts on lives, economic possessions and environmental assets (UNDRR, 2017; Wisner et al., 2004). Disasters, more often than not, exceed the capacity of the impacted community or society to adjust using their resources (Hajer Al-Dahash et al., 2016; UNISDR, 2009). Therefore, recovery from disasters may be unlikely without external support (Wisner et al., 2004).

Disasters are most often acutely experienced at the local level (Cutter et al., 2012), resulting from a combination of exposure, conditions of vulnerability and low capacity or measures to reduce or cope with the potential negative consequences of hazards (UNISDR, 2009). The human impact and disruption to the functioning of an affected community are, therefore, central to the definition of disasters (Esnard & Sapat, 2014; Malalgoda et al., 2016). The adverse impacts may be immediate and localised, but could also be far-reaching and prolonged (UNDRR, 2017).

The term “disasters” has attracted wide usage in academia and traditional media. Unfortunately, the use of “natural disasters” to describe disasters caused by natural hazards communicates a lack of control over the event, as if they were acts of God (Chmutina & von Meding, 2019; World Bank & United Nations, 2010b). “Natural” disasters are unnatural, and result from human acts of omission and commission (for example, building in flood-prone locations) and socio-economic factors (Chmutina & von Meding, 2019; World Bank & United Nations, 2010b). Those who ascribe to the traditional view of disasters perceive disasters as acts of nature. In contrast, the contemporary understanding of disasters perceives them from a social construction viewpoint (Chmutina & von Meding, 2019; Ray-Bennett, 2018).

In the current research, disasters are understood from a social constructivist position, which argues that disasters are the interaction of hazardous physical events with conditions of social

vulnerability (Lavell et al., 2012; Siriwardena et al., 2013). Disasters are, therefore, not "unavoidable natural events which need to be managed" (Mercer, 2010). Indeed, without conditions of vulnerability (vulnerable people in risk-prone locations), disasters may never occur (Oliver-Smith et al., 2016; Wisner et al., 2004). The gradual change in terminology from "natural disasters", which was pervasive for so long in human history, is significant (Smith, 2013), since the idea of natural disasters excuses human culpability in the creation of conditions of vulnerability (Chmutina & von Meding, 2019; Oliver-Smith et al., 2016).

Disaster impacts include loss of life, injury, disease, and other environmental, social, and economic changes, such as human physical, mental and social well-being, damage to property, destruction of assets, loss of services, social and economic disruption and environmental degradation (Lavell et al., 2012; Shaw et al., 2015; UNISDR, 2009). These impacts are indicators of complex environmental, social, and economic issues existing in human society (Shaw et al., 2015; Siriwardena et al., 2013).

According to UNDRR (2019a), disasters may be small-scale or large-scale. Small-scale disasters affect only local communities, while large-scale disasters affect a whole society, requiring national or international aid. Disasters may also be frequent or infrequent, depending on the probability of occurrence and the return period of the hazard and its adverse impacts. It is essential to understand that the impacts of frequent disasters, such as annual flooding events, may be cumulative. The rapidity of onset can also differentiate disasters. Slow-onset disasters emerge gradually over some time, while sudden-onset disasters emerge quickly or unexpectedly. Examples of sudden-onset disasters are earthquakes, volcanic eruptions and flash floods (UNDRR, 2019a).

2.2.3.1 Disaster are Indicators of the Changing Climate

There is a growing trend in hydro-meteorological disasters (Brown et al., 2018; Phong & Shaw, 2015). According to Ray-Bennett (2018), the number of people affected by these disasters has been increasing yearly. However, UNDRR (2019a) data between 2000 and 2015, from 83 countries, shows no clear trend in the number of affected people. Nevertheless, several authors agree that the impacts have increased , most certainly as a result of unsustainable development practices and climate change (Phong & Shaw, 2015; Shaw et al., 2015). According to UNDRR (2019a), disasters caused by natural hazards displaced about 24 million people worldwide each year during the last decade 2008-2018. Figure 2 depicts the number of new displacements caused by disasters between 2008 and 2017.

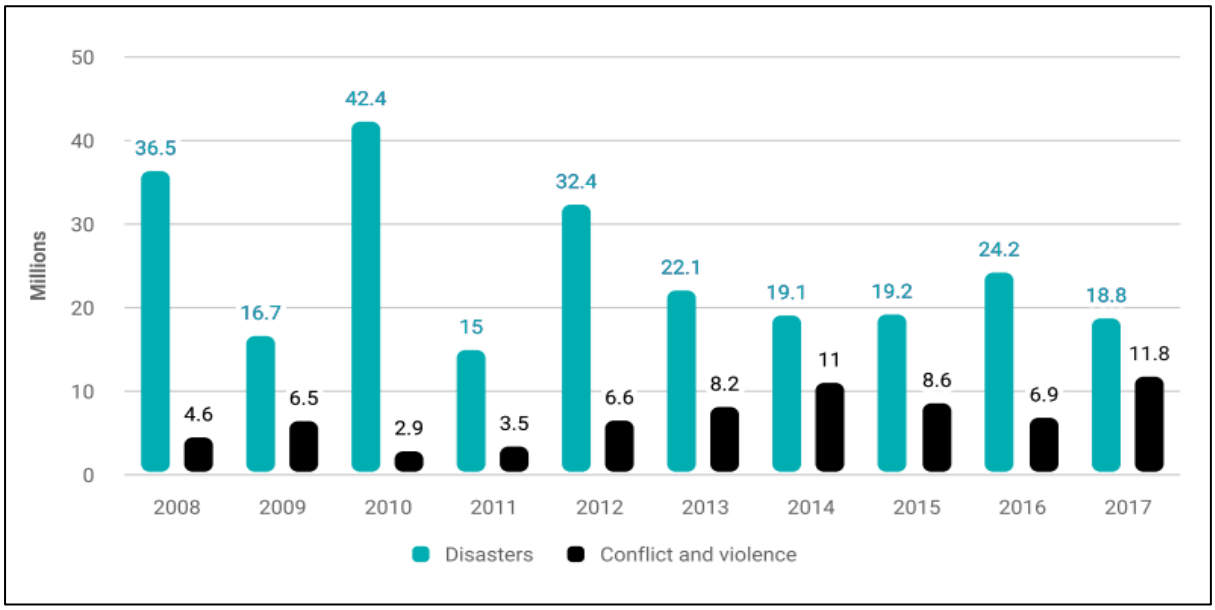

Figure 2: New Displacements Caused by Disasters Between 2008 and 2017

Source: UNDRR (2019a)

UNDRR (2019a) estimates show that 62% of economic losses due to disasters are in the housing sector. They further revealed that floods (including flash floods and rain) were the leading causes of housing sector losses between 2005 and 2015 (UNDRR, 2019a). Figure 3 shows losses in the housing sector due to disasters in 83 countries between 2005 and 2015.

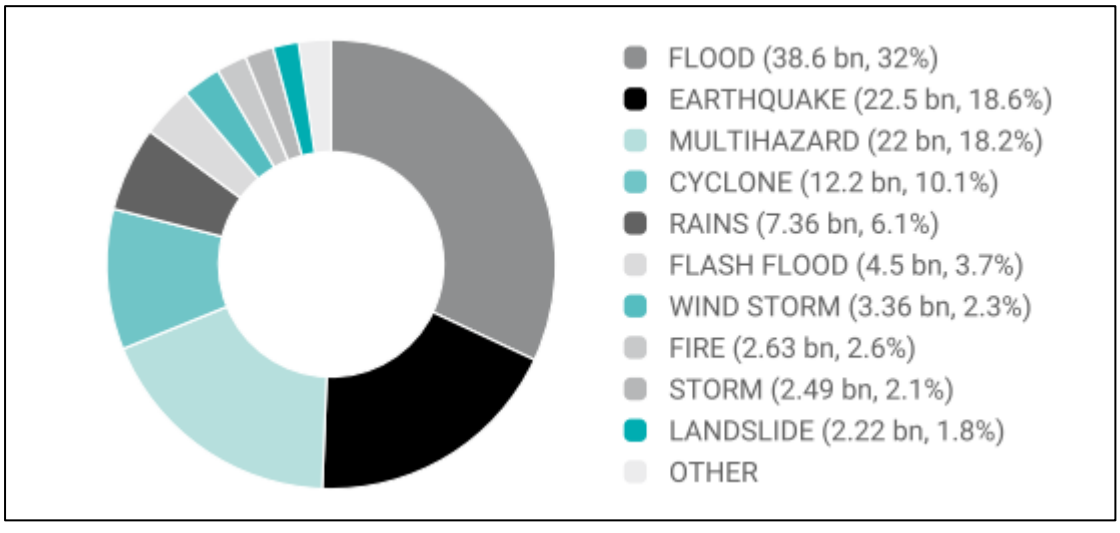

Figure 3: Losses (constant 2010 US $) between 2005–2015 in Housing sector in 83 countries by hazard

Source: UNDRR (2019a)

Disaster losses have revealed severe inequalities between high and low-income countries, as the low-income countries endure the highest relative cost of disasters (UNDRR, 2019a). The increasing impacts of disasters are also a tell-tale sign of the changing climate (GCA, 2019; Gifford et al., 2018; Thayaparan et al., 2014), since climate change is not directly discernible without disasters (GCA, 2019; Whitmarsh, 2008). It can, therefore, be argued that disasters have played a big role in bringing climate change to the attention of the general public (Shaw et al., 2015). UN-HABITAT (2016) estimates that 87% of disasters in 2014 were climate related.

Besides, projections show that climate change could increase the frequency and severity of extreme weather events and disasters, which are likely to affect developing countries more than the developed countries (Brown et al., 2018; Collins et al., 2013; Ray-Bennett, 2018). Even though the number of extreme events is unlikely to exceed that of the developed countries, vulnerabilities in the developing countries could lead to higher impacts (Jha et al., 2012; UN-HABITAT, 2016). There are also likely to be differential impacts in developing countries as well. Urban dwellers in informal settlements and other risk-prone locations often suffer more damage and loss as a result of climate-related disaster events (Brown et al., 2018; Houston et al., 2011). In the case of flood events, there is a direct relationship between losses and informality, poverty and human vulnerability (Amoako & Inkoom, 2017). It is thus pertinent to discuss the underlying social, economic, political, physical and cultural factors that make informal settlements relatively prone to natural hazard-based disasters.

2.3 Informal Settlements

According to Wisner et al. (2004) and Oliver-Smith et al. (2016), people's vulnerabilities are rooted in social processes. These social processes are often very remote from the hazard events themselves and influence the extent and severity of the impacts of the hazards. Tellingly, the vulnerability of cities to climate-related risks and disasters is a product of urbanisation patterns, economic development, physical exposure, urban planning and disaster preparedness (Tasantab, 2019; UN-HABITAT, 2016; Williams et al., 2019). Other inherent factors, such as age, gender, race, income and location, contribute to the vulnerabilities of groups and individuals (Gran Castro & Ramos De Robles, 2019; UN-HABITAT, 2016). UN-HABITAT (2016) estimates that four out of every ten temporary houses in developing countries (especially in slums and informal settlements) are situated in areas prone to floods, landslides and other nature-induced disasters.

Thus, people's vulnerability and exposure to flood hazards, risks and disasters stems from the unsafe locations they inhabit (Amoako, 2017; Twum & Abubakari, 2019). They are also vulnerable because of the inadequacy of essential services and infrastructure, social inequality, poverty and inadequate social security systems (Amaratunga et al., 2018; Schaer, 2015). Geographically, they are usually located along railway lines, streams, in waterlogged areas, along refuse dumps, steep slopes, and at the centre or periphery of cities (Sakijege et al., 2012; Tshikotshi, 2009). Complex urbanisation, economic and social issues push these people into these risk prone locations (Okyere et al., 2018; Panda & Amaratunga, 2019; UN-HABITAT, 2016).

An "informal settlement" is an urban settlement that transgresses the formal codes of the state in terms of land tenure, urban planning and land use and building construction (Dovey, 2015; Satterthwaite et al., 2020). One of the most defining characteristics of these settlements is that inhabitants have no security of tenure to the land they occupy (UN-HABITAT, 2015b). The settlements may have other characteristics, such as lack of durable housing, inadequate living area or congestion, inadequate access to improved water, inadequate access to sanitation and derelict appearance (Satterthwaite et al., 2020; Thorn et al., 2015). The housing may not comply with current planning and building regulations and is often situated in geographically and environmentally hazardous locations and it is often the most at risk from flood hazards and other extreme natural hazard events (Archer, 2016; UN-HABITAT, 2015b). Informal settlements and slums are not the same. While informal settlements contravene existing laws and regulations, slums do not, but are characterised by poor housing quality, inadequate urban services and overcrowding (Satterthwaite et al., 2020).

In Ghana, the majority of settlements classified as informal settlements will most likely be contravening regulations regarding building construction and land use planning (UN-HABITAT & AMA, 2011). Research asserts that the development of informal settlements in Ghana is being driven by factors such as poverty, rapid population growth, rural-urban migration and weak institutions and governance structures (Gaisie et al., 2018). Migration may be the biggest factor in the growth of the informal settlements (Okyere et al., 2018). Gaisie et al. (2018) also report that informal settlements in Kumasi Ghana are densely populated due to new migrants into the city preferring to first settle closer to their relatives. According to Amoako (2017), some of these migrants are compelled to live in hazard-prone locations due to their cheap accommodation. Okyere et al. (2018) further argue that "rising land prices, a decline in the access to land, and a lack of access to housing finance" have pushed many low-income

earners into informal settlements. Informal settlements in Ghana have characteristics similar to other informal settlements in Africa. Most of the housing is derelict and overcrowded. The streets are narrow and may be non-existent at some places. There is lack of or inadequate supply of potable water. Electricity is unreliable and expensive; most people may illegally connect to the grid or obtain it from their neighbours who have illegally connected to the grid. They are most often located at hazard-prone locations, either at the periphery or centre of the city (Abunyewah et al., 2018; Amoako, 2015; COHRE, 2004; Okyere et al., 2018). These conditions of vulnerability are compounded by their reduced or lack of adaptive capacity, insecure land tenure and marginalisation (Amoako, 2015; COHRE, 2004).

While natural hazards play a role in disaster risks, the deaths and damages often result from human acts of omission and commission (Chmutina & von Meding, 2019; World Bank & United Nations, 2010a). Due to the projected extreme climatic events, it is crucial to establish modalities for preventing disasters or improving disaster risk reduction (Oliver-Smith et al., 2016). This will require measures that reduce exposure and vulnerability in the informal settlements (World Bank & United Nations, 2010a). Informal settlements could become resilient if city governments initiate measures to reduce their risk at the household or individual property level, neighbourhood level or settlement level (Satterthwaite et al., 2020). However, Satterthwaite et al. (2020) contend that some urban governments hold a hostile attitude towards informal settlements and either ignore them or harass their residents with evictions.

2.4 Concepts of Vulnerability and Resilience

In the preceding sections, the concepts of hazards, risks and disasters were discussed. In these discussions, it was emphasised that disaster risk is created by the interaction of hazards, vulnerability and capacity. In this section, the concept of vulnerability and its related concept, resilience, will be explained. The purpose is to provide a brief overview of the concepts and note the important differences. It is the understanding of this researcher that vulnerability and resilience are inherent properties of a system (Ran et al., 2020) and could co-exist in the same populations (Manyena, 2006).

2.4.1 The Concept of Vulnerability

Vulnerability refers the physical, social, economic and environmental conditions that expose people and groups to harm and limit their ability to anticipate, cope with, and recover from harm (UNDRR, 2017; Wisner, 2016). Others suggest that vulnerability is the interplay of exposure, sensitivity and adaptive capacity (Adzawla et al., 2020; Palliyaguru et al., 2014). The

disaster Pressure and Release (PAR) model conceptualised the above-stated characteristics as root causes, dynamic pressures and unsafe conditions that make people vulnerable (Wisner et al., 2004). Vulnerability is also seen as the potential for loss (Zhou et al., 2010) or the degree to which a system is likely to suffer harm due to exposure to a hazard (Turner et al., 2003).

Lei et al. (2014) posit that vulnerability focuses on the situation before a disaster. This agrees with Cutter et al. (2008)'s assertion that vulnerability is the pre-event condition or characteristic of a social system that produces the potential for harm. In other words, vulnerability is a risk factor (Combaz, 2014), as was clearly elucidated in the discussion of risk.

The notion of vulnerability is that a person or thing has the propensity to be injured or wounded (Luna, 2018). Vulnerability is, therefore, fundamental to the understanding of urban flood risk and its reduction (Gibb, 2018). In particular, social vulnerability takes into consideration who is at risk and the degree to which they can be harmed (Birkholz, 2014). That makes vulnerability a context-specific characteristic (Adzawla et al., 2020), an indication that some people or populations in certain geographical locations may be more vulnerable than others (Ran et al., 2020). The conditions are constantly in flux due to changes in geophysical and social processes (Smith, 2013). The social framing of vulnerability postulates that economic, social and political influences create disaster risk (Gibb, 2018). Reducing urban flood risk, therefore, requires a decrease in vulnerability and increase in resilience through the improvement of social conditions (Gibb, 2018).

However, some scholars argue that the concept of vulnerability is a negative orientation of society's ability to cope or adapt to risk (Few, 2006; Smith, 2013). Few (2006, p21) argues that a "focus on vulnerability may run the risk of labelling, alienating and disempowering those it describes".

2.4.2 The Concept of Resilience

Resilience is the ability that a community or society has to survive, cope with, resist, absorb, accommodate, transform, adapt to and recover from a hazard event in an efficient and timely manner with minimum impact and damage (Cutter et al., 2008; UNDRR, 2017). This definition incorporates the capacity to reduce or avoid losses, contain the impacts of disasters, and recover with minimal social disruptions (Manyena, 2006; Panda & Amaratunga, 2019).

Unlike vulnerability, which deals with people's inability to prevent harm to themselves, resilience suggests that people have abilities and capacities that enable them to cope with, adapt to or recover from hazard events (Smith, 2013). That, however, is not an admission that

resilience and vulnerability are opposites. While definitions alone may point to the oppositeness of the concepts, Smith (2013) and Manyena (2006) posit they are not opposites. According to (Manyena, 2006), some communities have built certain levels of resilience over many years of dealing with hazards, although they are dwelling in conditions of vulnerability. This research, therefore, emphasises resilience to flooding risk, since it shifts the focus of risk reduction from top-down measures to more collective bottom-up approaches (Lamond et al., 2013).

Resilience is a more positive and proactive expression of community disposition toward natural hazards (Cutter et al., 2008). Focusing on resilience can enhance actions to reduce disaster risk, since it advocates for holistic attention to hazards, exposure, risk, vulnerability and capacity (Combaz, 2014). The concept of resilience also offers hope for dealing with uncertainty and future changes, and enabling factors to create proactive responses (O'Brien et al., 2012).

Zobel and Baghersad (2020) contend that any discussion of resilience must identify the specific system that is resilient, how the system is resilient and what it is resilient to, and how the resilience is exhibited. There are various dimensions of resilience, such as technical, organisational, social and economic, making such a clarification relevant.

Social resilience is more relevant to this research, as it emphasises the capacity of individuals, households and communities or groups to recover from disaster events (Zobel & Baghersad, 2020). This resilience is influenced by the availability of infrastructure and physical assets and community cohesion (Jones & d'Errico, 2019).

Consequently, the rest of this literature review shall discuss how urban communities can respond to flood risk and the factors that influence their adaptation. According to (Birkholz, 2014), the need for urban communities to respond to and resist flood risk calls for efforts to understand the factors that influence people's motivation and capacity to adapt to flood risk.

2.5 Reducing Flood Disaster Risk

This section elaborates on disaster risk management (DRM) and disaster risk reduction (DRR). These concepts are relevant to the current research, since DRM and DRR strategies foster adaptation.

2.5.1 Disaster Risk Management

According to UNDRR (2017), disaster risk management is the application of disaster risk reduction strategies and policies to reduce current disaster risk, stop new disaster risk and manage residual risk, contributing to the reduction of disaster losses and strengthening of resilience. Disaster risk management strategies may be prospective, corrective or compensatory (UNDRR, 2017; UNISDR, 2015). Prospective disaster risk management actions are designed to avoid new or increased disaster risks. Thus, their focus is on disaster risk that may occur in future if appropriate disaster risk reduction strategies are not initiated. Conversely, corrective disaster risk management seeks to eradicate or lessen existing disaster risk. Also, compensatory disaster risk management seeks to strengthen the economic and social resilience of individuals and societies due to the existence of residual risks that cannot be effectively reduced. Strategies to reduce disaster risk may also be mitigation or preparedness (Onwuemele, 2012).

Disaster risk management has evolved over many years from what was initially civil defence and crisis management in the mid-1930s and early 1940s (UNISDR, 2015). The legislation, policies and administrative arrangements that were enacted to protect the public later influenced disaster risk management. Disaster risk management standards and norms also emerged from such areas as public health, environment, planning and building. However, during the 1970s, scholars began to argue for a broader approach that includes not only emergency management but also actions to reduce disaster risk, and ensure post-disaster recovery and reconstruction (Scolobig et al., 2015; UNISDR, 2015). These academic discourses led to the emergence of the disaster management cycle, which captured risk reduction, preparedness, response and recovery activities in a cyclical process. Further progress was made over a number of years, leading to the Hyogo Framework for Action that put disaster risk management on the agenda for governments globally and locally (UNISDR, 2015).

The Sendai Framework underscores the necessity of disaster risk management as opposed to disaster management. It is also believed that effective disaster risk management stimulates sustainable development (Dias et al., 2017; UN, 2015; UNISDR, 2015). Due to the benefits of DRM, the global assessment report noted that several countries had either formulated new policies or updated existing ones following target E of the Sendai Framework (UNDRR, 2019a). DRM also has financial benefits, as UNISDR (2015) estimates that a US$6 billion annual investment in appropriate disaster risk management strategies could result in benefits of US$360 billion in risk reduction.

Disaster risk management policies may target both national and local disaster risk reduction, as the Sendai Framework target E recognises the need for national and local disaster risk reduction strategies (UNDRR, 2017). Disaster risk management involves many actors, including international organisations, NGOs, national governments, local governments, businesses, communities and individuals (Ray-Bennett, 2018; UNISDR, 2015).

There is a recognition that some countries may need to enhance their capacity and capability to design and implement disaster risk management policies and plans at both the national and local level (Scott & Few, 2016; UNDRR, 2019b). It is also understood that disaster risk may not be reduced unless DRM policies and plans create the enabling environment to reduce vulnerabilities and exposure to natural hazards (Vink & Takeuchi, 2013). DRM capacity building aims to strengthen and sustain the capacity of societies, individuals and organisations to reduce disaster risk (Scott & Few, 2016). For this reason, community-based disaster risk management (CBDRM) is crucial. CBDRM engages affected communities in the management of disaster risk at the local level. That includes involving the communities in the assessment of hazards, vulnerabilities and capacities. It also promotes the involvement of the community in planning, implementation, monitoring and evaluation of disaster risk reduction actions at the local level (UNDRR, 2017).

The need for local-level disaster risk reduction actions also calls for the approach of DRM to shift from overly top-down to people-centred (Scolobig et al., 2015). A people-centred, bottom-up approach to DRM may enable sharing of responsibility for disaster risk reduction between the public and the government (Garschagen, 2016; Scolobig et al., 2015; UNDRR, 2019a).

Following the explication of disaster risk management, the next sub-section shall briefly explain disaster risk reduction. Subsequent subsections shall also discuss disaster risk mitigation and preparedness, since they have been identified as the main disaster risk reduction approaches.

2.5.2 Disaster Risk Reduction (DRR)

As the policy objective of disaster risk management (UNDRR, 2017), disaster risk reduction aims to reduce disaster risk through the systematic analysis and management of the factors causing disasters, including the reduction of exposure to hazards, reduction of the vulnerabilities of people and property, wise land and environment management, and improved preparedness for adverse events (Thayaparan et al., 2015; UN-HABITAT, 2015a). It seeks to prevent new, and reduce existing, disaster risk while also managing residual risk (UNDRR, 2017). DRR can, therefore, strengthen resilience and lead to the achievement of sustainable

development (UN, 2015; UNISDR, 2015). Consequently, goal 13 of the Sustainable Development Goals seeks to strengthen resilience and adaptive capacity to climate-related hazards, and natural hazard induced disasters (Hoffmann & Muttarak, 2017).

According to Twigg (2004), DRR approaches, such as mitigation and preparedness, can help to minimise vulnerabilities and disaster risk. Consequently, the next two subsections will discuss disaster risk mitigation and preparedness with an emphasis on flood risk reduction at the local level.

2.5.2.1 Disaster Risk Mitigation

Mitigation (of disaster risk and disaster) is the reduction of the probable adversarial impacts of hazards through measures that lessen hazards, exposure, and vulnerability (UN-HABITAT, 2015a). This definition of disaster risk mitigation suggests that it is a future-oriented reduction of disaster risk. Mitigation can, therefore, be seen as the embodiment of prospective disaster risk management policies and plans. Mitigation is a recognition that disaster risk cannot be entirely prevented; however, its severity can be significantly reduced with various actions and strategies (UNDRR, 2017). Disaster mitigation reduces the financial impact of disasters on the population, creates safer communities, minimises post-disaster disruptions and enables individuals to recover quickly (FEMA, 2020).

According to Jung and Lee (2013), hazard mitigation is proactive, and actions are taken in advance to reduce or eliminate the long-term risk to human life and property from natural hazards, in contrast to reactive, crisis-oriented action that only takes effect after disaster strikes. Mitigation measures can be structural, including engineering techniques and hazard-resistant construction (such as flood defences or safe building design)) or non-structural, such as improved social and environmental policies, training, land use planning and public awareness (Twigg, 2004; UNDRR, 2017).

According to FEMA (2020), the goal of mitigation is to reduce the loss of life and property by reducing the impacts of disasters. Therefore, mitigation action needs to be taken before disaster occurs. Some mitigation actions are designed to assist individuals and communities in preparing, surviving or recovering from floods (Kierce et al., 2002; Poussin et al., 2015). Often, mitigation on a large scale needs public funding (Kierce et al., 2002). Disaster risk mitigation actions also require an understanding of local risk and investment in long-term community welfare, including existing structures and future construction before and post-disaster (FEMA, 2020). Flood mitigation, in particular, is approached in three ways: flood modification, property modification and response modification (Kierce et al., 2002).

- Flood modification seeks to avoid loss by keeping floodwater away from developments. Existing risks are the main focus, as such mitigation is provided by structural measures. For example, construction of embankments, dykes, levees and retention dams).

- Conversely, property modification measures avoid or lessen losses from flooding by keeping developments away from floodwater. That is achieved through land-use planning, building design, appropriate siting and flood-resistant construction materials.

- Also, response modification approaches seek to modify people's responses to flooding. It thus uses approaches such as providing flood risk information and education programmes, preparedness (planning for emergency), forecasts and warning systems and national emergency response strategies (Kierce et al., 2002).

Most government-agency-led mitigation actions are mainly structural, top-down and may require colossal financial resources (Bird et al., 2013; Few, 2003). Despite their potential to reduce the impacts of flood hazards, they have been criticised for their top-down approach. Also, it has been argued that structural top-down mitigation measures are insufficient to adequately protect or buffer populations from extremes that society is predicted to face (Hoffmann & Muttarak, 2017; Nelson et al., 2007). Furthermore, traditional flood mitigation measures founded on a stable climate are no longer able to ensure a safe future for the vulnerable due to the changing climate (Wilby & Keenan, 2012). Traditional mitigation measures, such as embankments, levees and dykes, may also make communities complacent, harm ecosystems and reduce long-term resilience (Liao, 2012). Besides, a combination of structural and non-structural flood mitigation measures is more advantageous than structural or non-structural measures alone (Consoer & Milman, 2017).

It is estimated that every US$1 invested by homeowners and local communities in hazard mitigation that exceeds standard building codes could save the country US$4 in future disaster costs (FEMA, 2020). People exposed to floods have, therefore, been encouraged to take measures that reduce the consequences of the hazard events (Porter et al., 2014; UNECE, 2003). That has led to research investigating the factors that motivate individuals or households to take mitigation measures to reduce the adverse impacts of flooding on their lives and property (Babcicky & Seebauer, 2019; Botzen et al., 2019; Poussin et al., 2014; Weyrich et al., 2020). It is understood that flood mitigation by individuals is influenced by socio-economic (income, age, gender, tenancy status, etc.) behavioural (perceptions and cultural worldviews

and physical factors (presence of structural measures such as embankments, dykes, and levees) (Abbas et al., 2018).

2.5.2.2 Disaster Preparedness

Individual disaster preparedness is crucial for proper response to natural hazards (Hoffmann & Muttarak, 2017). In low and middle-income countries, households' precautionary measures are particularly critical to save lives and avoid property loss, as governments may not have the adequate capacity to ensure effective disaster risk management (Hoffmann & Muttarak, 2017; Nojang & Jensen, 2020).

Disaster preparedness may be defined as the measures that ensure that crucial resources for effective response are available before a disaster occurs (Najafi et al., 2017). It has been said that when people are prepared for disasters, they suffer adverse impacts less (Onuma et al., 2017). Onuma et al. (2017) believe that disaster (flood) preparedness involves two approaches: buying insurance and stockpiling emergency supplies (such as water, food, a radio, energy sources and medicine). Najafi et al. (2017) also add "preparing a household emergency plan, preparing an emergency kit, and other activities that reduce risk or injury and damage" as part of disaster preparedness actions.

According to Rañeses et al. (2018), disaster preparedness in New Zealand is approached using the 4Rs (reduction, readiness, response and recovery).

- With the reduction approach, measures are taken to analyse and reduce long-term risks to lives and properties, eliminate risks if possible, and reduce the severity of hazard impacts and the likelihood of disaster occurrence.
- Conversely, readiness entails putting in place operational systems and capabilities before a disaster occurs, including self-help and response programmes for the public, lifeline utilities and other agencies.
- Response actions are taken before, during and after disaster events to save lives and properties, and to aid community recovery.
- Also, recovery seeks to bring about immediate, medium and long-term restoration of the community after a disaster (Rañeses et al., 2018).

Kienzler et al. (2015) also suggest that disaster preparedness involves activities to avoid or reduce loss from flood disasters. These activities include:

- Information and behavioural actions, such as obtaining information about flood risk and protection, and participation in networks.

- Flood-proofing and retrofitting of building structures, adapting the usage of buildings, and purchasing water barriers, among others; and
- Undertaking risk precautions, such as buying flood insurance.

It is evident from the above classifications that disaster preparedness is the responsibility of all stakeholders, including the government (government agencies), local government, communities and individuals. Najafi et al. (2017) believe that disaster preparedness is a behavioural approach, and efforts geared towards health behaviour change may be necessary to encourage people to take up the practice. They further contend that factors that affect disaster preparedness include risk awareness, risk perception, self-efficacy perception, collective efficacy, fatalism, anxiety, previous disaster experience, societal norms, perceived responsibility, social trust, and available resources. Others have raised the possibility of risk communication influencing disaster preparedness (Abunyewah et al., 2019, 2020; Maidl & Buchecker, 2015).

The discussions of disaster risk mitigation and preparedness have revealed that both approaches to disaster risk reduction can be undertaken by individual community members or households and governments (both national and local). Nevertheless, the focus of this study is property-level mitigation and preparedness measures by individuals and households. Despite the importance of property-level mitigation and preparedness in reducing and avoiding the harmful impacts of flood disasters, research has revealed that some households and individuals do not undertake them (Ayeb-Karlsson et al., 2019; Babcicky & Seebauer, 2019; Botzen et al., 2019). These individuals resort to reactive actions to survive flood disasters (Mensah & Ahadzie, 2020). The next sections will discuss these individual reactive actions, collectively called coping actions, and contrast them with proactive mitigation and preparedness actions called adaptation measures.

2.6. Household-Level Response to Flood Risk

The discussions in the preceding section revealed that individual property-level actions (mitigation and preparedness) to reduce flood disaster risk or avoid loss and harmful impacts may be structural or non-structural, and may be initiated before, during or after disaster events. In this section, it will be revealed that actions that are taken proactively, that is, in anticipation of flood disaster events, are more beneficial than reactionary actions taken amid flood disaster events for survival. These actions are broadly categorised as coping measures and adaptation measures. Emphasis on coping and adaptation to flooding risk has become necessary because

the financial cost of government-initiated structural measures makes widespread coverage impossible in flood-prone developing countries (Few, 2003).

2.6.1 Coping with Flood Risk

Coping strategies are reactive and short term measures to deal with immediate risk, survive a hazard event or react to the already existing floods (Hooli, 2016; Lavell et al., 2012; Wamsler & Brink, 2014). They involve approaches that seek to protect against, accommodate and retreat from flood risk. They are bottom-up, privately implemented and depend on the in-built capacities of communities and households to be successful (Few, 2003; Twum & Abubakari, 2019). Coping and adaptation converge when responses made to reduce the impact of current risks simultaneously reduce the impacts of future events (Reser & Swim, 2011).

The purpose of coping strategies is to avoid loss of lives and/or properties during floods (Bird et al., 2013; Hooli, 2016). Coping with hazards repeatedly can build repositories of knowledge about dealing with floods (Amoako, 2017). These memories and past experiences are central in communities' coping processes (Hooli, 2016; Islam et al., 2018).

Studies into coping strategies in Ghana have revealed that the usual coping measures include elevation of land abutting buildings, construction of gutters to channel water away from buildings, placing sandbags and bags of stones in flooded areas, placing valuables on shelves, a temporary refuge with neighbours and transfer of valuables to neighbours (Danso & Addo, 2017; Mensah & Ahadzie, 2020; Twum & Abubakari, 2019). The above corroborate the findings of Amoako and Inkoom (2017) on grassroots resilience and flood responses in informal settlements. In broad terms, these measures can be categorised into: measures *within the house, modifications to the house structure, modifications around the house and improvements at the neighbourhood level* (Douglas et al., 2008). Coping measures are most often low-resources strategies (Koerth, Jones, et al., 2013). This suggests that coping measures require fewer resources for their execution compared to adaptation strategies, which may be resource-intensive, especially mitigation actions. The following table differentiates coping and adaptation (Table 3).

Table 3: Differences between Coping and Adaptation

Dimension	Coping	Adaptation
Exigency	Survival in the face of immediate, remarkably significant threats, when resources, which may have been limited, to begin with, are overstretched.	Changes focus in response to recent past or expected future change, typically without particular reference to resource limits.
Constraint	Survival is the principal concern, and actions are delimited by existing knowledge, experience, and resources.	Adjustment is the emphasis, and approaches are inhibited less by current restrictions than by expectations regarding future resource availability and trends.
Reactivity	Decisions are primarily tactical and made to protect basic welfare and provide for basic human security after an event has occurred.	Decisions are strategic and concentrated on anticipating change and addressing this proactively, even if stimulated by current events seen as indications of further change.
Orientation	Emphasis is on preceding events that influence present circumstances and limitations; by extension, it places focus on hitherto successful tactics.	Attention on future conditions and approaches; past strategies are relevant if they might enable adjustment. However, some experts think that past and future orientation can overlap and blend.

Source: (Lavell et al., 2012)

There are differences between coping and adaptation, as seen in Table 3. Nevertheless, a great deal of literature (Fenton et al., 2017; Jabeen et al., 2009; Limthongsakul et al., 2017; Thorn et al., 2015; Wamsler & Brink, 2014) on individual responses to flooding risk has used the terms interchangeably. However, it is crucial to ensure conceptual differentiation between the two terms, as the focus of the strategies is different. Islam et al. (2018) contend that making a conceptual differentiation between coping and adaptation is vital for flood risk management. In consonance with the views of Islam et al. (2018), Lavell et al. (2012) and others, it is now reaffirmed that coping and adaptation are different, conceptually and practically.

Despite the importance of coping mechanisms in reducing the impacts of flood hazards, they may reduce coping capacity when repeatedly used without adequate time and provisions for recovery (Lavell et al., 2012). Households are also unable to build long-term adaptive capacity and are, therefore, reliant on reactive coping practices (Porter et al., 2014). Thus, rather than

enhance adaptation, communities forced to cope may become increasingly vulnerable to flood hazards. Also, climate change makes conventional and traditional knowledge for coping either obsolete or no longer suitable (Lavell et al., 2012; Wamsler & Brink, 2014). Coping responses may also be expensive over the long term (Porter et al., 2014), as they use up limited resources to achieve temporary gains (Islam et al., 2018).

Furthermore, successful coping practices only reveal the capacity of households to deal with immediate threats without disclosing their long-term capacity (Schaer, 2015). Thus, when people manage to survive a flood disaster, the trauma experienced remains a reminder that they will have to adopt similar measures in future (Islam et al., 2018). That underscores the need to promote a long-term perspective when addressing disasters (Schaer, 2015).

According to Islam et al. (2018), people resort to coping measures because they lack the resources and capacity to undertake long-term measures. They also suggest that local people may know what to do to prepare for flooding but are not empowered to do so. Lack of resources, therefore, restricts people's ability to use their local knowledge for adaptation. Despite their arguments, other factors may be influencing people's decision to cope or adapt. The current research will identify such factors. Besides, not all prospective and corrective flood risk reduction measures are resource intensive.

Coping can enhance long term disaster risk reduction by informing locally appropriate adaptation strategies (Adelekan et al., 2015). This results from learning and innovating from the failures and successes of coping measures to help communities implement better strategies for flood risk reduction (Cutter et al., 2008). The local knowledge used in coping can also be crucial to flood risk adaptation (Islam et al., 2018). Experiences from coping are, therefore, valuable to help move communities beyond reactive to proactive strategies (Osberghaus, 2017). Hence, there is an urgent need for communities and households to improve on and innovate using existing responses to flood risk in order to be able to adapt to future risks (Amoako, 2017).

2.6.2. Adaptation to Flood Risk

Flood risk adaptation begins at the household level (Porter et al., 2014). Households can either make decisions that enable them to adapt or suffer the consequences of others' maladaptive actions (Porter et al., 2014).

In the climate change literature, adaptation is defined as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates the

harm or exploits beneficial opportunities (UNISDR, 2009). By extension, flood risk adaptation comprises the strategies used by individuals or households at the property level or community level to respond to existing or expected flooding risk that moderates harm or exploits beneficial opportunities. Flood risk adaptation can be seen as the policy objective of prospective and corrective flood risk management. It also refers both to the process and the condition of being adapted (Smit et al., 2001).

In this study, adaptation is viewed as a process that leads to resilience (Manyena, 2006). Manyena (2006) suggests that viewing adaptation as a process emphasises the role of people in disasters. Adaptation in communities can be influenced by local knowledge of locally appropriate solutions to hazards, and this local knowledge may be derived from coping with previous extreme events (Archer, 2016; Islam et al., 2018). Adaptation as a process signifies how people learn and innovate on improved and proactive ways of dealing with hazards (Amoako, 2017). Flood experience is a major explanatory factor in adaptation behaviour (Koerth, Vafeidis, et al., 2013). It influences how people perceive and respond to future risks (Zaalberg et al., 2009). Communities that can use their experiences to evolve and improve adaptive actions are considered to have high adaptability or capacity to adapt (Folke et al., 2010). Adaptability shows the capacity of a community to learn and to combine experience and knowledge to adjust its responses to risks (Folke et al., 2010).

Adaptation focuses on the future (Lavell et al., 2012) and occurs in the post-disaster phase (Manyena, 2006). According to (Smit et al., 2000), adaptation has become necessary because adaptations of various kinds can modify climate change-induced flood impacts and their severity. Secondly, adaptation is an essential strategy in response to concerns of increased flood risk under climate change. Also, adapting to flood risks develops strong resilience in vulnerable communities (Chatterjee, 2010; Mertz et al., 2009). Adaptation has several aspects, including the social, psychological and cultural (Wolf, 2011). Both individual and household mitigation and preparedness strategies are essential in flood risk adaptation.

2.6.2.1 Types of Adaptations

Adaptations vary based on where they occur, who undertakes them, the climatic stimuli that prompt them, the timing of the adaptation, and their functions, forms and effects (Fenton et al., 2017; Smit et al., 2001). Adaptations may lead communities to retreat from hazards, accommodate hazards, or protect against hazards (Fenton et al., 2017).

Retreat strategies may include withdrawal, abandonment or relocation from exposed locations (Bird et al., 2013; Fenton et al., 2017). These may apply to infrastructure, structures, future

developments, and families (Bird et al., 2013). Accommodation, on the other hand, enables continuous occupation of vulnerable locations (Fenton et al., 2017). Accommodation strategies may involve education and awareness, temporary evacuation plans, hazard zone mapping, minor construction alterations to houses and infrastructure, community self-reliance, new technologies and new forms of social communication (Bird et al., 2013). Protection strategies, such as dams, levees, and significant drainage works, are usually initiated by the government to protect communities because of their high financial outlays (Bird et al., 2013). Emphasis in this study is placed on individual (rather than government-led) adaptation strategies, and as such more attention is given to retreat and accommodation strategies.

Adaptation can also be distinguished by whether it provides an enabling environment for subsequent adaptive measures or implements measures to manage flood risk (Wilby & Keenan, 2012). The enabling environment for adaptation is usually undertaken by government agencies and is top-down. That includes the dissemination of risk information and institutional structures for response before, during and after floods (Bird et al., 2013; Wilby & Keenan, 2012).

It is pertinent to note that unplanned and uncoordinated adaptations at the community level may lead to maladaptation (Adger et al., 2003; Schaer, 2015). Maladaptation occurs when implemented adaptation options inadvertently increase the vulnerability of individuals (Klein et al., 2014). Maladaptation has the potential to increase vulnerabilities in the same or adjoining locations (Smit et al., 2001).

2.6.2.2 Adaptive Capacity

Adaptive capacity determines the degree to which adaptation can be pursued in a community (Lavell et al., 2012). Capacity illustrates all the strengths, attributes and resources available in a community or society that can be used to achieve stated goals (UNISDR, 2009).

Adaptive capacity, therefore, refers to the capacity to adjust to change, moderate the effects, and cope with disturbance (Cutter et al., 2008). This capacity influences the vulnerability of communities to climatic hazards. Every household or community has in-built capacities that enable them to undertake actions to remediate flood risk and avoid loss (Satterthwaite et al., 2007). These capacities can be determined by socio-economic variables, such as wealth, employment, livelihood diversity, housing condition, durable assets, insurance coverage, education, preparedness measures, skills and experiences, knowledge, knowledge sharing, social organisations and social support networks (Amoako, 2017; Nhuan et al., 2016).

Adaptive capacity reflects changing economic, social, political and institutional conditions over time (Smit & Wandel, 2006). It can, therefore, be enhanced or depleted. The access model shows that major threats, such as hazard events, can deplete the ability of households to meet their needs, recover from hazards or protect themselves from other hazards (Wisner et al., 2004).

Adaptive capacity enables long-term sustained adjustments in anticipation of extreme hazard events (Lavell et al., 2012). It can be improved by learning from past and current adjustments (López-Marrero, 2010). This learning process can help to innovate and improve methods of dealing with extreme events (Osberghaus, 2017). It also has the potential to reduce the likelihood of maladaptation. Learning offers the opportunity for communities and individuals to change their knowledge, skills or attitudes and thus improve on their ways of responding to risks (de Kraker, 2017). Also, incremental learning from previous experiences with hazards shapes people's responses to hazards over time (Amoako, 2017).

Cognitive factors are the other important determinants of the adaptive capacity of communities (Koerth, Vafeidis, et al., 2013; López-Marrero, 2010). Indeed, cognitive factors play an essential role in stimulating adaptation (Zheng & Dallimer, 2016). Literature suggests that when people are equipped with information about risks they will face their adaptive capacities are enhanced; it often motivates them to implement adaptive responses (Bradford et al., 2012; Raaijmakers et al., 2008; Zheng & Dallimer, 2016). It is understood that insights into the subjective and cognitive drivers of adaptation will strengthen adaptation behaviour (Zheng & Dallimer, 2016).

Grothmann and Patt (2005), citing Risbey et al. (1999), suggest that the adaptation process involves four stages:

- Signal detection, where what is to be adapted to is decided;
- Appraisal, where the risk is appraised;
- Decision and response, which results in an observable change in the behaviour and performance of the individual; and
- Feedback, which involves monitoring of the outcomes of the decisions.

The preceding sections have discussed hazards, risks and disasters; vulnerability and resilience to these hazards and risks; and disaster risk management that provides the policies and plans to guide disaster risk reduction. It was also noted that an individual response to disaster risk could encompass both mitigation and preparedness. Depending on the focus, long-term potential and

spontaneity of the mitigation measures, they could be classified either as coping or adaptation. Based on these discussions, the next section will explicate the theories and models that explain what factors to consider to encourage people to adapt to, instead of cope with, flooding risks.

2.7 Risk Perception and Flood Risk Adaptation

As emphasised in Chapter 1, individuals, households, and vulnerable communities are already taking coping actions during and after floods to reduce their impacts (Amoako, 2017; Wamsler & Brink, 2014). However, section 2.6.1 makes it clear that these measures may become obsolete due to climate change (Lavell et al., 2012) and the fact that they do not help to build long-term resilience (Porter et al., 2014; Tasantab et al., 2018). With this knowledge in the foreground, the current section explores the theoretical frameworks that postulate how to encourage and sustain protective behaviour (adaptation to flood risk).

According to Rana et al. (2020), risk perception predicts the willingness of exposed people and communities to protect themselves and reduce or avoid disaster risks. It involves people's judgements about limited and uncertain information (Messner & Meyer, 2006). It also encompasses their awareness, emotions and behaviour towards hazards (Kellens et al., 2011). The whole process entails collecting, evaluating and interpreting signals about the probable impacts of hazard events (Fuchs et al., 2017). It can, therefore, be used to predict public acceptance or opposition to flood risk adaptation (Kortenkamp & Moore, 2011; Rana et al., 2020).

While scientific assessment of risk is objective, risk perception is subjective (Kammerbauer & Minnery, 2019; Kellens et al., 2011; Wang et al., 2011). It may involve both emotions and cognition (Kortenkamp & Moore, 2011). According to Kellens et al. (2011), this subjective assessment of risk has currently gained prominence in flood risk management. It is believed that subjective judgements hold the key to understanding what influences people's choices and response to risks (Birkholz, 2014). Global goals, such as the Sustainable Development Goals, the New Urban Agenda and the Sendai Framework, all seek to create resilient societies. However, Rana et al. (2020) contend that it may be impossible to achieve such goals without an adequate understanding of people's risk perceptions.

Besides, individual and public risk perception is very complex and is much determined by situational and cognitive factors (Bradford et al., 2012; Fuchs et al., 2017). In the case of flood risk, situational factors reflect an individual's physical location relative to a flood-prone area and are, therefore, subject to characteristics of the hazard (Bradford et al., 2012; Fuchs et al.,

2017). Previous flood experience, and the socio-economic and demographic characteristics (age, gender, education level, income) of people at risk, are some of the situational factors influencing risk perception (Bradford et al., 2012). Cognitive factors, on the other hand, show the personal and psychological composition of the individual, and include emotional and behavioural traits that explain the specific emotions evoked by flooding and mediate how people act towards flooding (Bradford et al., 2012).

According to Elrick-Barr et al. (2017), the perception of risks, capability and responsibility are critical barometers of local action. The perception of capacity, in particular, galvanises local adaptation to climate-related risks. Therefore, risk perception is the main determinant of citizens' actions and a good source of information in determining individuals' behaviours towards hazards (Adomah Bempah & Olav Øyhus, 2017). There is an urgent need to understand the way the public perceives risk in the light of new scientific knowledge about climate extremes (Pidgeon, 2012).

Based on the recognition of the importance of risk perception in determining the motivation of individuals and groups to adopt adaptive behaviours, several theoretical frameworks have been propounded to explain the critical variables. Indeed, the literature has revealed that cognitive factors might even influence adaptive behaviour more than situational factors like socio-demographic characteristics (Koerth, Vafeidis, et al., 2013; López-Marrero, 2010).

It has also been emphasised that knowledge of the exposure of a population to flooding alone is not enough to address the risks. Such knowledge must be applied in conjunction with the risk perception of the people (Santoro et al., 2019). Since risk perception is context-specific and differs from one society or community to another (Santoro et al., 2019), information on risk perception can strengthen risk communication, and the provision of risk information encourages and sustains flood risk adaptation action (Abunyewah et al., 2019).

Perceived risks and perceived adaptive capacity influences people to act to reduce risks (Santoro et al., 2019). However, some of those decisions may be based on cognitive heuristics and biases, as the decision makers may not have all the information needed to make informed decisions (Burnett, 2015; Kuhn, 2007; Lockton, 2012). In the conceptual model developed for this research, the crucial role of household experiences has been highlighted. The formulated hypotheses (H1 to H6) specifically postulate how households' experiences (flood experience and coping experience) influence fear/worry regarding flooding risks, flood risk appraisal and adaptation appraisal. Flood risk appraisal and adaptation will be discussed in detail in section 2.8.

2.7.1 Cognitive Heuristics and Biases

Notwithstanding the principal role of risk perception in protective behaviour formation, it is "subject to cognitive limitations rising from a set of cognitive heuristics and biases" (Wang, 2016, p 25). Heuristics and biases originated in the 1970s from the seminal work of cognitive psychologists Daniel Kahneman and Amos Tversky (Carp & Shapira, 2018; Kuhn, 2007). The theory postulates that when individuals need to decide on risk but do not have all the information about the risk, a series of cognitive heuristics, or 'rules of thumb', provide reasonable and 'shortcut' strategies for making judgements or decisions (Burnett, 2015; Kuhn, 2007; Lockton, 2012).

In some situations, heuristics help decision makers to understand complicated and unclear information (Cossette, 2014; Osmani, 2016). However, it may be prone to inaccurate judgements and error because only incomplete information may be available when making the decision (Burnett, 2015; Wang, 2016). When these inaccurate judgements and decision errors are repeated unconsciously, they become biases (Osmani, 2016). Heuristics and biases arose from the observation that "human behaviour can be seen as decision-making, and so understanding and influencing those decision-making processes could be an important component in design for behaviour change" (Lockton, 2012, p 1).

Several types of cognitive biases and heuristics have been noted in the literature. These include:

- The availability heuristic, which postulates that people are most likely to make decisions based on events or occurrences that immediately come to mind (Carp & Shapira, 2018; Kuhn, 2007; Wang, 2016). Such events are then perceived as more likely to occur (Kortenkamp & Moore, 2011). That also means events that have not been experienced in the past or cannot easily be recalled are perceived as unlikely to occur (Burnett, 2015). For instance, individuals who have experienced flood damage may perceive flood damage as most likely to occur and take steps to prevent it, and vice versa (Siegrist & Gutscher, 2006).

- Decision makers may also approximate the effectiveness, value or benefits of an impending decision based on past effectiveness, value or benefits (Carp & Shapira, 2018; Cossette, 2014). This behaviour is termed an anchoring and adjustment heuristic (Carp & Shapira, 2018; Kuhn, 2007). For example, a person may judge the effectiveness or benefit of an adaptation action based on prior actions.

- Confirmation Bias. This bias suggests that in decision-making, people tend to search for information that confirms their prevailing beliefs, feelings or expectations (Kuhn, 2007; Lockton, 2012).

- Optimism bias. Sometimes people tend to believe that certain events are unlikely to affect them (Wang, 2016). This optimistic 'it will not or cannot happen to me' attitude underestimates risks. This type of bias has been revealed in people who dwell behind structural mitigation infrastructure such as levees (Grothmann & Reusswig, 2006; Liao, 2012). Such optimism may, however, be detrimental to disaster risk preparedness and resilience (Liao, 2012).

- The Affect Heuristic (Carp & Shapira, 2018; Slovic et al., 2007) is different from the preceding heuristics and biases as it is based on emotions rather than cognitive judgments. It encompasses people's reliance on feelings derived from deep-seated responses to threats (Slovic et al., 2007). These automatic reactions to threats may either be positive or negative (Carp & Shapira, 2018; Slovic et al., 2004). According to Slovic et al. (2007), affect plays a fundamental role in information processing, thinking, and knowing. The Affect proposition indicates that harsh emotional experiences with hazards may be an essential factor for risk perception and for provoking adaptation behaviour (Siegrist & Gutscher, 2006).

These heuristics and biases bring to the fore what has been termed as 'the risk-as-feelings hypothesis' (Altarawneh et al., 2018; Loewenstein et al., 2001; Slovic et al., 2004). It posits that responses to risks partially arise from direct, emotional influences, such as feelings, worry, fear, dread, or anxiety. Also, it emphasises that emotions are essential in provoking adaptation motivation and how people respond to existing and predicted flood risk (Schlösser et al., 2011).

Next, in this review of risk perception, is the explication of how cognitive factors influence adaptive behaviour. This specifically addresses the Cognitive Perspective of Protective Behaviour. Theories of health behaviour have been used to study why and how people adopt protective behaviours in response to threats. The following section, therefore, explains the Cognitive Perspective of Protective Behaviour with particular emphasis on the Protection Motivation Theory.

2.7.2 The Cognitive Perspective of Protective Behaviour

Cognitive factors play important roles in determining the adaptive behaviour of people (Grothmann & Patt, 2005; Grothmann & Reusswig, 2006; López-Marrero, 2010). The major theories emphasising this perspective include the health belief model (HBM), social-cognitive theory (SCT), the theories of reasoned action (TRA) and planned behaviour (TPB), and the protection motivation theory (PMT) (Munro et al., 2007; Najafi et al., 2017). However, PMT is widely used among these theories (Bamberg et al., 2017; Munro et al., 2007).

The cognitive perspective theorises that cognitive variables play a significant role in behaviour change. It holds the supposition that attitudes and beliefs, as well as the anticipation of future events and outcomes, are the critical elements of protective behaviour (Munro et al., 2007). These attitude-behaviour theories provide the background for explorations of the relationship between the attitudes people hold and their choice and adoption of protective responses (Birkholz, 2014). Essentially, the behavioural theories suggest that people will adopt problem-focused adaptive mechanisms (i.e. actions/activities that reduce risk) when they consider that their actions will alleviate the risks and that they are capable of undertaking the adaptive actions (Birkholz, 2014).

However, Munro et al. (2007) suggest that the cognitive perspective has been criticised because:

- It does not adequately address the skills needed to ensure protective behaviour;
- It gives little attention to the origin of beliefs and how these beliefs may influence other behaviours; and
- It ignores other factors that may impact on protective behaviour, such as power relationships and social considerations (Munro et al., 2007).

Notwithstanding these criticisms of the cognitive perspective, the Protection Motivation Theory (PMT) has emerged as a versatile theory (Birkholz, 2014). Arthur and Quester (2004) also postulate that the theory has facilitated researchers' understanding of fear appeals in behaviour change communication. Protection motivation theory can, therefore, help to conceptualise and communicate about the need for adaptation to flooding risk (Cismaru et al., 2011). Cismaru et al. (2011) further opine that the PMT can be applied to the study of flood risk because the severity and impacts of the risk are likely to induce fear.

2.8 The Protection Motivation Theory (PMT)

The Protection Motivation Theory (PMT) was primarily applied in health behaviour psychology (Koerth, Vafeidis, et al., 2013; Munro et al., 2007) to study how fear appeals influence health behaviour and attitudes. More recently, the theory has been adapted in the study of natural and technological hazards, climate change adaptation (Grothmann & Patt, 2005) and flood risk (Bubeck et al., 2013; Grothmann & Reusswig, 2006; Koerth, Vafeidis, et al., 2013). The theory has proven to be an elaborate framework for understanding human behaviour (Grothmann & Reusswig, 2006). The PMT has therefore been chosen among these behavioural theories because of its "conceptual conciseness", its reputation as a behavioural-intention theory (Birkholz, 2014), and the availability of a diverse range of studies testing and refining the theory in both the health (Munro et al., 2007) and hazards literature (Bamberg et al., 2017; Grothmann & Reusswig, 2006; Koerth, Jones, et al., 2013).

The PMT was developed by Rogers (1975) to understand the influence of appeals to fear on behaviour and attitudes. It was further elaborated in 1983 (Maddux & Rogers, 1983; Rogers, 1983). The model explains that when an individual perceives a threat, protective behaviour towards that threat is influenced by two main cognitive appraisals, namely threat appraisal and coping appraisal. These appraisals take place sequentially (Arthur & Quester, 2004). Threat appraisal involves the appraisal of the severity of an adverse event and a person's vulnerability to that event (Floyd et al., 2000). Coping appraisal, on the other hand, concerns the appraisal of response-efficacy (whether the protective action will be able to reduce the harm), self-efficacy (whether the person has the skills and know-how to take the protective action), and the coping cost (the time, money, effort involved in taking the protective action) (Arthur & Quester, 2004). These appraisals take place before an at-risk person proceeds to take action, if they are convinced that the risk is high and adaptive actions will reduce the perceived effects (Bamberg et al., 2017; Grothmann & Patt, 2005; Rogers, 1975, 1983). Threat appraisal often precedes coping appraisal (Grothmann & Patt, 2005).

The coping appraisal will only take place after the threat is perceived to be high, and the possible harm seen to be severe (Arthur & Quester, 2004; Grothmann & Patt, 2005). For the protective action to be taken, the benefits of taking action must outweigh the cost involved. The literature suggests that the high perceived cost of a protective action can reduce people's motivation to undertake adaptive measures (Bubeck et al., 2013). The basic proposition of the PMT is that protection motivation will be created after the cognitive appraisal of a depicted

event perceives it as harmful and the suggested response actions are perceived to be sufficient to protect against the occurrence of that harmful event (Birkholz, 2014).

One major limitation of the theory is that not all environmental and cognitive factors that could influence protective behaviour have been identified (Munro et al., 2007). It is also evident from the literature that the original PMT does not factor the influence of harmful experiences on protective behaviour (Grothmann & Patt, 2005). Furthermore, the theory did not take into consideration the influence of previous coping mechanisms on risk and coping appraisals.

2.8.1 Modified Protection Motivation Theories

Due to the criticisms and gaps revealed in Rogers' conceptualisation of the theory, several researchers have added components that they deem to be relevant to protection motivation. It has also been modified by others to suit their disciplinary and research focus. One such modifications is the Model of Private Proactive Adaptation to Climate Change (MPPACC) (Grothmann & Patt, 2005).

The proponents of MPPACC envisioned it as an upgrade to the Protection Motivation Theory (Grothmann & Patt, 2005). What is most evident about this model is its application to climate change adaptation. Therefore, threat appraisal was termed climate change risk appraisal while coping appraisal is adaptation appraisal. These changes in the names of concepts, especially in the change from coping appraisal to adaptation appraisal, is crucial since coping refers to reactive and short-term strategies, whereas adaptation denotes proactive and long-term actions.

Also, the proponents observed that personal experience influences protective behaviour since preparedness increases with the severity of past damage. They also added components such as fatalism, denial and wishful thinking to their model, suggesting that they represent "avoidant maladaptation." Reliance on public adaptation measures and cognitive biases and heuristics were also considered, which they suggested could negatively influence both risk appraisal and adaptation appraisal.

Arthur and Quester (2004), citing Bandura (1977), also reported that feelings of self-efficacy are influenced by personal experience, vicarious experience and verbal persuasion in their model based on the PMT. They posited that cognitive appraisal of threatening stimuli indirectly influences behavioural intentions through the mediating variable fear. They further suggested that fear results from threat appraisal.

Regarding fear, Raaijmakers et al. (2008) submitted that it was mostly dependent on the awareness of the frequency of occurrence of the hazard in question. Furthermore, the expected

severity of the consequences of a hazard will cause individuals to fear (or worry) about the damage caused by it. Grothmann and Reusswig (2006) also believed that fear influences threat appraisal, since appraisal of past risk (risk experience) will induce a fear of those risks occurring and thus positively influence the appraisal of the risk. Furthermore, Grothmann and Reusswig (2006) see "fear" as the third component of threat appraisal, which, however, plays an indirect role by affecting the estimate of the severity of the threat. Fear thus influences threat appraisal and leads to a demand for actions to reduce the threat or its damaging effects (Zheng & Dallimer, 2016).

Rogers' (1983) revised model also identified that perceived extrinsic rewards (e.g. peer approval) and intrinsic rewards (e.g. physical satisfaction) could negatively influence threat appraisal. These so-called 'rewards' could be termed competing interests or perceived benefits that can cause a negative response to risk. They do not, in a real sense, help to reduce or eliminate the risk. For risk appraisal to result in the decision to take adaptive action, the benefit of the adaptive action must outweigh the intrinsic and extrinsic rewards (Floyd et al., 2000).

The various aspects of the PMT discussed above have influenced the conceptual model and hypotheses formulated in the current research. Specifically, hypotheses H7 to H10 speak to the belief that flood risk appraisal (substituted for threat appraisal) is a function of perceived severity, perceived vulnerability, extrinsic rewards, and intrinsic rewards. The hypotheses H11 to H13 also highlight the assumption that adaptation appraisal (substituted for coping appraisal) is a function of self-efficacy, response efficacy and perceived adaptation cost. Furthermore, hypothesis H14 highlights the PMT's postulation that threat appraisal precedes and influences coping appraisal. Hypotheses H15 and H16 were also formulated to reflect the PMT's assertion that the cognitive appraisals (flood risk appraisal and adaptation appraisal) motivate, encourage, and sustain protective motivation.

2.8.2 Application of PMT in Disaster Risk and Climate Change Adaptation Studies

As noted in the preceding discussions, the PMT has been modified and applied in several disciplinary fields. In the context of disaster risk reduction, flood risk and climate change adaptation, a number of studies (Babcicky & Seebauer, 2019; Bagagnan et al., 2019; Birkholz, 2014; Botzen et al., 2019; Bubeck et al., 2018; Chen, 2020; Ghanian et al., 2020; Grothmann & Patt, 2005; Grothmann & Reusswig, 2006; Koerth, Vafeidis, et al., 2013; Poussin et al., 2014; Weyrich et al., 2020) have all applied the theory in research with varying modifications. Bamberg et al. (2017) are the only researchers to have conducted a meta-analysis of the use of PMT in flood risk reduction research. They observed that PMT could reveal the factors and

processes that impact on people's flood perception and preventive behaviours. Nevertheless, Floyd et al. (2000) and Milne et al. (2000) have also conducted meta-analyses of the use of the theory in research relating to health behaviour. They found that risk appraisal and coping (adaptation) appraisal were useful in predicting health behaviour intentions (Milne et al., 2000). More specifically, risk severity, vulnerability to the risk, response efficacy, and self-efficacy were seen to be facilitators of adaptive intentions or behaviours (Floyd et al., 2000). Common across these various studies are the risk appraisal and adaptation (coping) appraisal components of the theory.

The application of the PMT will, therefore, help to explain the factors that influence adaptation to flooding risks. It is understood that taking a cognitive perspective can provide a better prediction of household-level adaptation (Bamberg et al., 2017; Grothmann & Reusswig, 2006; Koerth, Jones, et al., 2013).

2.9 Development of Conceptual Model and Hypothesis

Up until this stage in the literature review, the discussion has focused on hazards, risks and disasters, and how to respond to them to reduce harm or take advantage of beneficial opportunities. The discussions of vulnerability, resilience and disaster risk reduction literature have also shown the factors that influence individuals' and groups' responses to disaster (flooding) risk. The Protection Motivation Theory (PMT) has also been discussed, and provided a detailed theoretical direction about the factors that predict adaptation intention.

The various research applying the PMT has highlighted that flood experience (personal experience, vicarious experience, coping experience), flood risk appraisal, adaptation appraisal and fear influence how people adapt to flood risks. The explanatory power of the PMT, therefore, provides a clear theoretical framework for this study. The conceptual model postulated below is underpinned by Roger's revised PMT (Rogers, 1983). The conceptual framework also incorporates the experience gained by individuals and households, especially in informal settlements, through their application of coping mechanisms. The incorporation of flood experience, coping experience and fear into the components of the PMT seeks to rectify some of the criticisms of health-behaviour theories outlined by Munro et al. (2007)

Figure 4, therefore, presents the conceptual model postulating how flood experience, coping experience, fear, flood risk appraisal, and adaptation appraisal could predict adaptation intention to flood risk. These factors interact in three stages. The first stage involves information sources that inform and create awareness of flood risk. The second stage is the

appraisal of the risk and appraisal of adaptation capacity. The final stage involves the formation of adaptation intention (which predicts adaptation behaviour). Figure 4 shows the model and hypothesised relationships. Note that the broken line in the figure 4 depicts hypothesised moderating effects.

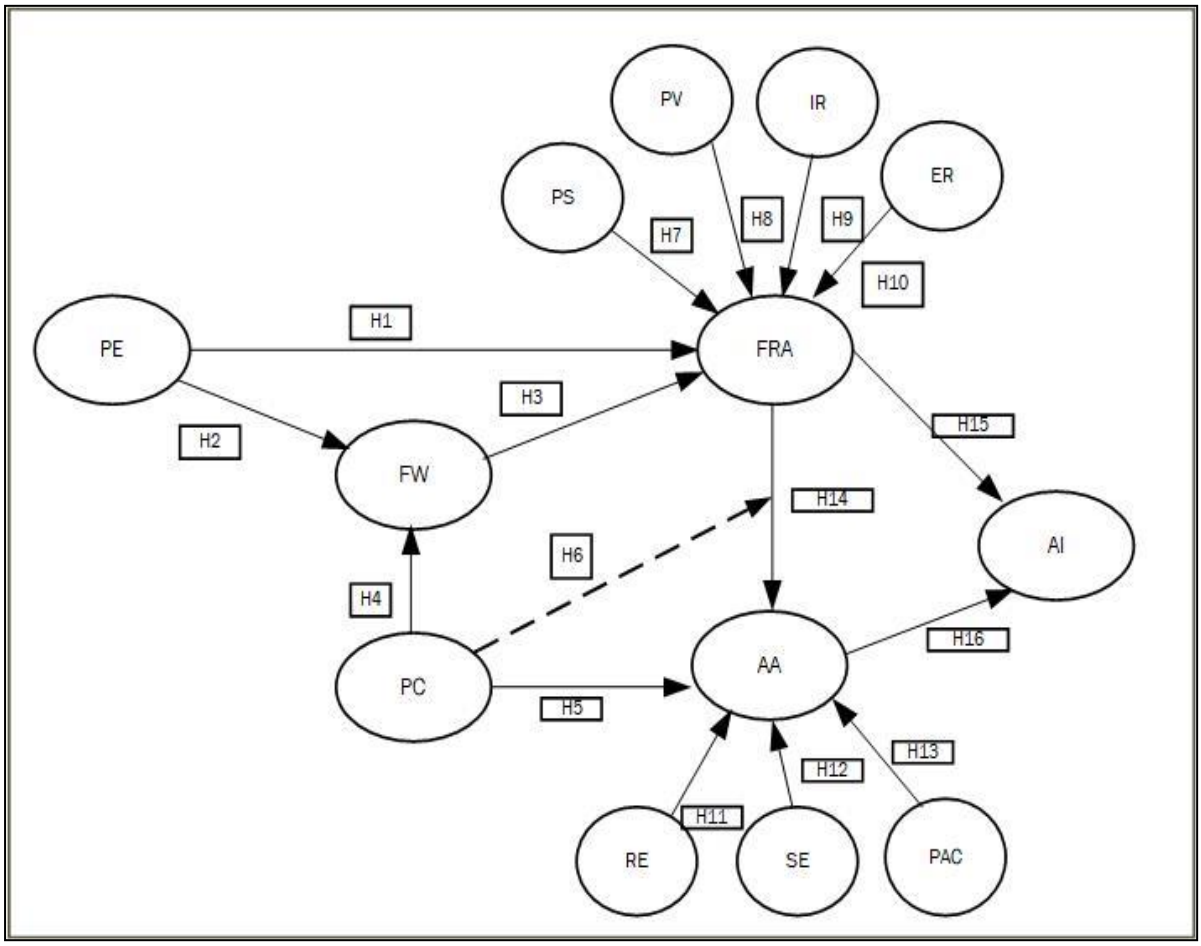

Figure 4: Conceptual Model of Variables and hypothesised Relationships Predicting Adaptation Intention
Source: Author

The model shown here depicts a progression of factors that are necessary to create the intention to take adaptation actions. Table 4 summarises the critical variables of this model.

Table 4: Summary of variables influencing adaptation intention

Important variables	Subcomponents
Past Flood Experience (PE): • Assessment of the severity and adverse impacts of past floods (Bamberg et al., 2017; Hudson et al., 2020; Poussin et al., 2014; Weyrich et al., 2020).	
Past Coping Experience (PC): • Assesses experience gained from coping actions against past floods (Floyd et al., 2000; Grothmann & Patt, 2005; Weyrich et al., 2020)	
Fear (FW): • Plays an indirect role by influencing the estimate of the severity of future flood risk (Arthur & Quester, 2004; Cismaru et al., 2011; Potter et al., 2018). It may result from the experience of past flooding and vulnerability.	
Flood Risk Appraisal (FRA): • Describes a person's assessment of their vulnerability to future flood risk. Also describes their assessment of future flood severity and its adverse impacts (Bamberg et al., 2017; Grothmann & Patt, 2005; Koerth, Vafeidis, et al., 2013; Rogers, 1983).	**Perceived Vulnerability (PV):** • A person's assessment of their exposure and vulnerability to flooding. **Perceived Severity (PS):** • A person's assessment of harmfulness and severity of future flooding. **Intrinsic (IR) and extrinsic rewards (ER) (Maladaptive response rewards):** • Perceived rewards of non-protective actions
Adaptation Appraisal (AA): • A person's appraisal of their adaptive capacity (Arthur & Quester, 2004; Bamberg et al., 2017; Bubeck et al., 2018; Grothmann & Patt, 2005; Koerth, Vafeidis, et al., 2013; Milne et al., 2000; Rogers, 1983).	**Response efficacy (RE):** • The perception that adaptation actions will be effective in reducing risk or harm from flooding hazards. **Self-efficacy (SE):** • The perceived ability of a person to perform an adaptation action. **Perceived adaptation costs (PAC):** • The assumed cost of taking adaptation actions (i.e. financial, time, and personal effort).
Adaptation Intention (AI) (Bamberg et al., 2017; Bubeck et al., 2018; Chen, 2020; Koerth, Jones, et al., 2013; Poussin et al., 2014; Terpstra, 2011)	The motivation or intention to undertake adaptation actions, including the specific measures to be implemented.

Source: Author

2.9.1 Summary of Hypotheses

Based on the theoretical and empirical literature discussed in the preceding sections, the following hypotheses will be tested in the study. Each of these hypotheses corresponds to a path relationship in the conceptual model, as shown in Figure 4, and highlights the assumptions of the modified protection motivation theory in the current research. Below are the formulated hypotheses and a brief explanation of the assumptions underpinning them.

- ***H1: Past flood experience (PE) positively influences residents' perception of flood risk.***
- ***H2: Past flood experience (PE) positively influences residents' fear (FW) of flood risk.***

The hypothesis H1 suggests that residents' experiences from flooding in the past positively influence how they perceive future flood risk. If the flood experience was severe (low), the residents might have a high (low) perception of future flood risk. H2 indicates that residents may obtain information about future flood risks through past experience (whether vicarious or direct) of flood risk (Arthur & Quester, 2004; Osberghaus, 2017). This knowledge and experience can then induce fear or worry about future risk and the harm they could face without adaptive actions (Bradford et al., 2012; Raaijmakers et al., 2008). It is envisaged that severe (low) flooding experience will result in intense (low) fear/worry/anxiety about future flooding and its adverse impacts.

- ***H3: Fear (FW) mediates the association between past flood experiences and flood risk appraisal (FRA).***
- ***H4: Experiences from past coping mechanisms have an inverse relationship with fear/worry/anxiety about future flooding and its adverse impacts.***

H3 hypothesises that Fear (FW) mediates the relationship between flood experiences and flood risk appraisal. If fear is high (low), the perception of future flood risk will also be high (low). H4 also postulates that experiences gained from coping with flooding in the past have an inverse relationship with fear. The association is, therefore, expected to be negative.

- ***H5: Past coping experience (PC) influences adaptation appraisal.***

Hypothesis 4 proposes that past coping experience influences adaptation appraisal. That is, it is dependent on the outcome of such coping responses. The relationship here could, therefore, be negative or positive depending on the success or failure of coping responses in the past.

- ***H6: Past coping experience moderates the relationship between flood risk appraisal and adaptation appraisal.***

  H6 Proposes that coping experience influences the strength of the relationship between flood risk appraisal and adaptation appraisal.

- ***H7: Perceived severity (PS) is a significant component of flood risk appraisal***
- ***H8: Perceived vulnerability (PV) is a significant component of flood risk appraisal.***
- ***H9: Intrinsic rewards (IR) negatively influence the perception of flood risk.***

- ***H10: Extrinsic rewards (ER) negatively influence the perception of flood risk.***

Literature shows that flood risk appraisal is a composite of perceived severity (H7), and perceived vulnerability (H8). It has also been identified that intrinsic rewards (H9) and extrinsic rewards (H10) negatively impact on flood risk appraisal.

- ***H11: Response efficacy (RE) is a significant component of the appraisal of adaptation capacity.***

Based on the literature, response efficacy is a crucial component of perceived adaptive capacity.

- ***H12: Self-efficacy (SE) is a significant component of the appraisal of adaptation actions***

Based on the literature, self-efficacy is a crucial component of perceived adaptive capacity.

- ***H13: Perceived adaptation cost (PAC) is a significant component of the appraisal of adaptation capacity***

Based on the literature, perceived adaptation cost also influences perceived adaptive capacity. It has a negative effect on the overall adaptive capacity. Thus, the higher the adaptation cost, the lower the chances of adaptation intention, all things being equal.

- ***H14: Flood risk appraisal positively influences the appraisal of adaptation (AA) capacity***.

Flood risk appraisal precedes adaptation appraisal (Grothmann & Reusswig, 2006). It is postulated here that adaptation appraisal will only take place if the flood risk is perceived to be high. Therefore, flood risk appraisal predicts and influences adaptation appraisal. The effect is expected to be positive.

- ***H15: Flood risk appraisal positively influences adaptation intention (AI).***

Adaptation Intention is perceived to be influenced by flood risk appraisal. Specifically, the perception of flood severity and vulnerability influences individuals, households or communities to consider adaptation actions that can prevent or reduce harm and damage.

- ***H16: Adaptation appraisal positively influences adaptation intention.***

Adaptation appraisal consists of three aspects: appraisal of how effective potential adaptation actions would be (response-efficacy), appraisal of the capacity to undertake those adaptive

actions (self-efficacy), and appraisal of the cost involved, or time or effort spent on adaptation actions (adaptation cost). If the appraisal of self-efficacy and response-efficacy is high, it influences adaptation intention. High adaptation cost, on the other hand, could have a negative influence on adaptation intentions. The result of adaptation appraisal is a specific perceived adaptive capacity (Grothmann & Patt, 2005). Adaptation appraisal also mediates the relationship between flood risk appraisal and adaptation intentions.

Adaptation intention, once developed, should inform adaptation behaviour. Research in other fields (notably exercise science) has shown that intention positively correlates with behaviour (Gomes et al., 2017; Koerth, Vafeidis, et al., 2013; Sheeran & Webb, 2016). Several factors (including the cognitive and social factors already discussed) have been shown to mediate this intention-behaviour association (Gifford et al., 2011; Milne et al., 2000). Self-efficacy and response (adaptation) cost variables, for instance, were revealed to be associated with concurrent behaviour (Milne et al., 2000). Milne et al. (2000) research revealed that intention was most often associated with subsequent behaviour, with a significance ratio of 66%.

2.10 Summary of the Chapter

In this chapter, it has been established that people are increasingly exposed to flood risk, which is predicted to be severe in future due to climate change. In order to reduce people's exposure to flood hazards and their impacts, adaptation has been identified as well-suited for preparing individuals and communities for future risk. Vulnerable people are already taking measures to survive flood hazards. However, these measures are short-sighted, reactive, and too expensive when repeatedly used, emphasising the need for proactive, anticipatory and long-term actions (adaptation).

It has also been established that several factors influence adaptation intention to expected flood risk, including the nature of past flood experience (Amoako, 2017), the success of past efforts to cope with floods (Kreibich & Thieken, 2009), socioeconomic characteristics, and cognitive (Bamberg et al., 2017; Floyd et al., 2000; Koerth, Vafeidis, et al., 2013) and affective processes (Altarawneh et al., 2018; Brown et al., 2018; Loewenstein et al., 2001). Also, past experiences, socio-economic characteristics and affective factors serve as information sources that influence how people process the cognitive variables informing risk perception (Floyd et al., 2000; Grothmann & Patt, 2005).

The chapter further discussed the cognitive perspective of health behaviour, which theorises that cognitive variables play a significant role in behaviour change. The protection motivation

theory, which is one of the key theories among the cognitive perspectives of health behaviour, was discussed in detail, as it has proven useful in revealing the factors and processes that impact on people's flood perception and preventive (and protective) behaviours. The theory was also modified to reflect the peculiar experiences of households in flood-prone informal settlements.

In order for people to commit to adapt to future risk, such risk must be perceived as deleterious, individual capacity and ability to reduce or eliminate such risk must be perceived as high, and the probability of the success of the adaptive actions must also be high (Bamberg et al., 2017; Floyd et al., 2000; Rogers, 1983). Therefore, it has been postulated that risk perception influences intentions to adapt to flooding risk (Koerth, Vafeidis, et al., 2013; Milne et al., 2000). It has also been postulated that intentions to adapt positively correlate with adaptation behaviour (Gomes et al., 2017; Koerth, Vafeidis, et al., 2013; Sheeran & Webb, 2016). Therefore, understanding how people perceive future flood risk is necessary when planning disaster risk reduction and adaptation communication strategies (Burnett, 2015).

Based on the above literature, theoretical exposition and postulated hypotheses and structural model, the next chapter will specify the methodology that will be adopted to collect and analyse the data.

CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN

3.1 Introduction

The purpose of this chapter is to explain the methodology and methods applied to address the research questions and objectives of the study. A methodology is a philosophical framework for the central assumptions of research (Creswell & Plano Clark, 2011). The research design explains the plan or procedure used to conduct the research (Creswell, 2009). Therefore, this chapter discusses the philosophical worldview of the study, the research strategy and research methods, techniques and procedures. Figure 4 is a diagrammatical representation of the methodological framework.

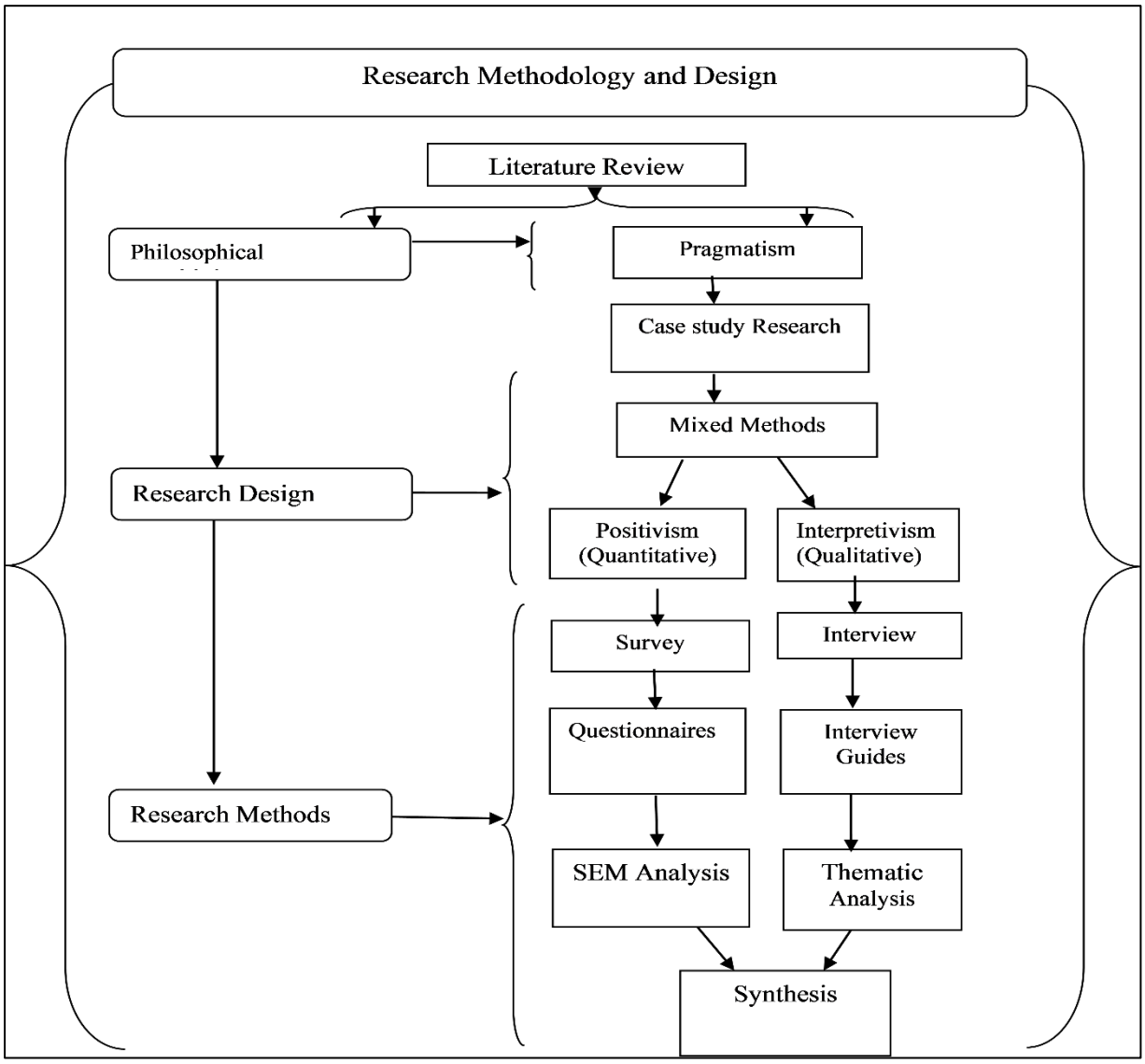

Figure 5: Research Methodological Framework
Source: Author

The chapter is presented in seven (7) sections. Section 3.2 discusses the philosophical underpinning of the research. Section 3.3 follows up with an elaboration of the case study

strategy, its philosophy and how it addresses the purpose of the research. The section further explains the mixed methods approach adopted for the study. Afterwards, section 3.4 addresses the quantitative research methodology. It explains the sample design, development of the measurement, data collection and analysis processes and validation of the data. Section 3.5 discusses the methodology of the qualitative strand of the research. It explains the qualitative sampling design, the development of interview guides, data collection and analysis procedures, and validation of the qualitative data. Section 3.6 discusses how the quantitative and qualitative results will be synthesised. Also, section 3.7 explains the consideration of research ethics. Finally, section 3.8 summarises the chapter.

3.2 Research Philosophy

This section discusses the prevalent philosophical worldviews of the research design. Research philosophies/paradigms provide a firm and consistent foreground for the design and implementation of research undertakings (Ling & Ling, 2016). According to Ling and Ling (2016), a paradigm is a worldview or a way of thinking about or categorising the approach that underpins all aspects of research work or motivation for the research. The research paradigm was initially conceptualised as a way to summarise researchers' beliefs about their efforts to create knowledge (Shannon-Baker, 2016). While there exist multiple research paradigms with differing ontologies, axiologies and epistemologies (Amaratunga et al., 2002; Blaikie & Priest, 2017), three research paradigms were purposively considered in the current study. These paradigms include positivism, interpretivism and pragmatism (Creswell, 2009; Ling & Ling, 2016). As Blaikie and Priest (2017, p. 23) suggest, social researchers need to select and argue for paradigms that are assumed to be the most suitable to provide the knowledge needed to answer the research question at hand. The paradigms thus provide alternative approaches to addressing the research problem (Blaikie & Priest, 2017, p. 23). Table 5 summarises the ontology, axiology, epistemology, and outcome of the selected worldviews.

Table 5: Philosophical Worldviews that Underpinned the Research

Worldview	Ontology	Axiology	Epistemology	Outcome
Pragmatism	Reality is not the issue. The issue is finding what works.	It is determined by practical need relevant to the researcher.	Its practical value determines the integrity of an understanding.	Evidenced praxis—through the use of knowledge. A constructed, evidenced, defended practical solution.
Positivism	A consistent or ordered reality.	The objective pursuit of knowledge and truth based on theory.	Knowable objective truth.	Knowledge derived from affirmation, contradiction or modification of contemporary understanding.
Interpretivism	The only understanding available is based on observation and interpretation.	The pursuit of an understanding in which the value position of the researcher is inherent.	Understandings of elements of the world are subjective and socially constructed.	A defended, evidenced, socially constructed, personal interpretation of the subject researched.

Source: (Amaratunga et al., 2002; Ling & Ling, 2016)

3.2.1 Pragmatism

The pragmatic paradigm blends a variety of worldviews, research techniques and tools to suit the practical purpose of the research (Ling & Ling, 2016). The paradigm often employs a mixed methods research design (Johnson & Onwuegbuzie, 2004; Shannon-Baker, 2016).

The paradigm offers researchers the opportunity to mix quantitative and qualitative data and methods to fully understand the research problem (Creswell, 2011; Ling & Ling, 2016). It allows researchers to use design components that are suitable for answering the research question in the best way possible (Johnson & Onwuegbuzie, 2004). In pragmatic research, the logic of inquiry may include the use of deduction (testing of theories and hypotheses), induction (or discovery of patterns), and abduction (uncovering and relying on the best set of explanations for understanding the research results (Johnson & Onwuegbuzie, 2004). In Table 6, Creswell (2009) explains some of the ideals of the pragmatic paradigm.

Table 6: Ideals of the pragmatic worldview

• Pragmatism is not bound by one system of philosophy and reality. It suits mixed methods research because researchers can freely choose from both quantitative and qualitative assumptions in their research.
• Pragmatist researchers look to why and how to research, based on the intended outcome.
• Pragmatists agree that research always occurs in social, historical, political, and other contexts.
• For the mixed methods researcher, pragmatism opens the door to multiple methods, different worldviews, and different assumptions, as well as different forms of data collection and analysis.

Source: (Creswell, 2009).

Pragmatism was adopted as the overaching philosophical paradigm in the current research due to its flexibility and suitability for mixed methods research (section 3.3.1 explains the rationale for the adoption of mixed methods research). It allowed for either positivist or interpretivist approaches to be adopted to suit the quantitative and qualitative strands of the research respectively. Thus the pragmatism paradigm was supported by the philosophies of positivism and interpretivism, with particular attention to the components that best suit a mixed methods research. The use of pragmatism as the overarching paradigm therefore ensured a full understanding of flood risk adaptation intentions, since both the causal relationships between constructs and the underlying intentions, ideas, opinions and perspectives held by the research participants were uncovered.

3.2.2 Positivism

Positivism posits that objective reality, which is unbiased from human perceptions, exists (Irshaidat, 2019). It is deductive in nature and leans heavily on verifying hypotheses and experimentation through its operationalisation of constructs and measures to advance knowledge (Amaratunga et al., 2002; Park et al., 2020). Context is not important in positivism, and it favours research approaches that produce generalisable and reproducible findings (Kivunja & Kuyini, 2017). As such, quantitative methods are usually adopted in research underpinned by positivism (Kankam, 2019). One of the objectives of the research was to "test hypotheses on the relationship between the constructs representing household experience and appraisals, and the flood risk adaptation intentions using quantitative data." The strand of the research that addressed that research objective was therefore underpinned by positivism, as the paradigm enabled the formulation and testing of the hypotheses and causal relationships to be established (Bonache, 2020) between household experiences, appraisals and flood risk adaptation intentions.

3.2.3 Interpretivism

Interpretivism suggests that knowledge is socially constructed and thus rejects the notion that facts are fixed (Irshaidat, 2019; Kankam, 2019). It recognises that in relying on culture, concepts and behaviour can lead to the understanding of human actions (Irshaidat, 2019). Interpretivism strives to understand human experience through research participants' viewpoints (Bonache, 2020; Kivunja & Kuyini, 2017). As Hesse-Biber (2010, p. 104) observes, the "social world is not something independent of individual perceptions but is created through social interactions of individuals with the world around them." Since there was a need in the research to expose the deep nuances between the risk perceptions of research participants and their actions (Woodside, 2010), interpretivism was therefore adopted in the qualitative strand of the research to enable a better understanding of the flood risk adaptation intentions in the informal settlement without restricting them to *a priori* analytic categories (Bonache, 2020). Thus, an inductive method of inquiry was applied, where thematic descriptions of the data were produced (Blaikie & Priest, 2017). As interpretivism places importance on comprehending human behaviour, its adoption enabled the comprehension of participants' actions and the perspectives that shaped those actions (Dainty, 2008).

3.3 Case Study Strategy

Case studies investigate phenomena in depth and in their real-life context (Yin, 2009). They focus on one (or a few) instance of the phenomenon (Denscombe, 2010; Yin, 2015). Woodside (2010) posits that a case study may focus on describing, understanding, and/or predicting the behaviour of the individual (i.e., process, person, household, etc.).

Case studies are the preferred strategy when the research involves "how" and "why" questions (Yin, 2009). According to Yin (Yin, 2009; Yin, 2015), the goal of case studies may be to expand and generalise theories (analytic generalisations). Yin (2015), posits that in analytic generalisation, a study's findings may be used to inform a particular set of concepts, theoretical constructs, or a hypothesised sequence of events. These concepts or theoretical constructs can then be used to make implications for other similar situations. For single case studies, in particular, generalising to a larger population might not be the focus of the case, but rather to discover patterns and processes within the case. The analytic generalisation is, however, used to extract the lessons learnt (Yin, 2015). Also, it enables the case study strategy to capture the deep nuances that other strategies may not be able to capture (Woodside, 2010).

Yin (2009) further states that case study inquiry may involve many variables of interest. It may, therefore, rely on multiple data sources, with data needing to be converged in a triangulating manner. It may also benefit from the prior development of theoretical propositions to guide data collection and analysis. The strategy further allows for the mixing of quantitative and qualitative data (Denscombe, 2010). Woodside (2010) also contends that using mixed methods in case study research increases the accuracy and complexity or coverage of the study. Woodside further argues that a mixed methods case study enables the confirmation and disconfirmation of some of the beliefs, opinions and feelings of research participants within the research population.

It is also useful to contrast the case study research design with other types of research designs such as action research design, experimental design, survey research design, ethnography, and cross-sectional design. **Action research design** is usually undertaken as a form of self-reflexive enquiry by participants (practitioners) in a social situation to improve practice, improve understanding of practice or improve the situation in which the practice take place. In action research, moral and ethical issues are highlighted. Researchers may also revise and develop their study in cycles, gathering data as they go in order to spur positive change (Atkins & Wallace, 2015). By contrast, **experimental research designs** enable researchers to establish whether independent variable(s) significantly predict dependent variables when all other factors are held constant. The researchers randomly assign groups and meticulously control for extraneous variables. Any statistical variations in the experimental group compared with the control group are then attributed to the experimental manipulation. It is a type of quantitative research method (Ruble, 2018).

Survey research is another research design that is widely used. It is based on a positivist paradigm, mostly quantitative and utilises questionnaires in data collection. Researchers may use survey research with a goal to generalise to a larger population or for the purpose of transferability. Nevertheless, the research design can also be embedded in other research designs such as ethnographies, case studies, or experimental research. (Andres, 2012). In the current research the survey design was embedded in the case study design. Conversely, **ethnography** is both a design and a method that researchers use to study a particular social or cultural group to better understand it. In ethnography, the researcher participates actively in the group to obtain an insider's viewpoint and to gain experiences comparable to the group members. The researcher thus engages in participant observation and approaches the study inductively (Kramer & Adams, 2018). **Cross-sectional design** is also utilised by researchers to examine and compare single variables across multiple subgroups that are analogous in other

characteristics. The data is collected at a single point in time. The design is used to find patterns, associations, and prevalence rates of a subject of study within a population (Cummings, 2018).

It is evident from the above comparisons of the designs that case study was the most appropriate design to achieve the objectives of the research, as it is mostly pragmatic and can blend easily with other designs such as survey. Therefore, the study adopted a mixed-methods case study strategy. This approach blends quantitative and qualitative methods (Creswell, 2011; Hesse-Biber, 2010). In mixed methods research, the collection, analysis and interpretation of quantitative and qualitative data may be made in a single study or a series of studies about the same phenomenon (Creswell & Plano Clark, 2011; Leech & Onwuegbuzie, 2009). The central idea of a mixed methods case study is that the use of quantitative and qualitative data in combination provides a better understanding of research problems than either source of data alone (Creswell, 2009; Creswell & Plano Clark, 2011).

3.3.1 Classifications of the Case Study Strategy

The current study adopted a single case study strategy. While statistical generalisation may be difficult in a single case study like the present one, the blending of quantitative and qualitative methods in the single case about the same phenomenon justifies the use of the single case study strategy. The mixed methods approach increases the reliability of the findings since the weaknesses of the single case study would be counteracted. Also, the study pursued analytic generalisation, which Yin (2015) contends enables the extraction of lessons learnt. Woodside (2010) and Mariotto et al. (2014) also support the analytic generalisation in a single case study, emphasising that it enables deep nuances in the case to be captured, something that other strategies may fail to obtain. Furthermore, single case studies have proven useful in generating and testing theories (Mariotto et al., 2014) and offer rich, comprehensive descriptions of situations and their context (Sammut-Bonnici & McGee, 2015).

The type of case study design adopted in this study can also be classified as an embedded case study. According to Scholz and Tietje (2002) embedded case studies involve multiple units of analysis and allows for multiple methods to be applied within the subunit of the study. In the current research, the units of analysis included households, opinion leaders, and NADMO officials. The embedded case study design enabled both quantitative and qualitative methods to be used to study the different units of analysis.

Another way to classify case studies is their motivation. According to Scholz and Tietje (2002), a case study may be classified as intrinsic or instrumental based on its motivation. In intrinsic

case study, the case is studied on its merit, while in instrumental case study the understanding of a particular situation, problem, or theory is more important than the case itself (Mills et al., 2010). Multiple interests converged in the selection of the case for the current study in line with its pragmatic philosophical underpinning. As Mills et al. (2010) notes, researchers may have several motivations for engaging in both intrinsic and instrumental case study. In the present research, Glefe was purposely selected as the case due to its reputation is one of the most flood-prone informal settlements in Ghana (Amoako, 2017; Bokpe, 2014). Glefe is both an informal settlement and flood prone. The researcher's familiarity with the settlement was also a secondary factor. These factors made Glefe the most appealing settlement to explore the flood risk adaptation intentions of informal settlements because it was most likely to provide rich information about the phenomenon (Mills et al., 2010). The type of case study could therefore be classified as instrumental (Mills et al., 2010). The case could also be classified as an extreme case due to Glefe's vulnerability to flooding (see section 1.7). The above justifications for the case selection are supported by Mills et al. (2010) who explained that researchers may "select cases that help to identify the specific conditions and characteristics of a phenomenon."

3.3.2 Mixed Methods Approach

Mixed methods is a novel research design that combines data in the form of words, pictures, and narratives to add meaning to the quantitative data (Hesse-Biber, 2010). This mixture of methods entails the combination of quantitative and qualitative data through the collection, analysis and interpretation of such data in a single or multiphase study (Creswell & Plano Clark, 2011; Hesse-Biber, 2010).

There are several ways that mixed methods research can be designed. The common design types include Sequential and Concurrent design (Creswell, 2009). These approaches are judged based on the timing (sequential or concurrent), the weighting, the mixing and the nature of theorising of both the quantitative and qualitative strands of the research (Creswell, 2009). The quantitative strand of this research used a survey with a Likert-scale-type questionnaire, while the qualitative strand employed interviews as the data collection technique.

The current study used the concurrent mixed methods approach (Creswell & Plano Clark, 2011). With this approach, both the quantitative and qualitative components of the study were implemented simultaneously (Morse, 2010). According to (Creswell & Plano Clark, 2011), the concurrent mixed methods approach taken may be either Concurrent Triangulation Design,

Concurrent Embedded Design or Concurrent Transformative Design. The concurrent triangulation design was judged to be appropriate for this study.

In the concurrent triangulation design, the researcher collects and analyses both the quantitative and qualitative data separately (Creswell & Plano Clark, 2011; Onwuegbuzie & Collins, 2007). The phases are independent of each other in this design (Onwuegbuzie & Collins, 2007). The different results are then merged by comparing and contrasting them during the interpretation. This enables the researcher to compare and validate, confirm or corroborate quantitative results with qualitative findings (Creswell & Plano Clark, 2011; Onwuegbuzie & Collins, 2007). It, therefore, helps the researcher to arrive at valid and well-substantiated conclusions about the study (Creswell & Plano Clark, 2011).

The mixing of data could be done such that both strands of data are equal or one strand takes prominent emphasis over the other. In this research, the quantitive (QUAN) strand took precedence over the qualitative (qual) strand (i.e. QUAN + qual) (Johnson & Onwuegbuzie, 2004). Thus, the mainly positivist (quantitative) aspect was supported by the views, perceptions and perspectives of the interpretivist (qualitative) aspect to provide a nuanced understanding of the research problem. Figure 6 below depicts the concurrent triangulation mixed methods design.

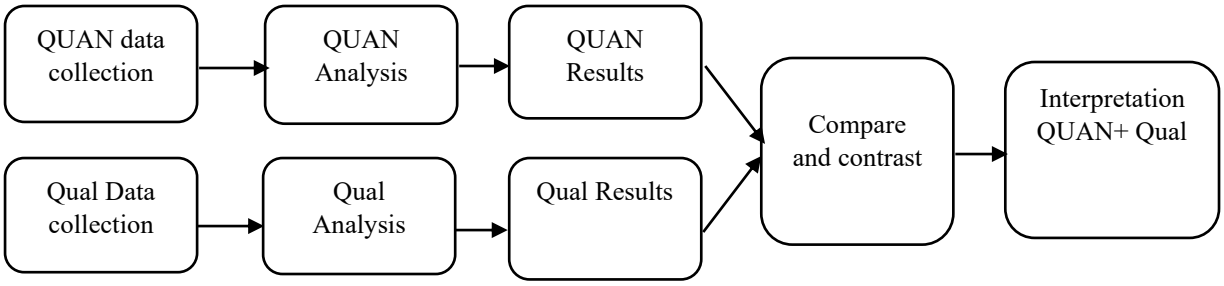

Figure 6:Concurrent Triangulation Mixed Methods Design Flowchart
Source: Author

3.4 Quantitative Research Methodology

Having discussed the case study strategy and the mixed methods approach to data collection, analysis and interpretation, this section will expound the sampling design of the quantitative strand of the research. According to Shapiro (2011), sampling design is a framework that is used as a basis for selecting a survey sample, and affects other critical aspects of the survey. It

specifies the population of interest (sampling frame), and the methodology that is used to select the sample.

3.4.1 Research Population and Sampling Frame

Sampling refers to the selection of the unit of analysis of the research from the population of interest (Trobia, 2011). Conversely, the sample frame is the list of the population of interest from where the sample is selected (Hall, 2011). In the present research, the sample frame was multi-level. Glefe was first selected as the population of interest in Accra based on characteristics discussed in Chapter 1, section 1.7. As the research was about household experiences and appraisals, households therefore became the population of interest in Glefe. However, housing in Glefe was such that multiple households resided in the same house. Thus, there was a need to consider the houses as part of the sampling frame, even though the houses were not the major consideration, but the households residing in them. It was not possible to list the houses in the community, since there was no street addressing system in place in the community. Nevertheless, a google map of the community was used and all houses were numbered. That ensured that all houses in the community were covered. There were approximately 2368 households, who resided in 1074 houses in Ghana (GSS, 2012a).

3.4.2 Sample Size Determination

The estimation of a minimum sample size appears to be one of the key issues in Structural Equation Modelling (SEM) (Kock & Hadaya, 2018). While many rules of thumb exist, such as the 10-times rule (Hair et al., 2017; Kock & Hadaya, 2018), and the $N \geq 100$ rule (In'nami & Koizumi, 2013), these rules of thumb may, however, lead to gross underestimation of SEM minimum sample size (Hair et al., 2017; Kock & Hadaya, 2018). The 10-times rule states that the sample size should be equal to the larger of:

- Ten times the largest number of formative indicators used to measure a single construct, or
- Ten times the largest number of structural paths directed at a particular construct in the structural model (Hair et al., 2017; Kock & Hadaya, 2018).

However, Kock and Hadaya (2018) and Hair et al. (2017) prove that this rule of thumb is unhelpful for Partial Least Squares Structural Equation Modelling (PLS-SEM). Also, Wolf et al. (2013), using Monte Carlo simulation, suggest that structural equation modelling sample sizes vary between 30 and 460 cases, depending on key model properties. However, it is still

essential to determine a minimum sample size that can result in specific effect size, statistical power and error probability (Hair et al., 2017). Hair et al. posit that the minimum sample size should be determined using power analyses based on the part of the model with the largest number of predictors. Kock and Hadaya (2018) also recommend that a minimum effect size to determine a minimum sample size should be twice (that is 0.04) Cohen's recommended effect size (f^2=0.02) for complex models.

The above recommendations were taken into consideration to determine the minimum sample size necessary in this research. The G*Power programme was then used to estimate the minimum sample size based on an effect size of 0.04, error probability of 0.05, power of 0.80 and the maximum number of connections to a construct in a structural model (that is, 4). The resultant sample was N≥ 156. Kock and Hadaya (2018) used another method they called the Inverse Square Root method, which, they suggest, will result in generating minimum sample size estimates that are both reasonably precise and safe (with slight overestimations), whether the data is normal or non-normal. The estimated minimum sample size using this method was N≥160. However, 392 participants were recruited to cater for non-response and other unusable responses.

3.4.3 Development of Quantitative Measurement Instruments

The development of measurement instruments for this research began with the review of the theoretical and empirical literature on factors that influence protective behaviour. The indicators used here were developed based on existing measurements scales in the literature. In the case where there were no existing measurement scales for any construct, literature was used to inform the question statements.

The measurement items for the survey component were also based on constructs and indicators used in the literature. Table 7 presents all the variables in the formulated conceptual model. It also shows the sources from which these variables and indicators were adapted. Most of the indicators, primarily the items measuring experience, fear, flood risk appraisal, adaptation appraisal and adaptation intention, were measured on five-point Likert scales: 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree. Some measurement items had slight variations of the five-point Likert scale. Demographic and socio-economic variables were not measured using the Likert scale.

Table 7: Variables of the quantitative survey

LATENT VARIABLES	INDICATORS (MEASURED VARIABLES)	KEY REFERENCES
Past Flood Experience (PE1 to PE3 were measured from "none to very severe)", (PE4 to PE7: Strongly disagree to strongly agree)	• PE1: The physical damage to my house was • PE2: The impact on my friends/relatives was • PE3: The loss of my valuable belongings during recent floods was • PE4: Past floods had negative effects on my well-being • PE5: I am still suffering from the impact of past floods • PE6: Someone in the household suffered health problems due to the floods • PE7: Someone in the household is still suffering an ongoing injury or illness • PE8: Coping actions reduced the impacts of past floods	(Kienzler et al., 2015; Kreibich et al., 2015; Kreibich & Thieken, 2009; Mills et al., 2016; Nhuan et al., 2016; Osberghaus, 2017; Poussin et al., 2014; Thieken et al., 2007)
Past Coping Experience PC2-PC11 are based on the success of the coping measures. These were measured on the scale "Strongly disagree to strongly agree."	• PC1: If coping measures were adopted during recent floods • PC2: Rebuild damaged walls of buildings • PC3: Remove water from inside house • PC4: Store important documents in safe places • PC5: Create water barriers in flooded areas • PC6: Clear gutters, drains or waterways in the community • PC7: Transfer valuables to a safer place • PC8: Temporary relocation to another community • PC9: Temporary relocation to higher ground in this community • PC10: Channel water away from my house • PC11: Repair damage roofs	(Amoako, 2017; Botzen et al., 2009; Grothmann & Reusswig, 2006; Kreibich & Thieken, 2009; Thieken et al., 2007)
Fear Fear was measured from "Strongly disagree to strongly agree."	• FW1: I fear for the safety of the people in my household • FW2: Rate your level of concern/worry about future flooding • FW3: I am concerned about my house (building) • FW4: I am worried about the loss of peoples' jobs • FW5: I am concerned about the safety of people in my community • FW6: I am concerned about the safety of houses in my community • FW7: Floods don't happen often enough to make them a high priority	(Arthur & Quester, 2004; Floyd et al., 2000; Grothmann & Reusswig, 2006; Osberghaus, 2017; Raaijmakers et al., 2008; Zaalberg et al., 2009; Zheng & Dallimer, 2016)

LATENT VARIABLES		INDICATORS (MEASURED VARIABLES)	KEY REFERENCES
Flood Risk Appraisal This was measured from "Strongly disagree to strongly agree."	**Perceived Severity**	• PS1: Future flooding will be more severe • PS2: Future flooding will be more frequent • PS3: If the floods occur, it could be that the destruction will be great • PS4: The problems caused by floods in the future will take longer to rectify • PS5: I need more information about the severity of future floods • PS6: I need more information about the potential risk of future floods • PS7: I think I am likely to experience a serious future flood	(Birkholz, 2014; Botzen et al., 2009; Floyd et al., 2000; Grothmann & Reusswig, 2006; Koerth et al., 2014; Koerth, Vafeidis, et al., 2013; Lindell & Perry, 2012; Poussin et al., 2014; Reser & Swim, 2011; Rogers, 1975, 1983)
	Perceived Vulnerability	• PV1: My location is prone to flooding • PV2: I think my house will be flooded • PV3: My house often gets flooded • PV4: Flooding causes health problems in my household • PV5: Flooding can lead to people in my household being out of work • PV6: Flooding in my area damages houses • PV7: Flooding will financially cost my household a lot	
	Intrinsic Rewards	• IR1: Flood risk adaptation is NOT something important to be concerned about • IR2: NO NEED to adapt because future floods will not bring any big changes • IR3: I can still live here in the future WITHOUT adaptation • IR4: OTHER PRIORITIES to think about instead of floods • IR5: Thinking about flood risk will make me FEEL INSECURE	(Koerth, Jones, et al., 2013; Koerth, Vafeidis, et al., 2013; Lindell & Perry, 2012; Poussin et al., 2014) (Birkholz, 2014; Floyd et al., 2000; Grothmann & Patt, 2005; Grothmann & Reusswig, 2006; Koerth, Vafeidis, et al., 2013)
	Extrinsic Rewards	• ER1: People will laugh at me if I take actions to adapt to future floods • ER2: None of my friends/my family are taking any adaptation actions • ER3: The people in this community are not interested in adaptation	
Adaptation Appraisal	**Self-efficacy**	• SE1: I can take proactive actions to reduce future flood impacts • SE2: I can take long-term actions to reduce future flood impacts • SE3: I can take advantage of beneficial opportunities brought by future floods • SE4: I have the skills to undertake adaptation measures • SE5: I know what to do to adapt to future floods • SE6: It is too difficult to adapt to floods	(Bamberg et al., 2017; Cismaru et al., 2011; Floyd et al., 2000; Grothmann & Patt, 2005; Grothmann & Reusswig, 2006; Koerth, Jones, et al., 2013; Koerth et al., 2014; Koerth et al.,

		• SE7: I am creative in finding solutions to flood risks	2017; Koerth, Vafeidis, et al., 2013; Lindell & Perry, 2012; Maddux & Rogers, 1983; Poussin et al., 2014; Reser & Swim, 2011; Rogers, 1975; Siegrist & Gutscher, 2008; Swim et al., 2009)
	Response Efficacy	• *RE1:* Proactive measures will reduce future flood damage to my house. • *RE2:* Proactive measures will increase the safety of my household from floods. • *RE3:* For me, long term actions will reduce my chances of being seriously flooded • *RE4:* Beneficial opportunities will make us strong against future flood impacts • *RE5:* Adaptation actions will make this community a safe place to live in the rainy season • RE6: Adaptation actions will prevent future losses due to floods • RE7: Adaptation actions will increase the value of my property	
	Perceived Adaptation Costs	• PAC1: Adaptation costs are less than the costs of inaction. • PAC2: I prefer spending my money on something else rather than adaptation. • PAC3: Adaptation is too time-consuming. • PAC4: Adaptation measures are too expensive • PAC5: Adapting to floods is inconvenient • PAC6: Adaptation measures will involve too much effort	
Adaptation Intention This was measured from "Strongly disagree to strongly agree.		• AI1: I will engage with actions so that future floods do not have impacts on my household • AI2: I will protect my house from damage due to future floods • AI3: I think the government should take the greater responsibility to protect us from future floods • AI4: I will strengthen the physical structure of my home • AI5: I will elevate my home • AI6: I will take out insurance on my home • AI7: I will permanently relocate out of this community • AI8: I will move to a less flood-prone area in this community • AI9: I will learn about adaptation options to apply • AI10: I will follow weather warnings more keenly • AI11: I will begin to lobby the government on improvements to storm-water networks • AI12: I will advocate for restrictions on development in flood-prone areas • AI13: I will involve myself in volunteer activities intended to adapt the community to floods	*(Amoako, 2017; Birkholz, 2014; Danso & Addo, 2017; Douglas & Alam, 2006; Few, 2003; Grothmann & Reusswig, 2006; Hooli, 2016; IPCC, 2012; Kienzler et al., 2015; Koerth, Jones, et al., 2013; Koerth et al., 2014; Koerth, Vafeidis, et al., 2013; Kreibich et al., 2015; Kreibich & Thieken, 2009; Poussin et al., 2014; Revi et al., 2014; Thieken et al., 2007; Wamsler & Brink, 2014)*

Source: author

3.4.4 Selection of Respondents and Data Collection Procedures

The primary quantitative research data were gathered through a survey of household heads in Glefe. The survey was administered through house-to-house visits. Research assistants administered the questionnaire that was developed for the survey in the presence of the participants. The research assistants attended a training session with the researcher before their participation in the research.

The survey participants were recruited through a systematic random sampling method with a random walk (Hoffmeyer-Zlotnik, 2003; Krótki, 2005). There were about 1100 houses in Glefe. Based on a google map of the area, these houses were numbered from 0001-1100. The community was then subdivided into four divisions, and one research assistant was assigned to each division. The research assistants then used random numbers generated for the sampling to identify the corresponding houses in their section to recruit for the survey. If there was no eligible adult (household head or any adult of 18 years or more), the next house corresponding to the next random number was selected until the survey sample (392) was obtained. More random numbers than required were generated to cater for abstentions or where the person in the house did not fit the inclusion criteria.

The survey administrators walked from house to house in a prescribed route using the settlement map as a guide (Hoffmeyer-Zlotnik, 2003; Krótki, 2005). In each house, one household was randomly selected to participate in the survey (there was more than one household in some houses), upon consent. Only one household member (the household head or, in their absence, an adult of 18 years or above) was recruited from each household. If the household head (or the adult household member) agreed to participate, the survey instrument was then completed with the assistance of research assistants using KoboCollect installed on android devices.

3.4.5 Reliability and Validity of Data

Several reliability and validity checks were conducted on the data collected to ensure that it was dependable (Creswell & Plano Clark, 2011). The PLS-SEM reliability and validity assessments, and convergent and discriminant validity, were evaluated as part of the measurement model assessment (Rasoolimanesh et al., 2015). The face validity of the survey instrument was established with the help of a statistical expert from the Statistical Support Service of the University of Newcastle. The Composite Reliability (CR) and Average Variance Extracted (AVE) were used to determine the convergent validity. The CR was preferred over Cronbach's alpha, as it is considered more suitable in PLS-SEM because it incorporates

information about the item loadings into its calculation (Rasoolimanesh et al., 2015). The results of the reliability and validity checks are presented in Chapter 4.

The study also used multiple methods of data collection for the purposes of triangulation. In addition, all the phases of the research were scrutinised by supervisors, who served as peer reviewers. Furthermore, the research process was peer-reviewed as part of the ethics approval requirements. These measures ensured that the quantitative data that was collected was reliable, and generalizable.

3.4.6 Data Analysis and Interpretation

The quantitative data was analysed using Statistical Package for Social Sciences (SPSS) v24 and WarpPLS version 6.0, a partial least squares structural equation modelling (PLS-SEM) software. The completed surveys were downloaded from the student researcher's account on the KoboCollect platform (an android-based data collection kit) to commence the analysis process. The data were downloaded in an excel format. The completed surveys were then physically inspected for completeness and consistency. Because KoboCollect was used to collect the data, the responses were pre-coded. Notwithstanding, a codebook was prepared to list the variables, their definitions and the numbers associated with each response (Creswell & Plano Clark, 2011).

The data in the excel spreadsheet was carefully cleaned to remove entry errors and missing variables. It was also necessary to remove variables that had a large number of missing values. According to Hair et al. (2017), missing data should be dealt with if the researcher anticipates using the SEM. Hair et al. (2017) also recommend that observations should be removed if the number of missing data on a questionnaire exceeds 15%.

After cleaning the excel data, it was imported into SPSS. The variables were then recoded from nominal data to numerical data (except the social-economic data) to enable analysis with the WarpPLS. The recording was done using the "recode into the same variables" function in SPSS. To further prepare the data for analysis with WarpPLS, variables with missing values, which were not removed in the initial data cleaning, were replaced using the "replace missing values" function in SPSS. After these transformations, the data was ready for descriptive analysis with SPSS and SEM analysis with WarpPLS.

3.4.4.1 Descriptive Statistics

Descriptive statistics, such as frequencies and means, were assessed for all variables used in the research, except for some socio-economic data (such as gender and marital status) where the means were not meaningful. In such instances, the means were ignored. The variables for the socio-economic data whose means were assessed were income, household size and duration of stay in the community. The means for all the variables of the measurement model, including Past Flood Experience (PE), Past Coping Experience (PC), Fear (FEAR), Perceived Severity (PS), Perceived Vulnerability (PV), Extrinsic Rewards (ER), Intrinsic Rewards (IR), Self-Efficacy (SE), Response Efficacy (RE), Perceived Adaptation Cost (PAC) and Adaptation Intention (AI) were also assessed.

3.4.4.2 Structural Equation Modelling

One of the main goals of this research was to explain and predict, in a reasonable manner (Tarka, 2018), the intention of the study population to adapt to future flood risk. It was established that by knowing the adaptation intentions of the population, their adaptation behaviour could be validly predicted (Gomes et al., 2017; Koerth, Vafeidis, et al., 2013; Sheeran & Webb, 2016). Structural equation modelling (SEM) makes this prediction possible by not only providing an elementary statistical description and recognising individual factors and behaviours, but also helping to determine the cause-effect linkages in the variables of interest (Hair et al., 2011; Tarka, 2018). Structural equation modelling (SEM) comprises two methods: covariance-based SEM (CB-SEM) and variance-based partial least squares (PLS-SEM) (Matthews et al., 2018).

A structural model was developed to test whether adaptation intention could be predicted by modelling the relationship between the observed and latent variables, flood experience, coping experience, fear, flood risk appraisal and adaptation appraisal. The model comprised both formatively and reflectively measured indicators. The component-based estimation approach, Partial Least Square Structural Equation Modelling (PLS-SEM), was used to test the proposed relationships among the latent and measured variables.

PLS-SEM provides a comprehensive statistical analysis (Ali et al., 2017; Hair et al., 2017). It can simultaneously test the relationships among all the variables of the conceptual model (Rasoolimanesh et al., 2015). It is a prediction-oriented approach to SEM, since it emphasises the explanation of variances, rather than co-variances (Ali et al., 2017; Hair et al., 2017). PLS-SEM focuses more on optimising prediction of the endogenous construct rather than on fit

(Matthews et al., 2018). It is the preferred method when the assumed cause-and-effect relationships between constructs have not been sufficiently explored, as pertains to some of the relationships in this study (Ali et al., 2017; Hair et al., 2017).

The conceptual model in this research was very complex, involving many formatively and reflectively measured constructs (Ali et al., 2017; Hair et al., 2017). For that reason, PLS-SEM was the preferred SEM method to model the relationships among the observed and latent variables. The latent variables of the model were aggregates of the measured variables (Hair et al., 2017).

The quality of PLS-SEM measurement and structural models are indicated by metrics showing the model's predictive capabilities (Hair et al., 2017). According to Hair et al. (2017), the most critical measurement model metrics in PLS-SEM are reliability, convergent validity and discriminant validity. The R^2 (explained variance), f^2 (effect size), Q2 (predictive relevance), and the size and statistical significance of the structural path coefficients are the most important metrics used to assess the structural model (Hair et al., 2017). The assessment of the PLS-SEM model, therefore, involved a two-step process: assessment of the measurement model and assessment of the structural model (Ali et al., 2017; Rasoolimanesh et al., 2015). In the evaluation of the measurement model, the relationship between each construct and its associated question-statements in the questionnaire were assessed (Rasoolimanesh et al., 2017).

The assessment of the structural model, on the other hand, related to the path relationships among the latent constructs (Rasoolimanesh et al., 2017). Each hypothesis that was specified in the conceptual model was associated with a causal link in the structural model. It, therefore, depicted the relationships among constructs representing the latent variables (Rasoolimanesh et al., 2015). Path coefficients, as well as their corresponding P-values, were calculated for each causal link in the model.

The model used in this research is what is called a Hierarchical Component Model (HCM), or Higher-Order Construct (HOC) (Hair et al., 2017; Matthews et al., 2018). That meant that the measurement model contained two layers of a construct, the higher-order component and the lower-order component (Matthews et al., 2018). In the present case, flood risk appraisal (FRA) and adaptation appraisal (AA) were higher-order constructs (HOC) measured by lower-order constructs (LOC), perceived severity (PS), perceived vulnerability (PV), intrinsic rewards (IR) and extrinsic rewards (ER) in the case of flood risk appraisal. Adaptation appraisal, on the other hand, was measured by self-efficacy (SE), response efficacy (RE) and perceived adaptation

cost (PAC). The relationships between the LOCs and their indicators were reflective, while the HOC and the LOCS formed a formative relationship, making the model a reflective-formative HCM. The use of HOC makes the model more parsimonious and easy to comprehend (Hair et al., 2017; Matthews et al., 2018). The use of the HCM was supported by the protection motivation theory (PMT) that underpinned the study.

A stage two HCM analysis approach was used (Hair et al., 2017; Kock, 2018; Matthews et al., 2018). In the first stage, the lower order construct was analysed to obtain indicator latent variable scores (Hair et al., 2017). These latent variable scores were then added to the data as new standardised indicators (Kock, 2018). The HCM was then analysed to obtain the metrics for model evaluation.

3.4.4.3 WarpPLS SEM Analysis

The WarpPLS 6.0 (Kock, 2018) was used to estimate the relationship between the observed and latent variables in the model. The analysis was conducted through five steps:

- Step 1: Open or create a project file to save the work
- Step 2: Read the raw data used in the SEM analysis
- Step 3: Pre-process the data for the SEM analysis
- Step 4: Define the variables and links in the SEM model
- Step 5: Perform the SEM analysis and view results

While the software has a default algorithm used for the SEM analysis, it also allows the researcher to select the algorithm to use for the SEM analysis, the resampling method used to calculate standard errors and P-values, as well as other elements that will define how the SEM analysis will be conducted (Kock, 2018). The outer model algorithm used for the present analysis was PLS Mode M (also known as a MIMIC, or mixed mode). In this algorithm, "the inner model influences the outer model through path coefficients" (Kock, 2018 pp34).

In terms of the inner model analysis algorithm, "Warp2" was used. It detects associations among latent variables defined by the functions whose derivatives are U-curves. The algorithm "warps" the predictor latent variable scores by finding best-fitting nonlinear functions that minimise sums of squared residuals on a bivariate basis (Kock, 2018).

The software also provides a resampling method for the calculation of P-values and other coefficients, such as standard errors (Kock, 2018). The "stable 3" (default) resampling method was used in the present analysis. According to Kock (2018), "stable 3" yields consistent and

more precise P-values, and relatively reliable results for path coefficients associated with indirect and total effects.

3.5 Qualitative Research Methodology

Qualitative research seeks to convey the thoughts and the feelings that affect the way people behave (Sutton & Austin, 2015). That is particularly important in this research, where the perceptions, feelings and intentions of respondents are central to predicting future behaviour in flood risk adaptation. Sutton and Austin (2015) suggest that in qualitative research, the researcher is merely trying to hear, interpret and report respondents' thoughts and feelings for others to read and learn.

Qualitative data is mainly text-based. It requires a bit of dynamism, intuition and a creative process that involves inductive reasoning, thinking and theorising (Wong, 2008). Wong (2008) defines qualitative data analyses as a process of systematically searching and arranging the interview transcripts, or observation notes that the researcher gathers to deepen their understanding of the phenomenon.

In qualitative analysis, it is essential to underscore how the data were sorted, organised, conceptualised, refined, and interpreted (Thorne, 2000).

3.5.1 Sampling Design

The sampling design used in the study was the concurrent parallel design (Onwuegbuzie & Collins, 2007), meaning different sample members participated in both the quantitative and qualitative phases of the research. The qualitative data, which was gathered from key informants, had a sample of 19 participants (Onwuegbuzie & Collins, 2007). These key informants comprised people who were considered knowledgeable about and experienced in the incidence of flooding in the community. The purposive sampling was used to recruit the participants for the interviews.

The persons of interest in the qualitative strand of the survey were people who had knowledge and experience of flooding risk in Accra and Glefe. Thus, there were two levels of persons of interest, officials and residents. Among the participants selected were two officials of the National Disaster Management Organisation (NADMO); one was an official at the Accra Metropolitan Assembly (AMA) NADMO office, while the other was an official from the national headquarters of NADMO. Both officials were directly involved in NADMO's flood management activities in Accra. NADMO is the national agency in Ghana responsible for

spearheading disaster management, response and recovery. Apart from the national office, the organisation also has decentralised offices in each Metropolitan, Municipal and District Assembly in Ghana. The NADMO officials were thus purposively selected for their experience and knowledge of the flood risk in Accra generally and Glefe specifically. Another participant who was purposively selected was the Assembly Member of the Glefe electoral area. The official possessed considerable experience regarding flooding risk in Glefe. As both a resident and elected local government representative of the community, this person was involved in the governance of Glefe. The Assembly Member was the first leader in the Glefe community that the researcher contacted. The researcher was then introduced to the traditional leaders of the community through the Assembly Member. Another person who was selected to participate in the interview was the traditional leader of the Glefe community. As the traditional leader, this person was the custodian of the land and the governing authority in the community. Their permission was needed in order to access the community to conduct the research. And their experience as both a resident and leader of the community was beneficial to the study. The other participants in the community were selected based on their length of residence in the community and their leadership roles. These persons were short-listed with the help of the Assembly Member and the traditional leader. Notwithstanding, they were all household heads in the community. Due care was taken to ensure that these household heads did not participate in both the quantitative and qualitative strand of the research. It was also ensured that an equal proportion of male (eight) and female (eight) households (and leaders) were selected to participate in the interviews in the Glefe community.

3.5.2 Development Data Collection Guide

As the primary data source for the qualitative strand of the research was the interviews, there was the need to develop an interview guide for the data collection. The conceptual model developed in the research (see Chapter 2, section 2.9) served as the guide to determine the focus of the interview guide. The interview guide was also developed with guidance from protocols used in similar research, such as the study of Birkholz (2014). The interview guide was semi-structured, and the discussion questions were open-ended (see appendices for the interview guide used). The guide was semi-structured to ensure that the interview was focused, but also to ensure that the interviews were in depth. Table 8 shows the variables in the research that were used as the basis for developing the interview guides. One interview guide was developed and later updated for each category of participants. Thus, there were different interview guides

for the NADMO officials, the Assembly Member, the Traditional Leader and the household heads (some of whom were leaders in the community).

Table 8: Concepts for key informant guide

Concepts	**Attributes**
Flood experience	The use of experience in understanding and describing flood risk
Coping experience	Concerns the efficacy of coping responses in the past
Fear	Fear (or Worry) about flood risk
Flood risk appraisal	Perceived vulnerability – the perception of the vulnerability of the settlement and exposure of individuals to flood risk
	Perceived severity – the perceived severity of flooding or its adverse damage to the person or community
Adaptation Appraisal	Self-efficacy. The perceived ability of the person to perform adaptive actions
	Response-efficacy – the perceived efficacy of the adaptive measures to reduce or eliminate flooding or its adverse impacts
	Adaptation cost – the perceived financial cost, time, and personal effort of taking adaptive responses
Adaptation Intention	The motivation or intention to undertake adaptation measures, including the specific measures to be implemented

Source: Adapted from (Birkholz, 2014; Koerth, Jones, et al., 2013; Koerth, Vafeidis, et al., 2013)

The first part of the interview guide for the NADMO officials requested their official title, number of years in the official position, age, and gender. The second part of the guide asked questions related to flood occurrences in Accra (and Glefe), measures used by residents to respond to flooding, the officials' perception of flood risk in Accra (and Glefe) and the adaptation measures that the organisation intends to undertake to adjust to future flooding. The interview guide for the Assembly differed slightly from that of the NADMO officials. Apart from questions about Glefe's flood experience risk perceptions, coping measures and intended adaptation measures, there were also questions about Glefe's history.

The interview guide for the traditional leader of Glefe and the other respondents residing in the community was structured into four parts. Similar to the interview guides for NADMO officials and the Assembly Member, the first part of the interview guide requested information such as age, gender, number of persons in their household and the number of years they had lived in the Glefe community. Part two of the interview guide was devoted to questions on flood experience and coping in Glefe, while part three addressed the flood risk appraisal and

adaptation appraisal of the respondents, mirroring the questionnaire of the quantitative strand of the research. Part four of the guide also mirrored the questionnaire of the quantitative strand of the research and addressed the respondents' flood risk adaptation intentions. The questions in the interview guides ensured that the participants' views, opinions, perspectives, and actions were captured by the research, reflecting the interpretivist philosophy of the qualitative strand of the research. As the participants in the interviews were mostly speakers of the English language, it was not necessary to translate the interview guides into the local dialect.

3.5.3. Qualitative Data Collection Processes

The interviews were conducted with community members (including the community leader), the local government representative of the community and the officials of the National Disaster Management Organisation (NADMO), both at the city administration (Accra Metropolitan Assembly) and the National Headquarters. Nineteen (19) respondents participated in the interviews, seventeen (17) community members and two (2) NADMO officials.

Together with the community's key informants, the Assembly member was first contacted and briefed about the research. The Assembly member then led the researcher to the traditional leader (chief) of the Glefe community. A written consent to enter the community to conduct the research was granted by the traditional leader. The traditional leader then gave the Assembly member the authority to help the researcher recruit interview participants. With the help of the Assembly Member, 25 participants were short-listed and contacted for recruitment into the survey. Nevertheless, other residents who met the interview criteria and expressed interest in the research were given the opportunity to participate. In total, seventeen (17) participants gave informed consent to participate in the interview. The participants were, however, given the opportunity to opt out of the interview if they wished to do so. However, none of the participants who gave informed consent opted out of the research.

The interviews followed the following process. First, the consent forms and information statements were sent to the purposively selected individuals. If they there granted consent to participate in the research, they were given the option of taking the interview at a later arranged time or at the same time they gave the informed consent. In some instances, the participants opted to take the interviews on the same day that they granted their informed consent.

The interviews with the NADMO officials occurred at their respective offices. Therefore, the researcher visited each of the offices and conducted the interviews in person. Conversely, the interviews with the Assembly Member, the Traditional Leader and the household heads took

place at a place appointed by the respondents. Out of the seventeen (17) people interviewed in Glefe, one respondent was interviewed in their house. The Assembly Member and the Traditional Leader were interviewed on the same day at the local office of the Assembly member. However, they were interviewed at different times of the day. The remaining respondents agreed to be interviewed on the same day at the same agreed location. The researcher, with the assistance of the research assistants, interviewed these respondents.

In all instances, the interview questions were read to the participants and their responses were recorded both on paper and audio-recording. The participants were informed that there would be audio-recording during the interview. Based on the response from the participant to the substantive questions, follow-up probes were used to ensure that their views and opinions were fully recorded, and a comprehensive and richer data was collected. The semi-structured in-depth interviews ensured that participants narrated their experiences, explained the reasoning for their actions and the motivations beyond their intentions. All interviews conducted during the data collection were face-to-face.

3.5.4 Qualitative Data Analysis Processes

The qualitative data analysis and interpretation follows five stages. These included (1) data preparation and organisation, (2) initial immersion, (3) coding, (4) categorising and theming, and (5) interpretation (Leavy, 2017). Phases 1 and 2 are captured in section 3.5.4.1, while phases 3 and 4 are captured in section 3.5.4.2. Phase 5, interpretation, is captured in section 3.5.4.3.

3.5.4.1 Note Taking and Transcription

The qualitative data acquired from the respondents were interview notes and audio recordings. The notes were often written verbatim. The notes were later reviewed to ensure completeness of sentences and to eliminate topographical and grammatical mistakes made during the note taking. The audio recordings were also transcribed verbatim by the researcher. Effort was made to ensure that all the information and responses given by the respondents were transcribed. The transcript was then carefully studied to eliminate typographical errors. During the interviews at the NADMO offices, the respondents referred to some official documents. The researcher requested these documents, which were made available by the respondents. Content from these documents were later used by the researcher to provide further information at the sections of the interview where these were referenced. Both the written notes, which were later typed into

the computer, and the transcribed notes were merged into one document and imported to NVivo 12, a qualitative data analysis software, for thematic analysis.

3.5.4.2 Coding of the Data

Once the full transcript of the nineteen (19) interviews was imported to NVivo, the researcher commenced coding the data. Since the interview guides were designed based on variables of the conceptual model formulated in the study, the variables became the unit of analysis and the majority of the themes followed the same pattern. However, there were certain issues raised in the interviews that did not explicitly fall within any of the predetermined major themes and were thus coded as new themes. The transcripts from each of the interviews were carefully studied and paragraphs, sentences, phrases, or a word (if appropriate) were selected and coded to the units of analysis that they closely aligned with. The coding process thus began with literal codes (Leavy, 2017). After initial coding was completed, the researcher engaged in a process of analysing and re-analysing the data (Leavy, 2017), recoding some information under different themes while grouping and regrouping other codes. Discussions were also held with the researcher supervisors to increase the reliability of the coding process. After those discussions, and the researcher's analysis and re-analysis of the codes, some themes that were originally coded as major themes were demoted to child codes, while others that were initially coded as child codes were made into major themes. Sometimes, certain themes in the first stage of coding were merged into other themes (either as child nodes or into the existing node) or renamed to reflect the content properly. The coding procedure that was adopted is what is commonly called in-vivo coding, which allowed for the participants' language to be maintained (Leavy, 2017).

3.5.4.3 Interpretation of the results

For the interpretation of the data, triangulation was adopted to examine the data (Leavy, 2017). With the data triangulation, literature, and the protection motivation theory (including the conceptual model postulated) were used to make meaning and to understand the results. As the research was designed such that the qualitative results would be used to validate, confirm or corroborate the quantitative results through the merging process, in-depth discussion of the interpretation of the results will be covered under that section.

3.5.5 Trustworthiness, Reliability and Validity of the Qualitative Data

It has been noted that qualitative research needs to address issues of trustworthiness, reliability, and validity of conducting, analysing, and reporting qualitative research (Rose & Johnson, 2020). Rose and Johnson (2020) opined that by considering social science practices that ensure trustworthiness, reliability, and validity in qualitative research, the quality, importance, and applicability of qualitative research can be strengthened. Validity in the qualitative research was ensured by using the research methods appropriately and making sure that the data collected, and the conclusions made from the findings were within the scope of the research. Data triangulation, discussed in the preceding sections, also helped to achieve validity.

Trustworthiness and reliability were achieved by following what Leavy (2017) terms explicitness, thoroughness, and congruence of the qualitative research. Leavy (2017) explains that explicitness means that the researcher has clearly explained the methodological strategies adopted in the research, as well as the role of the researcher. Leavy also explained congruence as how the various aspects of the research fit together, including how the questions, methods and findings fit together, and how the data collection and analysis fit together. Thoroughness, on the other hand, is explained by Leavy (2017) to mean how comprehensive the research components are, including the sampling and data collection. Explicitness, thoroughness and congruence were achieved by clearly explaining the methodology, sampling design, interview guide development, data collection processes and data analysis procedures, as found in the current chapter. Ensuring trustworthiness and reliability has made it possible for the research to replicable based on the descriptions (Rose & Johnson, 2020) in the present chapter.

3.6 Merging of Quantitative and Qualitative Results

After the quantitative and qualitative analyses were conducted separately, the results were synthesised into a coherent whole to understand the factors influencing flood risk adaptation intentions in informal settlements. The measurement and structural model assessment in the quantitative analysis and the subsequent testing of the hypothesis resulted in the prediction of the relationships among the constructs. The results from the qualitative analysis were then used to confirm, corroborate, and validate the quantitative results during the interpretation. Chapters 4 and 5, respectively, present the results of the quantitative and qualitative analyses, while Chapter 6 presents the synthesis of both sets of results from the quantitative and qualitative strands of the research. The synthesis enabled one overall interpretation of the findings of the research (Creswell & Plano Clark, 2011). The merging of the results followed the procedures

of the convergent triangulation mixed methods design. The purpose was to ensure valid and well-substantiated conclusions (Creswell & Plano Clark, 2011) about flood risk adaptation intentions in Glefe to enable a better understanding of flood risk adaptation intentions in similar contexts.

Furthermore, the merging of the results adhered to the conceptual and theoretical model postulated in the research. It further reflected the hypotheses developed and tested in the quantitative strand of the research. Each hypothesis was discussed and the qualitative themes that corresponded with the issues espoused by that hypothesis were used to collaborate, confirm or explain the quantitative findings. In cases where the quantitative results and the qualitative results were contradictory, both results were presented. Literature was then used to provide further explanations of why the results were contradictory. Literature was also used in much of the merging and discussions to explain whether the findings confirmed or contradicted previous research.

3.7 Research Ethics

Ethical issues are an essential component of research. According to (Yip et al., 2016), researchers are duty-bound to protect the life, health, dignity, integrity, privacy and confidentiality of research participants' information. Furthermore, it is required that good research be well adjusted, well-planned, appropriately designed, and ethically approved (Jenn, 2006).

Due to the importance of ethical issues in research, ethics approval was sought and obtained from the University of Newcastle's Human Research Ethics Committee (approval number: H-2018-0415). The data collection and handling of all participant information therefore adhered to the ethical requirements of respect, fairness, care and honesty.

- Respect. The research ensured that potential cultural sensitivities were acknowledged and addressed. The research was conducted according to the local customs of Glefe. It was necessary to ensure that cultural arrangements and hierarchy of leadership and information flow in the community were respected. For this reason, informed consent was first sought from the community leader (the Chief) as a mark of respect and then the local government representative (Assembly Member) for permission to enter the community.
- Fairness. It was also crucial that the research was locally relevant. This was proved by the fact that the research was about flooding risk, which was a current and continuing risk factor in the community. Also, local support systems (such as the respondents,

community leader, and research assistants) were compensated fairly for their contribution to the research. No exploitative and manipulative tactics were countenanced. Careful attention was given to the way the research was conducted to ensure that participants were not re-traumatise or given unrealistic expectations. All research participants who needed psychological support were directed to appropriate health facilities.

- Care. The research measurement instruments and recruitment information (informed consent procedures) were tailored to local requirements.
- Honesty. The roles of the research participants and the local contact persons were clearly stated in the information statements and consent forms. All information relevant to informed consent was presented honestly. Verbal instead of written consent was accepted in cases where participants declined to sign anything. It was made explicit to the participants that there would not be a direct benefit to them from participating in the research.

It was further ensured that the research participants and their personally identifying information was kept confidential. In the analysis of the qualitative data, codes were assigned to anonymise the responses.

3.8 Summary of Chapter 3

In Chapter 3, the methodology and methods applied in this research were discussed. That included the philosophical underpinnings of the research, the methods used, the sampling procedures and the measurement framework, and the data collection and analysis processes. The chapter further outlined the data processing and analytical techniques applied in the study. The chapter also discussed the processes that were undertaken to ensure that the research processes adhered to ethical requirements. The next Chapters, 4 and 5, will present the results of the quantitative and qualitative data analysis, respectively.

CHAPTER 4: RESULTS OF QUANTITATIVE DATA ANALYSIS

4.1 Introduction

In the previous chapter, the research design and methodology adopted in this research was presented. The current chapter presents the results of the analysis of the quantitative data. The chapter responds to objective two of the study, which sought to "test hypotheses on the relationship between the constructs representing household experience and appraisals, and the flood risk adaptation intentions using quantitative data." The first segment of the chapter captures the demographic and socio-economic characteristics of the study population in simple descriptive statistics. It further presents the descriptive statistics of the indicators used to measure constructs in the model. The chapter then details the results of the Partial Least Squares Structural Equation Modelling (PLS-SEM). The structural equation modelling (SEM) analysis was done using WarpPLS 6.0. The results particularly explicate the assessment of the measurement and structural models. Further analysis, such as the assessment of mediation and moderation effects, have also been presented. The final part of the PLS-SEM analysis results shows the outcome of the hypothesis testing.

4.2 Demographic and Socio-economic Characteristics of Respondents

The demographic and socio-economic information obtained during the data collection were gender, age, the highest level of education attained, marital status, household size, employment status, total household income and tenancy status. Table 9 shows descriptive statistics for the highest level of education attained and marital status of respondents.

The results revealed that the respondents were 37.2% male (n=146) and 62.8% (n=246) female. The number of females (62.8%) was higher than the 51.5% reported by the Ghana Statistical Service (GSS) 2010 census data for Glefe (GSS, 2012a). At the national level, the Ghana Statistical Service 2010 census report shows that females and males were 51% and 49% of the population, respectively. The report however clarified that in some localities, the females to males ratio was higher (GSS, 2014). The GSS report further suggests that a higher ratio of females to males in urban areas compared to rural areas may be an indication of more females migrating to the urban centres than males. The above may be one reason why there were more females than males in the study population. Another probable reason could be the timing of the survey. The majority of the survey data was collected during the weekday when most males would have gone into the city for work. That assertion is supported by Ghana Statistical Service analysis showing that two-thirds of females in urban Ghana were self-employed without

employees (see Table 10), mostly in the informal sector (GSS, 2014). Thus, females mostly operated their businesses in the community as compared to males, who had to travel outside the community to work.

Moreover, 61.5% (n=241) of the respondents were married, while 29.3% were single, as shown in Table 9. In comparison, 39.4% of Ghana's urban population above 12 years of age are married, while 45.9% are single (GSS, 2014). Besides, the average household size was 4.7. That compares favourably with the national average of 4.4 members per household (GSS, 2012b).

Furthermore, the highest level of education of most (41.8%) respondents was Middle school/Junior High School. The respondents who completed Senior High School or vocational/technical education represented 21.7% (n=85) and 5.9% (n=23) of the sample population, respectively. Just 1.8% (n=7) of the respondents attained a first-degree qualification, while 1.5% (n=6) completed a diploma. In comparison, the Ghana Statistical Service 2010 census report shows that 30.6% of the urban population completed Middle school/Junior High School, while 15.8% completed Senior High School or vocational/technical education. The report further shows that 3.4% and 2.8% of urban residents completed diploma and first-degree qualifications, respectively (GSS, 2014). Thus, the proportion of people in Glefe who attained higher education, such as diplomas and degrees, were lower than the national averages of urban Ghana. Table 9 shows the marital status and educational attainments of the respondents.

Table 9: Descriptive Statistics for Gender, Age. Highest Level of Education and Marital Status of Respondents

Demographic and Socio-economic Variable	Group/Category	Frequency	Percentage
Highest Educational Level	Primary	44	11.2
	Middle school/JSS/JHS	164	41.8
	SSS/SHS	85	21.7
	Vocational/Technical	23	5.9
	University Undergraduate	7	1.8
	Diploma (Nursing/Teacher/Polytechnic)	6	1.5
	Postgraduate	2	0.5
Marital Status	Single	115	29.3
	Married	241	61.5
	Separated	12	3.1
	Divorced	7	1.8
	Widowed	17	4.3

Source: Author

Also, 65.8% of respondents were self-employed, while 5.6% were employees in the private sector, and another 5.6% were employees in the public sector, as shown in Table 10. Comparatively, 60.9% of the urban dwellers were self-employed during the 2010 population and housing census (GSS, 2014). In terms of tenancy status, 46.7% (n=183) of respondents lived in dwelling units they owned, while 42.1% (n=165) were renting. In contrast, 32% of all urban households in Ghana were living in their own dwelling units, while 45% were renting during the 2010 census (GSS, 2014). The tenancy status of respondents may be crucial to property-level flood risk adaptation, as some existing research suggests that ownership of a home positively correlates with mitigation behaviour (Poussin et al., 2014).

Table 10: Household sizes, Employment Status and Tenancy Status of the Sample Population

Demographic and Socio-economic Variable	Group/Category	Frequency	Percentage
Employment Status	Unemployed	71	18.1
	Schooling	19	4.8
	Self-Employed	258	65.8
	Public Sector Employee	22	5.6
	Private Sector Employee	22	5.6
Tenancy Status	Owner Occupied	183	46.7
	Renting	165	42.1
	Rent-free	39	9.9
	Perching	4	1.0
	Squatting	1	0.3

Source: Author

Moreover, the income of households was collected as grouped data. Therefore, the values depicted in these results are midpoints of the grouped data. The mean monthly household income was GHS845.80. A majority of the respondents (27.8%) reported a monthly household income of about GHS501.00. The highest household monthly income was GHS3001.00, earned by 0.5% households, while the lowest income was GHS251.00. Households that did not report any monthly household incomes were 6.4% of the population. Figure 7 depicts monthly household income in Ghanaian Cedi (GHS). The income and employment characteristics were important in order to aid understanding of the economic situation of the households.

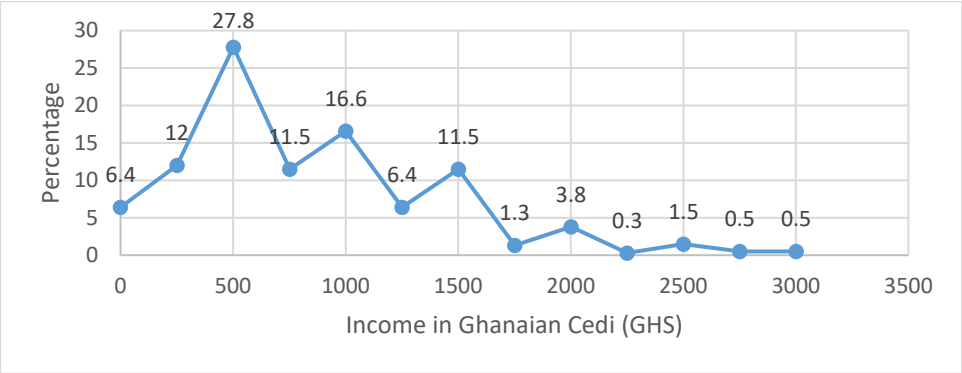

Figure 7: Monthly Income of Households in Ghanaian Cedi
Source: Author

4.3 Strategies to Cope with Flood Risk

This section examines the coping strategies used in Glefe to respond to flood risk. Out of a total of 392 respondents, 339 (approximately 87%) had adopted at least one approach to cope with flooding in the past. Table 11 shows the coping strategies used by respondents to deal with flooding in Glefe.

Table 11: Coping Strategies Used to Respond to Flooding

Coping Strategies	**Frequency**	**Percentage**
Rebuild damaged walls of buildings	62	15.8
Remove water from the inside of the house	154	39.3
Store important documents in safe places	47	12.0
Create water barriers in flooded areas	83	21.2
Clear gutters, drains or waterways in the community	87	22.2
Transfer valuables to a safe place	42	10.7
Temporary relocation to another community	27	6.9
Temporary relocation to higher ground in this community	38	9.7
Channel water away from the house	124	31.6
Repair damaged roof	25	6.4

Note: *Totals for each coping strategy are out of 392 possible responses.* Source: Author

As shown in Table 11, removing floodwater from the inside of the house was the most prevalent (39.3%) coping strategy used. The next most frequent strategy was channelling floodwater away from the house, which 31.6% of respondents adopted. It is, however, important to emphasise that the above responses were quite similar. The former means inundated households use buckets, cups and other containers to scoop floodwaters out of their dwelling. In contrast, the latter means the people dug channels through their walls or courtyard to channel

the floodwaters away from their homes. Some of the respondents (21.2%) also created water barriers to prevent floodwaters from entering their houses.

Moreover, 22.2% cleared gutters, drains or waterways of any debris or waste that might prevent the free flow of floodwaters. Temporary relocation to another community (6.9%) and repair of damaged roofs (6.4%) were the least adopted coping actions during or in the immediate aftermath of flooding. It is essential to emphasise, however, that one household could have adopted a combination of these coping actions. For example, eleven households both removed water from inside of their house, as well as channelled water away from their house. Similarly, ten households both cleared gutters, drains and waterways while also channelling floodwaters away from their house. Another seven households removed water from inside their house and created water barriers in flooded areas around their house. With the exception of rebuilding damaged walls and repairing damaged roofs, the coping measures provided only temporary protection and needed to be repeated during the next flood, as was discussed in the literature review, Chapter 2, section 2.6.

4.4 Descriptive Statistics of Indicators

This section presents the descriptive statistics (that is, the frequency, mean, standard error of the mean (SE), and standard deviation (SD)) of the indicators used to measure the constructs in the model. The latent constructs that were measured were Past Flood Experience (that is, previous experience of flooding), Past Coping Experience (previous attempts at coping with flooding), Fear (worry or anxiety about current and future flood risk), Flood Risk Appraisal (which is a second-order latent construct resulting from the first-order constructs Perceived Severity, Perceived Vulnerability, Intrinsic Rewards and Extrinsic Rewards), Adaptation Appraisal (a second-order latent construct resulting from the first-order constructs Self Efficacy, Response Efficacy and Perceived Adaptation Cost), and Adaptation Intention. The indicators were all measured on a five-point Likert scale.

4.4.1 Past Flood Experience (PE)

Respondents' experience with flooding was measured using eight indicators. However, four of these indicators did not receive responses due to the skipping pattern employed in the questionnaire. They were, therefore, removed during the data screening. Table 12 shows the descriptive statistics for the indicators of the "PE" construct. The mean values ranged from 2.04 (PE7) to 3.74 (PE2). For simplification purposes, the mean scores are classified as low (1.0 to 2.4), medium (2.5 to 3.4), and high (3.5 to 5.0). Thus, respondents rated PE2 (impact of

floods on friends and relatives) as high, while giving a low score to PE7 (someone in the household is still suffering an ongoing injury or illness). They also gave a 'medium' rating to PE1 (physical damage to their home).

The standard error of the mean (which is an indication of how the sample mean reliably represents the population mean) also ranged from 0.042 (PE7) to 0.076 (PE1). The low standard error of the mean (SE) certifies that the sample mean accurately reflects the population mean. The standard deviation scores also ranged from 0.839 (PE7) to 1.509 (PE1). The standard deviations show that individual responses to the question statements were a little over 1 point away from the mean. The majority of responses to 'experience with the past flooding' were thus either "severe" or "very severe".

Table 12: Descriptive Statistics of Past Flood Experience Indicators

Past Flood Experience (PE)	**None**	**Very Mild**	**Moderate**	**Severe**	**Very Severe**	**Mean**	**SE**	**SD**
	%	%	%	%	%			
PE1- The physical damage to my house was	26.3	6.1	17.9	27.0	22.7	3.14	0.076	1.509
PE2-The impact on my friends/relatives was	13.5	2.0	14.0	37.8	32.7	3.74	0.066	1.305
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**			
PE7- Someone in the household is still suffering an ongoing injury or illness	20.4	65.6	5.9	5.9	2.3	2.04	0.042	0.839
PE8- Coping actions reduced the impacts of past floods	7.4	27.0	3.8	44.6	17.1	3.37	0.063	1.250

Source: Author

4.4.2 Past Coping Experience (PC)

The 'Past Coping Experience' variable probed whether the respondents had undertaken coping measures in response to flooding in the past and how effective those measures were in reducing flood damage and impacts. Firstly, the respondents were asked whether they had engaged coping measures in the past. The majority (approximately 87%) acknowledged that they had resorted to coping measures during past floods. Based on these responses, a list of coping measures was presented to them to gauge their level of agreement that these coping mechanisms were effective in reducing or eliminating harm, damage and losses from the past flooding events. The mean scores for their responses ranged from 3.41 (PC8 - Temporary relocation to another community) to 4.28 (Channel water away from my house). The standard

error of mean values also ranged from 0.016 (PC11 - Repair damaged roofs) to 0.038 (PC3 - Remove water from the inside of the house). The standard deviation, on the other hand, ranged from 0.317 (PC11 - Repair damaged roofs) to 0.754 (PC3 - Remove water from the inside of the house), indicating that many responses were close to the mean. Table 13 shows the descriptive statistics for the indicators.

Table 13: Descriptive Statistics for Past Coping Experience Indicators

Past Coping Experience (PC)	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Mean**	**SE**	**SD**
	%	%	%	%	%			
PC2- Rebuild damaged walls of buildings	1.0	0.5	0.8	6.4	91.3	4.15	0.022	0.434
PC3-Remove water from inside house	3.1	8.2	62.7	19.9	6.1	3.45	0.038	0.754
PC4- Store Important documents in safe places	1.0	0.8	0.5	94.6	3.1	3.83	0.020	0.394
PC5- Create water barriers in flooded areas	3.6	1.8	0.8	87.2	6.6	3.60	0.033	0.659
PC6- Clear gutters, drains or water ways in the community	1.3	1.8	0.5	89.3	6.9	3.99	0.024	0.466
PC7-Transfer valuables to a safer place	1.3	1.8	0.5	93.9	2.6	3.50	0.022	0.437
PC8- Temporary relocation to another community	0.8	1.5	93.1	3.3	1.3	3.41	0.017	0.345
PC9- Temporary relocation to higher ground in this community	0.5	1.8	95.7	5.4	1.5	3.58	0.018	0.348
PC10- Channel water away from my house	0.5	1.3	1.3	82.7	14.3	4.28	0.024	0.477
PC11- Repair damage roofs	0.5	0.5	0	95.4	3.6	4.16	0.016	0.317

Source: Author

4.4.3 Fear (FW)

The ‘fear’ variable measured people’s dread, worry, anxiety or concern about current and future flood risk. The mean scores for the indicators of this variable show that the people had a high level of trepidation about flood risks. The mean scores ranged from 1.90 (FW7 - Floods don’t happen often enough to make them a high priority) to 4.16 (FW6 - I am concerned for the safety of houses in my community). The SE values also ranged from 0.034 to 0.066, showing that the sample mean reliably depicts the population. Moreover, the deviation of the individual responses from the mean ranged from 0.681 to 1.305. Table 14 shows the descriptive statistics for the “Fear” variable. The results displayed in Table 14 are an indication that respondents were very fearful of the risk and impacts of current and future floods.

Table 14: Descriptive Statistics for Fear Indicators

FEAR/Worry (FW)	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**			
	%	%	%	%	%	**Mean**	**SE**	**SD**
FW1- I fear for the safety of the people in my household	5.1	16.6	4.1	51.8	22.4	3.7	0.058	1.140
FW3- I am concerned for my house (building)	2.6	15.6	3.6	52.8	25.5	3.83	0.053	1.057
FW4- I am worried about the loss of people's jobs	3.1	8.7	3.3	58.4	26.5	3.97	0.049	0.960
FW5- I am concerned for the safety of people in my community	0.3	5.4	1.0	65.8	27.6	4.15	0.036	0.708
FW6- I am concerned for the safety of houses in my community	0.3	4.8	0.3	67.6	27.0	4.16	0.034	0.681
FW7- Floods don't happen often enough to make them a high priority	49.0	32.9	2.3	11.2	4.6	1.90	0.059	1.169
	None	**Low**	**Moderate**	**High**	**Very High**			
FW2- My level of concern/worry about future flooding	12.5	12.2	11.0	41.6	22.7	3.5	0.066	1.305

Source: Author

4.4.4 Perceived Severity (PS)

'Perceived Severity' is one of the constructs that constitute Flood Risk Appraisal (FRA). It measures respondents' perceptions of the severity of floods in terms of frequency of occurrence and impacts. The construct was assessed using seven (7) indicators. The mean scores show a high (3.5 to 5.0 mean value) level of agreement for all the propositions except the indicator 'PS4' (Problems caused by floods in the future will take longer to rectify), which had an average rating of 3.47. The standard error (SE) of all the indicators is low, signalling the reliability of the sample mean to reflect the population mean. Though the respondents generally held a high perception of the severity of future floods, there was also an indication that they needed more information about future flood probability. That was depicted by the mean score of 4.14 for PS6 (I need more information about the potential risk of future floods) as shown in Table 15. The SD (0.569 to 1.291) suggests that most responses were 0.569 to 1.291 away from the mean. The SE, which indicates the reliability of the mean, was also low (from 0.029 to 0.065) for all the indicators. The SE thus portrays the sample mean as representative of the population.

Table 15: Descriptive Statistics for Perceived Severity Construct

Perceived Severity (PS)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SE	SD
	%	%	%	%	%			
PS1- Future flooding will be more severe	2.3	7.1	31.9	34.7	24	3.71	0.050	0.984
PS2- Future flooding will be more frequent	1.3	8.4	38.5	33.7	18.1	3.59	0.047	0.923
PS3- it could be that the destruction will be great	1.0	5.9	26.0	37.0	30.1	3.89	0.047	0.937
PS4- Problems caused by floods in the future will take longer to rectify	4.6	17.3	24.0	34.4	19.6	3.47	0.057	1.126
PS5- I need more information about the severity of future floods	0.0	1.8	5.6	71.7	20.9	4.12	0.029	0.569
PS6- I need more information about the potential risk of future floods	0.0	2.0	6.1	68.1	23.7	4.14	0.030	0.602
PS7- I think I am likely to experience a serious future flood	7.9	19.9	13.5	31.6	27.0	3.50	0.065	1.291

Source: Author

4.4.5 Perceived Vulnerability (PV)

Exposure and vulnerability are vital components of flood risk appraisal. The latent construct, perceived vulnerability, therefore depicted these concepts. The construct was measured by seven indicators, depicting exposure and vulnerability in diverse ways. The majority of the indicators (PV1, PV5, PV6, and PV7) were rated highly, shown by the mean scores ranging from 3.53 (PV1 - My location is prone to flooding) to 3.97 (PV6 - Flooding in my area damages houses).

Table 16 shows that many respondents agreed with the propositions about their perceived vulnerability and exposure to future flood risk. The indicator ‘PV3’ (My house often gets flooded) had a mean score of 3.26. The indicator ‘PV4’ (flooding causes health problems in my household) also had a mean score of 3.28. That shows that a high number of respondents agreed with the proposition, while an equally high number disagreed with it, as represented in Table 16. The SD values, stretching from 0.934 to 1.375, showed that most responses were approximately 0.9 to 1.3 away from the mean. The SE values (ranging from 0.047 to 0.069) on the other hand, were low, showing that the sample mean provided a reliable depiction of the population mean.

Table 16: Descriptive Statistics for Perceived Vulnerability Construct

Perceived Vulnerability (PV)	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Mean**	**SE**	**SD**
	%	%	%	%	%			
PV1- My location is prone to flooding	11.7	18.4	2.3	40.3	27.3	3.53	0.069	1.368
PV2- I think my house will be flooded	11.0	24.2	7.1	35.2	22.4	3.34	0.068	1.349
PV3- My house often gets flooded	11.0	29.3	4.8	32.4	22.4	3.26	0.069	1.375
PV4- Flooding causes health problems in my household	5.4	33.7	4.6	40.3	16.1	3.28	0.062	1.234
PV5- Flooding can lead to people in my household being out of work	3.1	27.3	3.6	41.3	24.7	3.57	0.061	1.214
PV6- Flooding in my area damages houses	2.3	12.8	3.3	48.5	33.2	3.97	0.053	1.041
PV7- Flooding will financially cost my household a lot	1.0	13.0	2.8	59.4	23.7	3.92	0.047	0.934

Source: Author

4.4.5 Intrinsic Rewards (IR)

While 'Intrinsic rewards' form part of the first-order indicators that make up flood risk appraisal, the literature suggests it usually has a negative influence on the construct. 'IR' reflects perceptions that impede honest appraisal of flood risk, as shown in Figures 8 and 9. In a real sense, they are maladaptive responses that assuage people's fear of the risk or the need to take protective measures to reduce risk.

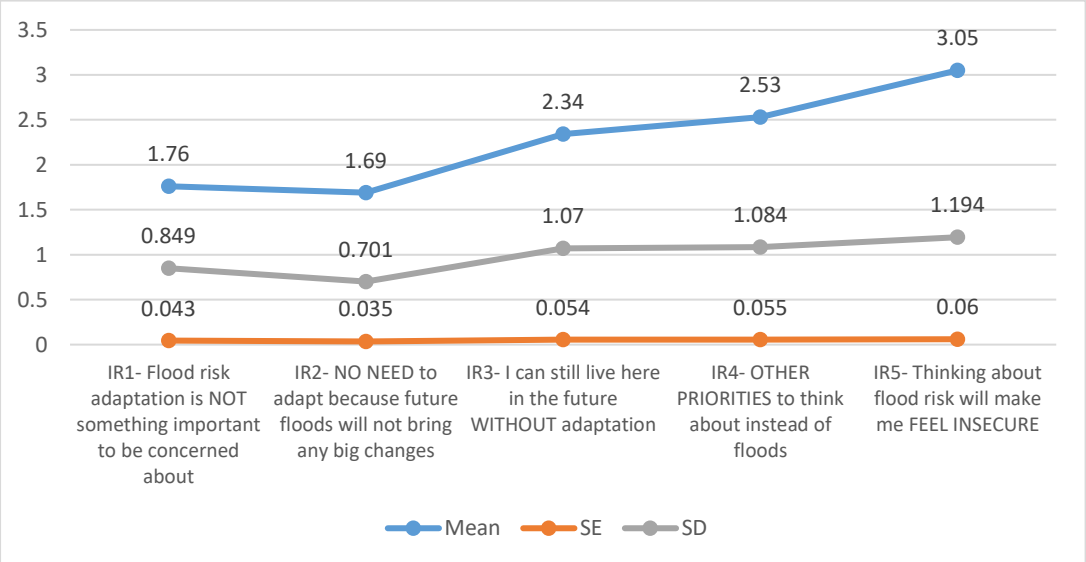

Figure 8: Mean, SE and SD of Intrinsic Rewards Indicators
Source: Author

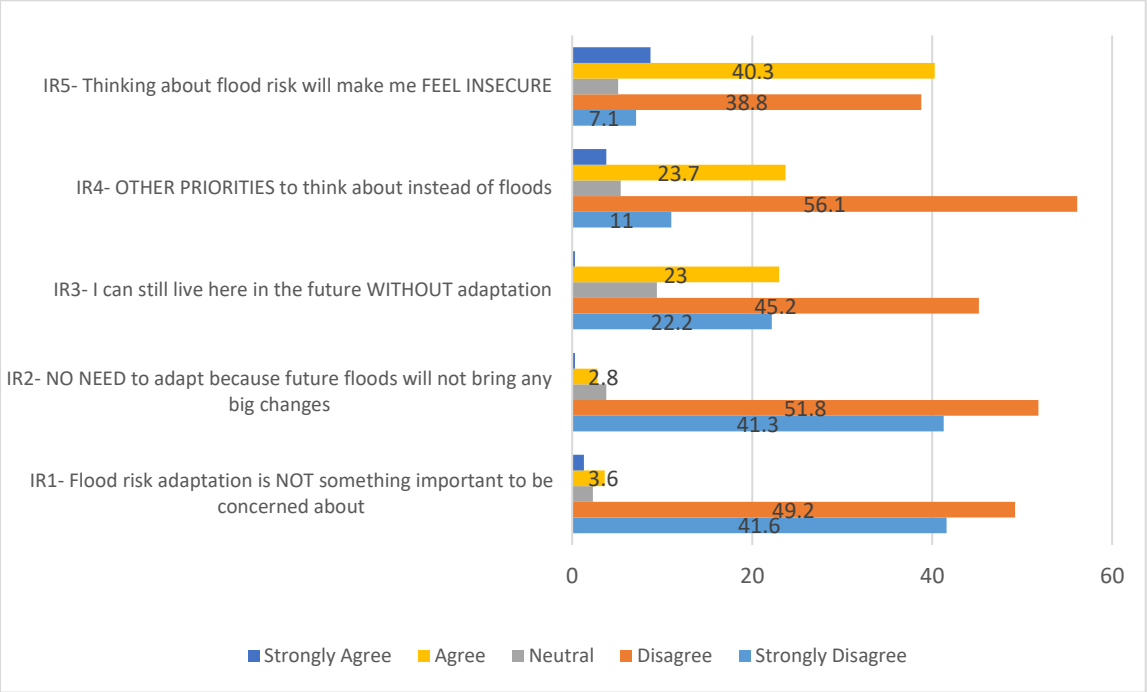

Figure 9: Frequencies (%) of Responses on Intrinsic Rewards
Source: Author

The responses to the five (5) indicators measuring the construct show a general disagreement with the question statements, with mean values ranging from 1.69 to 3.05, as shown in Figure 8. In particular, the 40.3% agreement (as shown in Figure 9) with IR5 (mean score of 3.05, SE of 0.060 and SD of 1.194) corroborates the finding that the respondents were very concerned about current and future flood risk.

4.4.6 Extrinsic Rewards (ER)

The 'Extrinsic Rewards' construct measured respondents' perceptions of other people's views about their adaptation actions. Three indicators measured the construct on a five-point Likert scale. The results show a general disagreement with the question statements. In all three of the propositions, strongly disagree and disagree received more than 70% of responses. The mean scores varied between 1.70 and 2.03, confirming that responses ranged from strongly disagree to disagree. As shown in Table 17, the SE values (0.033 to 0.051) for "extrinsic rewards" indicators were low, confirming the reliability of the sample mean scores to represent the population averages. Furthermore, the values of the SD (0.657 to 1.008) show that most responses were approximately 0.6 to 1 point above the mean.

Table 17: Descriptive Statistics for Extrinsic Rewards Construct

Extrinsic Rewards (ER)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SE	SD
	%	%	%	%	%			
ER1-People will laugh at me if I take actions to adapt to future floods	38.0	57.4	1.8	2.6	0.3	1.70	0.033	0.657
ER2- None of my friends/my family are taking any adaptation actions	35.5	38.5	14.8	9.9	1.3	2.03	0.051	1.008
ER3- The people in this community are not interested in adaptation	35.7	38.3	15.3	9.4	1.3	2.02	0.051	1.002

Source: Author

4.4.7 Self-Efficacy (SE)

'Self-Efficacy' is one of the first-order constructs that make up the higher-order construct Adaptation Appraisal (AA). Self-efficacy measures the respondent(s)' perceptions of their ability (know-how) to perform flood adaptation actions. Table 18 depicts the results of the measurements.

As shown in Table 18, mean values for the indicators varied from 2.87 to 3.59. The level of agreement with the propositions thus varied from disagreeing to agreeing. The SD values also ranged from 1.007 to 1.178, indicating that the responses were quite spread out, with high concentrations mostly above the mean. The SE values (0.051 to 0.060) are also low, confirming the accuracy of the sample means. On an individual indicator basis, the mean of 'SE1' (3.59) indicates that the majority (50.0%) of respondents perceived that they could "take proactive actions to reduce future flood impacts". On the other hand, the mean (2.87) of 'SE7' portends that the majority (51.0%) of respondents thought they were not "creative in findings solutions to flooding risks".

Table 18: Descriptive Statistics for Self-Efficacy Construct

Self-Efficacy (SE)	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**			
	%	%	%	%	%	**Mean**	**SE**	**SD**
SE1- I can take proactive actions to reduce future flood impacts	0.3	24.7	7.7	50.0	17.3	3.59	0.053	1.049
SE2- I can take long term actions to reduce future flood impacts	0.00	34.9	8.9	39.0	17.1	3.38	0.057	1.132
SE3- I can take advantage of beneficial opportunities brought by future floods	0.00	41.1	13.3	26.5	19.1	3.24	0.060	1.178
SE4- I have the skills to undertake adaptation measures	0.8	51.0	15.8	21.9	10.5	2.90	0.055	1.083
SE5- I know what to do to adapt to future floods	0.3	32.4	17.6	37.8	12.0	3.29	0.053	1.054
SE6- It is too difficult to adapt to floods	1.0	28.8	14.3	48.2	7.7	3.33	0.051	1.007
SE7- I am creative in finding solutions to flood risks	0.3	51.0	13.3	30.1	4.8	2.87	0.051	1.011

Source: Author

4.4.8 Response Efficacy (RE)

Response efficacy is another of the variables that comprise adaptation appraisal. This variable measured the perception of household heads about the effectiveness of proposed adaptation measures. As shown in Table 19, most respondents agreed (variable RE1 to RE6) that adaptation measures had the potential to reduce the impacts or harm caused by flood hazards. However, there were split opinions on the likelihood of housing property values appreciating due to adaptation measures. That is evidenced by the responses to 'RE7' (Adaptation actions will increase the value of my property), for which more than 50% of respondents either chose to disagree or neutral, as shown in Table 19. The mean scores ranged from a 'medium' value of 3.39 (RE7) to a high value of 3.90 (RE6). The low SE values (ranging from 0.046 to 0.059) indicate that the sample mean is a reliable representation of the population mean. The standard deviations, on the other hand, ranged from 0.903 to 1.165.

Table 19: Descriptive Statistics for Response Efficacy Construct

Response-Efficacy (RE)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SE	SD
	%	%	%	%	%			
RE1- Proactive measures will reduce future flood damage to my house	0.3	17.1	7.1	62.2	13.3	3.71	0.046	0.911
RE2- Proactive measures will increase the safety of my household from floods	0.00	16.3	6.9	61.7	15.1	3.76	0.046	0.903
RE3- Long term actions will reduce my chances of being seriously flooded	0.00	18.6	8.2	54.6	18.6	3.73	0.049	0.971
RE4- Beneficial opportunities will make us strong against future flood impacts	0.00	24.5	15.3	44.1	15.3	3.50	0.052	1.024
RE5- Adaptation actions will make this community a safe place to live in the rainy season	0.00	17.6	6.6	45.7	30.1	3.88	0.052	1.030
RE6- Adaptation actions will prevent future losses due to floods	0.00	15.6	6.4	50.8	27.3	3.90	0.049	0.975
RE7- Adaptation actions will increase the value of my property	0.8	29.8	23.2	22.4	23.7	3.39	0.059	1.165

Source: Author

4.4.9 Perceived Adaptation Cost (PAC)

Perceived adaptation is another component of adaptation appraisal. The variable portrays household heads' perception about the money, time and effort required to implement adaptation measures. A set of adaptation measures from the literature were shown to the respondents to assess the perceived cost of their implementation. As shown in Table 20, the mean values ranged from 2.58 (with the variable PAC2) to 3.29 (with the variable PAC4). The standard error for the various indicators ranged from 0.050 (PAC2) to 0.058 (PAC1). The low SE values mean that the sample mean is a reliable representation of the population mean. The standard deviations, on the other hand, ranged from 0.993 (PAC2) to 1.144 (PAC1), showing that most individual responses were about 1 point above the mean values.

The responses to 'PAC2' also indicate that the majority (64.7%) of respondents disagreed with the suggestion that it was more important to spend money on other things than adaptation. These responses agree with the responses to 'IR4' (other priorities to think about instead of floods) and 'IR1' (Flood risk adaptation is NOT something important to be concerned about). They show that the respondents agreed that flood risk required their attention.

Table 20: Descriptive Statistics for Perceived Adaptation Cost Indicators

Perceived Adaptation Costs (PAC), six items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SE	SD
	%	%	%	%	%			
PAC1- Adaptation costs are less than the costs of inaction	4.3	30.9	13.3	39.3	12.2	3.24	0.058	1.144
PAC2- I prefer spending my money on something else rather than adaptation	4.8	59.9	12.8	17.6	4.8	2.58	0.050	0.993
PAC3- Adaptation is too time-consuming	0.5	40.8	13.5	40.3	4.8	3.08	0.051	1.011
PAC4- Adaptation measures are too expensive	0.3	31.9	15.8	42.3	9.7	3.29	0.052	1.028
PAC5- Adapting to floods is inconvenient	0.8	33.7	12.0	45.7	7.9	3.26	0.052	1.036
PAC6- Adaptation measures will involve too much effort	1.0	32.4	12.0	48.7	5.9	3.26	0.051	1.011

Source: Author

4.4.10 Adaptation Intention (AI)

Adaptation Intention is the motivation for adaptation action that arises as an individual or household appraises flood risk and their capacity or efficacy to perform recommended adaptation measures with success. The construct was measured by 13 indicators, with three indicators being general adaptation intentions and the remaining 10 being specific adaptation measures that could be implemented to reduce flood risk.

As shown in Table 21, the indicators ‘AI1’ to ‘AI3’ had mean values ranging from 4.03 (AI1) to 4.22 (AI3), showing strong agreement with the propositions. When ‘agree’ and ‘strongly agree’ are aggregated for each of those three indicators (AI1, AI2, and AI3), more than 80% of respondents support the intentions postulated. Indicator AI3 (I think the government should take greater responsibility to protect us from future floods) had 53.6% of respondents “strongly” agreeing with the question statement. The indicators proposing more specific adaptation actions had means ranging from 2.68 (AI6- I will take out insurance on my home) to 3.87 (AI4- I will strengthen the physical structures of my home). The majority (56.9%) of respondents “disagreed” with the proposition of ‘AI6’ (I will take out insurance on my home). Moreover, the indicator ‘AI8’ (I will move to a less flood-prone area in this community) had 51% of respondents ‘strongly disagreeing’ and ‘disagreeing’ with the preposition. The SE

values also ranged from 0.043 (AI1) to 0.064 (AI7), confirming the reliability of the sample mean in representing the population. The SD values ranged from 0.832 to 1.258, indicating that most of the responses were above the mean.

Table 21: Descriptive Statistics for Adaptation Intention Indicators

Adaptation Intention (AI), 13 items	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Mean**	**SE**	**SD**
	%	%	%	%	%			
AI1- I will engage with actions so that future floods do not have impacts on my household	0.00	10.5	3.6	58.2	27.8	4.03	0.043	0.856
AI2- I will protect my house from damage due to future floods	0.00	8.9	4.3	57.1	29.6	4.07	0.042	0.832
AI3- I think government should take greater responsibility to protect us from future floods	0.00	13.0	5.9	27.6	53.6	4.22	0.052	1.035
AI4- I will strengthen the physical structures of my home	0.00	17.3	5.1	50.5	27.0	3.87	0.051	1.001
AI5- I will elevate my home	0.00	20.9	8.2	47.4	23.5	3.73	0.053	1.042
AI6- I will take out insurance on my home	4.8	56.9	10.7	20.4	7.1	2.68	0.054	1.074
AI7- I will permanently relocate out of this community	3.1	35.7	7.4	31.1	22.7	3.35	0.064	1.258
AI8- I will move to a less flood-prone area in this community	3.3	48.5	8.7	22.7	26.8	3.01	0.062	1.234
AI9- I will learn about adaptation options to apply	0.3	21.2	3.6	49.2	25.8	3.79	0.054	1.059
AI10- I will follow weather warnings more keenly	0.00	23.7	11.2	38.8	26.3	3.68	0.056	1.106
AI11- I will begin to lobby the government on improvements to stormwater networks	0.00	27.0	13.5	29.3	30.1	3.63	0.059	1.175
AI12- I will advocate for restrictions on development in flood-prone areas	0.3	27.3	10.2	29.1	33.2	3.68	0.061	1.203
AI13- I will involve myself in volunteer activities intended to adapt the community to floods	0.3	25.5	5.4	39.3	29.6	3.72	0.058	1.149

Source: Author

Having presented the descriptive statistics for the indicators, the subsequent sections will present the results of the structural equation modelling that was conducted to assess the theoretical model postulated in the study.

4.5 Model Assessment Using PLS-SEM

This section is the output of the model assessment to establish whether flood experience, coping experience and the cognitive appraisals of households could help to predict their flood risk adaptation intentions. The model assessment provides the results to test the hypothesised path relationships. The PLS-SEM analysis helps to address the second objective of the research. The PLS-SEM was done using WarpPLS version 6.0 (Kock, 2018).

Table 22 shows the general model elements used in the analysis. These include the outer model analysis algorithm, default inner model analysis algorithm, resampling method, number of data resamples used, and number of cases (rows) in model data, among others. The PLS Mode M outer model algorithm was used for the analysis. In this mode, the inner model influences the outer model through path coefficients. PLS Mode M, in a real sense, uses either PLS Mode A or PLS Mode B, based on whether latent variables are defined as reflective or formative, respectively (Kock, 2018). After running the analysis, the results were assessed based on defined criteria and rules of thumb in the PLS-SEM literature.

The assessment of the model, specified in Chapter 2, was a two-step process comprising the assessment of the measurement and structural model (Hair et al., 2017; Rasoolimanesh et al., 2017). The assessment of the measurement model centred around the relationship between the latent variables (LVs) and their associated question statements (Rasoolimanesh et al., 2015). The assessment of the structural model was concerned with the relationship between the LVs (Rasoolimanesh et al., 2015). In the evaluation of the measurement model, the observed variables' reliability (indicator reliability and internal consistency reliability) and validity (convergent and discriminant validity) were assessed (Ali et al., 2017). Reflective and formative indicators were assessed using different criteria (Kock, 2018). Table 22 shows the details of the PLS algorithm used.

Table 22: General model elements

Missing data imputation algorithm: Arithmetic Mean Imputation
Outer model analysis algorithm: PLS Mode M
Default inner model analysis algorithm: Warp2
Multiple inner model analysis algorithms used? No
Resampling method used in the analysis: Stable3
Number of data resamples used: 100
Number of cases (rows) in model data: 392
Number of latent variables in model: 6
Number of indicators used in model: 18
Number of iterations to obtain estimates: 5
Range restriction variable type: None
Only ranked data used in analysis? No

Source: Author

4.5.1 Dealing with the Higher-Order Constructs

The measurement model used in the research comprised two layers of constructs, the lower-order constructs (LOC) and higher-order constructs (HOC). As Figure 10 shows, the lower order components of Flood Risk Appraisal (FRA) and Adaptation Appraisal (AA) were multifaceted, capturing different attributes of the higher-order constructs (Hair et al., 2017). The lower-order constructs were, therefore, assessed as components of the higher-order construct's measurement model (Sarstedt et al., 2019). The use of a Hierarchical Component Model (HCM) was backed by the protection motivation theory (Floyd et al., 2000; Maddux & Rogers, 1983; Rogers, 1975, 1983) underpinning the research. It also made the model parsimonious and easy to grasp (Hair et al., 2017; Sarstedt et al., 2019). Figure 10 shows the overall model with lower-order and higher-order latent variables and the hypothesised relationships.

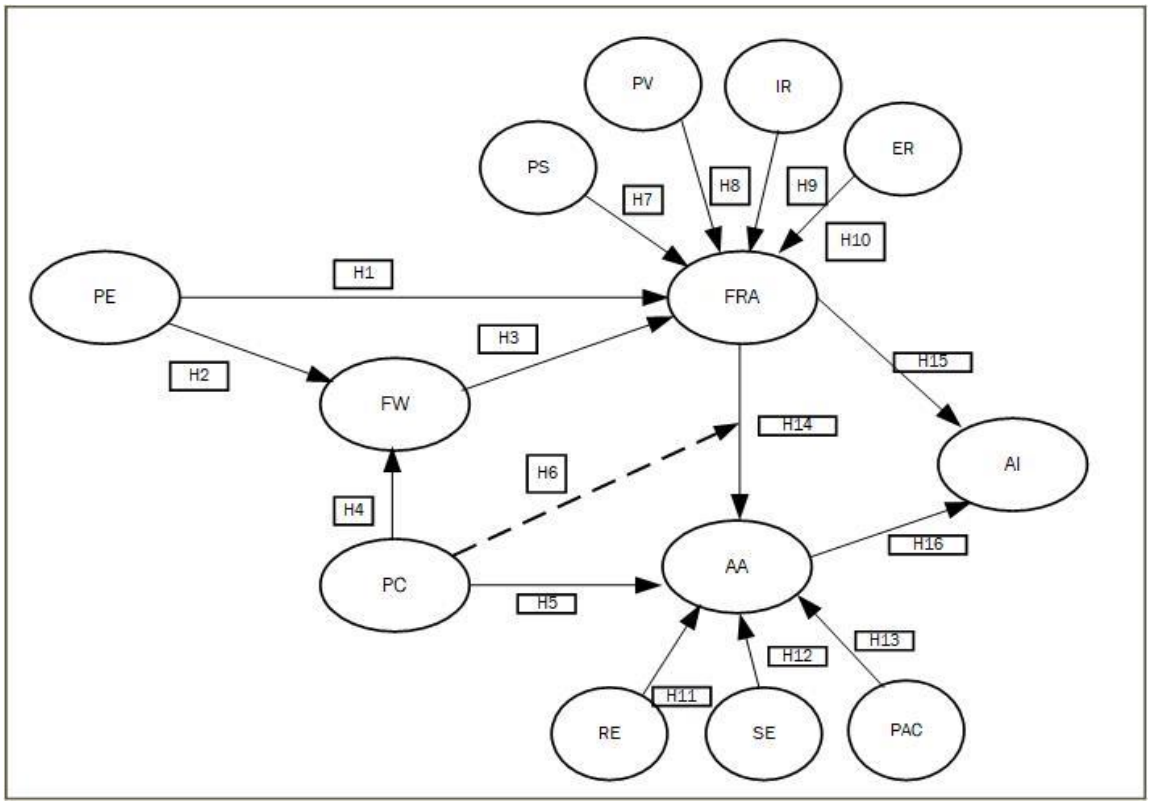

Figure 10: Model with Multifaceted Flood Risk Appraisal and Adaptation Appraisal Constructs
Source: Author

A two-stage approach was adopted to handle the HCM (Matthews et al., 2018). A combination of the repeated indicators approach and the use of latent variable scores of the LOCs as new standardised indicators was used to transform the LOCs to HOC indicators (Hair et al., 2017; Kock, 2018; Matthews et al., 2018).

In the first stage of the HCM analysis, the PLS-SEM analysis was executed based on the relationship between the first-order indicators and the LOCs. In order to transform the LOCs as indicators of the HOCs, the latent variable scores of the PS, PV, IR and ER (in the case of FRA,) and RE, SE and PAC (in the case of AA) were added to the data as new standardised indicators (Kock, 2018). The model estimates for the lower order constructs were not interpreted before the scores were added to the dataset (Sarstedt et al., 2019). The analysis was then executed in the final step with the LOCs now the indicators of the HOCs.

The relationship between the indicators and the lower-order constructs (PS, PV, IR and, ER SE, RE and PAC) was reflective. In contrast, the relationship between the LOCs and the higher-order constructs (FRA and AA) was formative, resulting in a reflective–formative HCM (Hair, Sarstedt, et al., 2019; Matthews et al., 2018). The measurement and structural model assessments are, therefore based on the HCM. Figure 11 shows the simplified model.

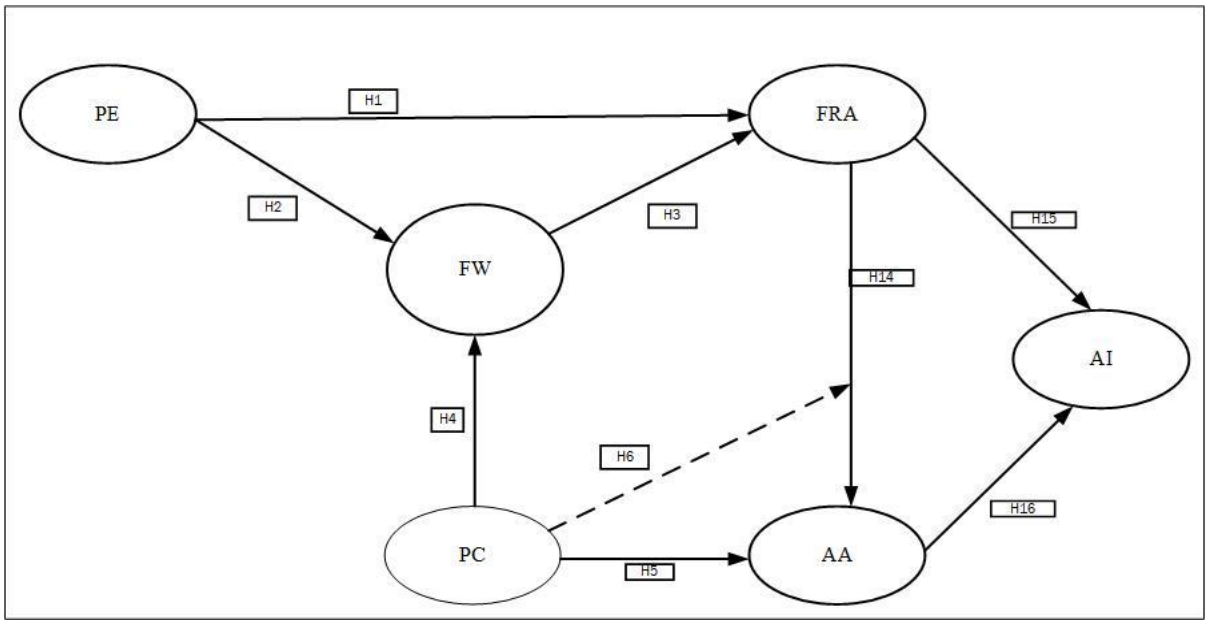

Figure 11: Structure of the Simplified HCM Model
Source: Author

4.5.2 Removed Indicators

After running the analysis using WarpPLS, the results were physically inspected and evaluated against recommended PLS-SEM criteria (Kock, 2018). Several indicators were removed from the final model due to issues of insignificant P values ($P>0.05$), collinearity (Variance Inflation Factors (VIFs) above the threshold ($VIFs<5$ for formative indicators)), negative Indicator Weight-Loading Signs (WLS), path loadings below the threshold (≥ 0.5), and indicator weights

with P values greater than 0.05 (Kock, 2018). Other indicators (that is IR, ER, AI11, AI9, PAC, PC3, PC7, PC9 and PC10) were removed because they had cross-loaded strongly on other latent constructs. Table 23 shows the indicators that were removed before the final analysis, based on which the measurement and structural models were assessed. Upon removing the non-conforming indicators, the analysis was further performed to satisfy the requirement that all indicators outside the recommended threshold were removed from the model (Hair et al., 2017; Kock, 2018).

Table 23: Non-conforming Indicators Removed from the Model

Latent Variable	Non-conforming Indicators Removed
PE	PE7, PE8
PC	PC3, PC5, PC6, PC7, PC9, P10, PC11
FRA	IR, ER
AA	PAC
AI	AI4, AI5, AI6, AI7, AI8, AI9, AI10, AI11, AI12

Source: Author

4.5.3 Assessment of the Measurement Model (Reflective)

Formative and Reflective indicators are assessed based on different criteria and rules of thumb. As the current HCM model had both formative and reflective indicators, they were assessed using their unique assessment criteria (Hair et al., 2017; Matthews et al., 2018). The constructs with reflective indicators were 'past flood experience (PE)', 'past coping experience (PC)', 'fear (FW)', and 'adaptation intention (AI)'.

4.5.3.1 Assessment of Convergent Validity

The convergent validity of the reflective measurement model was assessed using the structure loadings and cross-loadings provided by the WarpPLS software. Kock (2018) notes that some scholars favour the use of structure loadings and cross-loadings. According to (Kock, 2018), convergent validity of a measurement instrument means that the respondents understood the question-statements associated with each latent variable in the way intended by the researcher. Kock (2018) also suggests that indicator loadings should be equal to or greater than 0.5 to meet standard criteria for convergent validity. As shown in Table 24, all the indicator loadings (highlighted in bold) on their corresponding latent variables were equal to or greater than 0.5, thus showing the measurement instrument had good convergent validity (Kock, 2018).

Table 24: Structure loadings and cross-loadings of Indicators

	PE	PC	FW	FRA	AA	AI	PC*FRA
PE1	**0.926**	-0.147	0.541	0.595	0.289	0.304	-0.094
PE2	**0.79**	-0.149	0.374	0.328	0.401	0.36	-0.115
PC2	-0.08	**0.705**	0.013	-0.019	0.117	0.077	0.088
PC10	-0.171	**0.837**	0.037	-0.067	0.148	0.103	0.515
FW1	0.474	0.019	**0.825**	0.609	0.442	0.469	-0.002
FW2	0.555	0.004	**0.839**	0.706	0.361	0.365	-0.041
FW3	0.529	-0.005	**0.874**	0.659	0.452	0.466	-0.038
FW4	0.323	0.044	**0.769**	0.559	0.374	0.364	-0.014
FW5	0.358	0.081	**0.809**	0.531	0.47	0.452	-0.05
FW6	0.376	0.046	**0.776**	0.531	0.496	0.487	-0.029
PS	0.513	-0.054	0.681	**0.956**	0.446	0.408	-0.072
PV	0.533	-0.056	0.689	**0.865**	0.314	0.316	-0.076
SE	0.283	0.206	0.498	0.443	**0.866**	0.649	0.096
RE	0.39	0.137	0.482	0.379	**0.965**	0.81	0.046
AI1	0.298	0.126	0.474	0.349	0.706	**0.9**	0.058
AI2	0.274	0.126	0.458	0.327	0.706	**0.909**	0.056
AI3	0.364	0.023	0.389	0.282	0.668	**0.833**	-0.03
AI13	0.356	0.126	0.505	0.441	0.73	0.828	**0.089**
PC2*PS	-0.076	0.658	-0.035	-0.034	0.054	0.04	**0.869**
PC2*PV	-0.088	0.65	-0.048	-0.063	0.067	0.036	**0.827**
PC10*PS	-0.111	0.646	-0.025	-0.094	0.04	0.047	**0.729**
PC10*PV	-0.099	0.6	0.007	-0.07	0.044	0.044	**0.68**

Notes: *Loadings are unrotated, and cross-loadings are oblique-rotated. SEs and P values are for loadings. P values < 0.05 are desirable for reflective indicators.* Source: Author

4.5.3.2 Assessment of Discriminant Validity

The discriminant validity of the reflective measurement model was assessed using average variance extracted (AVE) and the table of latent variable correlations. Discriminant validity is the extent to which one latent variable is truly dissimilar from other latent variables (Hair et al., 2017; Rasoolimanesh et al., 2015). For a reflective measurement model to meet accepted discriminant validity, the AVE threshold must be equal to or higher than 0.5 (Kock, 2018; Rasoolimanesh et al., 2015). The AVEs for the latent variables were PE= 0.74, PC= 0.60, FW= 0.67, FRA= 0.83, AA=0.84, AI=0.89 and PC*FRA=0.61. They were thus above the 0.5 rule of thumb, showing acceptable discriminant validity.

Similarly, the square roots of AVE for each construct were higher than any of the correlations involving that latent variable (Kock, 2018), as shown in Table 25. These two indices proved that the model had acceptable discriminant validity.

Table 25: Correlations among latent variables with square roots of AVEs

	PE	PC	FW	FRA	AA	AI	PC*FRA
PE	**0.861**						
PC	-0.169	**0.774**					
FW	0.546	0.034	**0.816**				
FRA	0.564	-0.059	0.742	**0.911**			
AA	0.38	0.173	0.524	0.431	**0.917**		
AI	0.372	0.118	0.528	0.406	0.811	**0.868**	
PC*FRA	-0.117	0.013	-0.036	-0.08	0.068	0.052	**0.78**

Note: Square roots of average variances extracted (AVEs) shown on diagonal. Source: Author

4.5.3.3 Assessment of Construct Reliability

Construct reliability (or internal consistency reliability) was also assessed using the composite reliability (CR) coefficient. According to several PLS-SEM authorities (Hair et al., 2017; Kock, 2018; Rasoolimanesh et al., 2015), CR is a more suitable reliability coefficient for PLS-SEM due to the inclusion of information on item loadings in its calculation. Higher values of CR indicate higher levels of reliability (Hair et al., 2017). CR coefficients vary between 0 and 1, while acceptable CR levels are between 0.60 to 0.70 (Hair et al., 2017). The composite reliability of each of the reflective latent variables was higher than 0.7, indicating that the model had acceptable construct reliability (Hair, Risher, et al., 2019). Table 26 shows the composite reliability coefficients of the latent variables.

Table 26: Composite reliability coefficients of Latent Variables

PE	PC	FW	FRA	AA	AI	PC*FRA
0.85	0.748	0.923	0.907	0.913	0.924	0.86

Source: Author

4.5.4. Assessing the Formative Measurement Model

The previous section established that the reflective indicators met recommended criteria for the assessment of reflective measurement models. The current section assesses the formative indicators in the model to ascertain their compliance with recommended PLS-SEM rules of thumb. The constructs with formative indicators were ‘flood risk appraisal’ (FRA) and ‘adaptation appraisal’ (AA). The formative indicators were assessed based on different criteria from the assessment of the reflective indicators above.

4.5.4.1 Assessment of the Relevance and Statistical Significance of Indicator Weights

Assessment of the relevance and statistical significance of indicator weights is recommended for the assessment of convergent validity when formative indicators are included in a model (Hair, Risher, et al., 2019). Kock (2018) suggests that formative latent variable indicators

whose weights have P values greater than 0.05 should be considered for removal. Generally, indicators whose weights had P values greater than 0.05 were removed, whether reflective or formative.

Indicator weights close to 0 indicate a weak relationship, whiles weights close to +1 (or – 1) indicate a strong positive (or negative) relationship (Hair, Risher, et al., 2019). As shown in Table 27, the P values for weights of all the indicators retained in the model were significant (P<0.001) and, therefore, relevant.

Table 27: Indicator weights with significance values, effect sizes and VIFs

	PE	PC	FW	FRA	AA	AI	PC*FRA	P value	VIF	WLS	ES
PE1	0.708							<0.001	1.334	1	0.655
PE2	0.436							<0.001	1.334	1	0.345
PC2		0.559						<0.001	1.042	1	0.394
PC10		0.724						<0.001	1.042	1	0.606
FW1			0.211					<0.001	2.598	1	0.174
FW2			0.245					<0.001	2.476	1	0.206
FW3			0.23					<0.001	3.191	1	0.201
FW4			0.176					<0.001	2.001	1	0.136
FW5			0.178					<0.001	4.262	1	0.144
FW6			0.179					<0.001	3.79	1	0.139
PS				0.683				<0.001	1.852	1	0.653
PV				0.401				<0.001	1.852	1	0.347
SE					0.371			<0.001	1.981	1	0.321
RE					0.703			<0.001	1.981	1	0.679
AI1						0.289		<0.001	4.486	1	0.26
AI2						0.289		<0.001	4.724	1	0.263
AI3						0.272		<0.001	2.041	1	0.227
AI13						0.302		<0.001	1.903	1	0.25
PC2*PS							0.335	<0.001	4.846	1	0.291
PC2*PV							0.415	<0.001	4.482	1	0.343
PC10*PS							0.246	<0.001	7.098	1	0.179
PC10*PV							0.274	<0.001	6.69	1	0.187

Notes: *P values < 0.05 and VIFs < 5 are recommended for formative indicators; VIF = indicator variance inflation factor; ES = indicator effect size.* Source: Author

4.5.4.2 Assessment of Collinearity

Collinearity assessment has also been recommended for evaluating formative indicators. Formative indicators are expected to be devoid of multicollinearity (Hair et al., 2017). In WarpPLS, variance inflation factors (VIFs) indicate collinearity coefficients. The

recommended VIF threshold used in the assessment was ≤ 5 (Kock, 2018). Except for the moderating effect of product indicators, all the indicators had acceptable variance inflation factors (VIF ≤ 5), proving that they were not redundant. While the VIFs of the moderating variable product terms were higher than ≤ 5, they were not considered problematic because the VIFs were less than the lower threshold of VIF < 10 (Kock, 2018). According to Kock, indicators of formative latent variables are required to measure different aspects of the same construct. It is, therefore, expected that they are not redundant (Kock, 2018; Kock & Lynn, 2012). When multiple measures of the same construct are treated as if they are measures of different constructs, it results in redundancy among latent constructs (Kock & Lynn, 2012). Collinear variables usually tend to be redundant (Kock & Lynn, 2012). Table 27 proves that the formative indicators in the measurement model met acceptable criteria for convergent validity, collinearity and redundancy.

4.5.5 Common Method Bias

Five-point Likert scale question statements in a questionnaire may result in common method bias (Ned Kock, 2015; Kock, 2018; Tehseen et al., 2017). That is because the instructions given at the top of a questionnaire may influence the responses given by different respondents (Ned Kock, 2015). The indicators, as a result, tend to share some amount of common variation (Ned Kock, 2015). Common method bias (variance) is considered a potential threat to behavioural research (Min et al., 2016). Some methods have been used to investigate common method bias, including Full collinearity VIFs of Latent Variables (Ned Kock, 2015; Kock, 2018) and Harman's single factor test (Tehseen et al., 2017). The tests were therefore conducted to rule out common method bias in the questionnaire. Using the VIF threshold of < 10, Table 28 proves the absence of common method bias, as suggested by Kock (2015; 2018).

The Harman's Single Factor Test also confirmed the absence of common method bias. The test was done using principal component analysis in SPSS. The factor analysis extracted 16 factors that had eigenvalues greater than 1. These 16 factors accounted for 70.56% of the total variance. The first factor accounted for only 25.45% of the total variance. According to Tehseen et al. (2017), common method bias is present when one factor accounts for more than 50% of the co-variation. Table 28 shows a truncated version of the results, showing 16 components.

Table 28: Assessing Common Method Bias with Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	19.59	25.45	25.451	19.59	25.451	25.451	14.99	19.480	19.480
2	8.329	10.816	36.268	8.329	10.816	36.268	8.573	11.134	30.613
3	6.104	7.927	44.195	6.104	7.927	44.195	4.849	6.298	36.911
4	2.961	3.845	48.040	2.961	3.845	48.040	2.612	3.392	40.303
5	2.587	3.360	51.400	2.587	3.360	51.400	2.532	3.288	43.591
6	1.860	2.415	53.816	1.860	2.415	53.816	2.367	3.074	46.665
7	1.680	2.182	55.998	1.680	2.182	55.998	2.203	2.861	49.526
8	1.568	2.037	58.034	1.568	2.037	58.034	2.182	2.834	52.360
9	1.469	1.907	59.942	1.469	1.907	59.942	2.138	2.777	55.137
10	1.422	1.847	61.789	1.422	1.847	61.789	2.118	2.751	57.888
11	1.374	1.784	63.573	1.374	1.784	63.573	1.878	2.439	60.327
12	1.190	1.545	65.118	1.190	1.545	65.118	1.708	2.218	62.545
13	1.093	1.420	66.538	1.093	1.420	66.538	1.650	2.143	64.689
14	1.057	1.373	67.911	1.057	1.373	67.911	1.540	2.000	66.688
15	1.035	1.344	69.255	1.035	1.344	69.255	1.502	1.951	68.639
16	1.002	1.301	70.556	1.002	1.301	70.556	1.476	1.917	70.556

Source: Author

Having assessed the reliability and validity of the measurement model, and common method bias, the next step in the evaluation of the PLS-SEM results focuses on the assessment of the structural model (Durdyev et al., 2018; Hair et al., 2017; Hair, Risher, et al., 2019).

4.6 Structural Model Assessment

The preceding sections presented results from the assessment of the measurement model, showing that the model satisfied the recommended PLS-SEM criteria. The current section presents the results of the assessment of the structural model, using standard PLS-SEM criteria and rules of thumb. It examines the structural model's predictive capabilities and aims to establish relationships between the latent variables (Durdyev et al., 2018; Hair et al., 2017). Before the recommended structural model assessments were performed, it was necessary to assess the model's fit.

Table 29 shows the global model fit and quality indices of the model (Kock, 2018). The WarpPLS calculates these model fit and quality indices as averages of other parameters (Kock, 2018). Heuristic criteria that are determined by the model's predictive capabilities are primarily

used to assess the structural model (Hair et al., 2017). The model is assessed in terms of how well it predicts the endogenous variables/constructs (Hair et al., 2017). While PLS-SEM does not rely strongly on model fit indices like its covariance-based SEM (CB-SEM) counterpart, some methodological theorists have endorsed model fit indices for PLS-SEM (Hair, Risher, et al., 2019).

Table 29: Global Model Fit and Quality Indices

1.	Average path coefficient (APC)=0.377, P<0.001
2.	Average R-squared (ARS)=0.497, P<0.001
3.	Average adjusted R-squared (AARS)=0.494, P<0.001
4.	Average block VIF (AVIF)=1.416, acceptable if <= 5, ideally <= 3.3
5.	Average full collinearity VIF (AFVIF)=2.789, acceptable if <= 5, ideally <= 3.3
6.	Simpson's paradox ratio (SPR)=1.000, acceptable if >= 0.7, ideally = 1
7.	R-squared contribution ratio (RSCR)=1.000, acceptable if >= 0.9, ideally = 1
8.	Statistical suppression ratio (SSR)=1.000, acceptable if >= 0.7
9.	Nonlinear bivariate causality direction ratio (NLBCDR)=1.000, acceptable if >= 0.7

Source: Author

An explanation is given below of the indices in Table 29. As shown in the table, the structural model has met recommended thresholds for PLS-SEM model fit indices. The Average Path Coefficient (APC) is an index of the regression values of predictor variables on the criterion variables (AL-Alawi, 2017). Also, Average R-squared (ARS) is the variance explained in the criterion variable by the predictor variables (AL-Alawi, 2017). Average Adjusted R-squared (AARS), on the other hand, corrects for spurious increases in R-squared coefficients due to predictors that add no explanatory value in each latent variable block (Kock, 2018). P values for APC, ARS and AARS were significant at the 0.05 level (Kock, 2018).

Average block VIF (AVIF) and Average Full collinearity VIF (AFVIF) indices provide further scope that helps to comprehensively assess the PLS model's overall predictive and explanatory quality (Kock, 2018). The ideal threshold for both AVIF and AFVIF indices is <= 3.3 (Kock, 2018). The VIF checks vertical collinearity in a model's latent variable block, while AFVIF checks the collinearity of the whole model (AL-Alawi, 2017). The WarpPLS also generated the Tenenhaus GoF (GoF), a measure of the model's explanatory power and goodness of fit as part of the SEM analysis. However, it has not been reported here due to concerns that it was not necessary (Hair, Sarstedt, et al., 2019) and "has now been abandoned" in PLS-SEM (Latan, 2018).

Simpson's Paradox Ratio (SPR) is a suggestion of the existence of Simpson's paradox, which occurs when a path coefficient and a correlation associated with a pair of linked variables have

different signs. It is a possible indication of a causality problem, suggesting that a hypothesised path is either implausible or reversed (Kock, 2018). An SPR index of 1 means that 100 percent of the paths in the model are free from Simpson's paradox (Kock, 2018). R-squared contribution ratio (RSCR) also measures the extent to which a model is free from negative R-squared contributions (Kock, 2018). If the index equals 1, it means there is an absence of negative R-squared contributions in the model (Kock, 2018).

Moreover, the nonlinear bivariate causality direction ratio (NLBCDR) index measures the degree to which bivariate nonlinear coefficients of association offer support for the theorised directions of the causal links in a model. If the index is equal to or greater than 0.7, it means that in at least 70 percent of path-related instances in the model, the support for reversed theorised direction of causality is weak or less (Kock, 2018). In the present model, the index of 1 means that 100 percent of path-related instances in the model do not support reversed theorised direction of causality.

4.6.1 Evaluation of Collinearity of the Structural Model

In the assessment of the structural model, it is also essential to examine collinearity (in the same way as with formative constructs) to make sure it does not bias the regression results (Hair et al., 2017; Hair, Risher, et al., 2019). According to Rasoolimanesh et al. (2015), recent studies have recommended the assessment of lateral and vertical collinearity among latent variables. Vertical collinearity is a predictor-predictor collinearity test in all the individual latent variable blocks, while lateral collinearity is a predictor-criterion test of collinearity in the latent variables (Kock, 2018). Predictor-criterion collinearity, in particular, can result in misleading PLS-SEM results (Kock, 2018). Vertical and lateral collinearity are both assessed simultaneously by WarpPLS in the SEM model using full collinearity variance inflation factors (Full collinearity VIFs) (Kock, 2018). Table 30 shows the absence of problematic vertical and lateral collinearity, and redundancy in the structural model, using the recommended threshold of VIFs ≤5 (Garson, 2016; Kock, 2018).

Table 30: Full collinearity VIFs of Latent Variables

PE	PC	FW	FRA	AA	AI	PC*FRA
1.684	3.324	2.728	2.445	3.189	3.071	3.08

Source: Author

As there was no problem with collinearity, the significance of the path coefficients, the coefficients of determination (R^2 values), f^2 effect size, predictive relevance (Q^2 value) and the q2 effect size were then assessed (Hair et al., 2017; Hair, Risher, et al., 2019; Kock, 2018). Figure 12 is the structural model showing the results of the analyses involving the hypothesised paths.

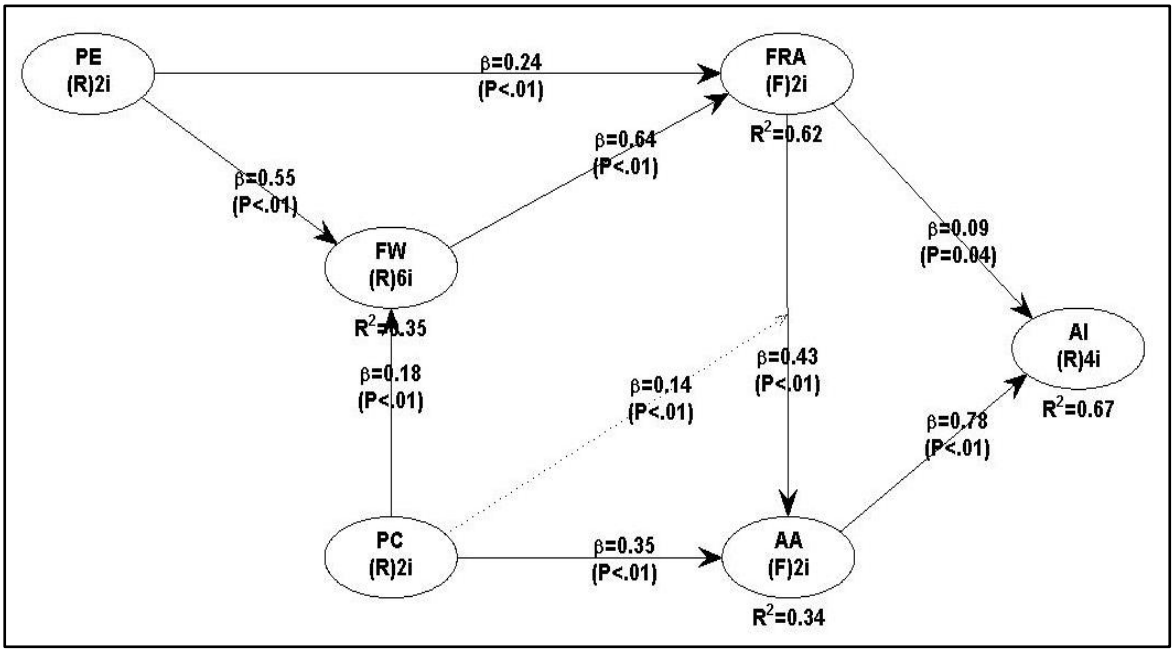

Figure 12: Structural Model Showing Results of the PLS-SEM Analysis
Source: Author

4.6.2 Evaluating the Path Coefficients in the Structural Model

The path coefficients represent the hypothesised relationships among the latent constructs (Hair et al., 2017). As shown in Table 31, each of the hypothesised direct relationships among the various constructs was significant at a significance level at $P < 0.05$.

Table 31: Structural Model Path Coefficients

Constructs	Path Coefficients (B)	P Values
PE →FRA	0.24	<0.001
PE→FW	0.55	<0.001
PC→FW	0.18	<0.001
PC→AA	0.35	<0.001
FW →FRA	0.64	<0.001
FRA→AA	0.43	<0.001
FRA→AI	0.09	0.039
AA→AI	0.78	<0.001
PC*FRA→AA	0.14	0.002

Source: Author

4.6.3 Evaluating the f^2 Effect Size

The assessment of the f^2 effect size is also recommended for the assessment of the structural model. The rule of thumb is that f^2 values of 0.02, 0.15 and 0.35 show small, medium and large f^2 effect sizes, respectively (Hair, Risher, et al., 2019). Table 32 depicts the effect sizes (f^2) for the latent variable relationships. The direct relationships AA→AI, FW →FRA and PE→FW had large effect sizes, while PE →FRA, FRA→AA and PC→AA had 'medium' effect size. The effect sizes of PC→FW, FRA→AI and PC*FRA→AA were, however, small.

Table 32: f2 Effect Sizes for Path Coefficients

Latent Variable Relationships	Effect sizes (f^2)
PE →FRA	**0.13**
PE→FW	**0.31**
PC→FW	0.04
PC→AA	**0.11**
FW →FRA	**0.49**
FRA→AA	**0.2**
FRA→AI	0.04
AA→AI	**0.64**
PC*FRA→AA	0.03

Source: Author

4.6.4 Evaluating the Coefficients of Determination (R^2)

The coefficient of determination (R^2) is a measure of the model's in-sample predictive (and explanatory) power (Hair, Risher, et al., 2019; Kock, 2018). It shows the variance in each of the endogenous constructs (Hair et al., 2017; Hair, Risher, et al., 2019). The coefficient is calculated for only the endogenous latent variables (Kock, 2018). The values range from 0 to 1, with higher values showing greater explanatory or predictive power (Hair, Risher, et al., 2019). Thus, values of 0.75, 0.50 and 0.25 are interpreted as substantial, moderate and weak, respectively (Hair, Risher, et al., 2019). The R^2 values for the current path model were FW= 0.35, FRA= 0.62, AA= 0.34, and AI= 0.67. Equivalent to the R-Squared is the adjusted R-squared, which corrects for spurious increases in the R^2 (Kock, 2018) and prevents bias in complex models (Hair et al., 2017). The adjusted R^2 values were thus FW= 0.34, FRA= 0.62, AA= 0.34, and AI= 0.67. It can therefore be concluded that the model had moderate to substantial explanatory or in-sample predictive power.

4.6.5 Evaluating the predictive relevance (Q^2) of the path model

The structural model's predictive relevance was also evaluated using the Q-squared coefficient (Stone-Geisser Q-squared coefficient). The coefficient assesses the predictive relevance, predictive validity or predictive accuracy of the endogenous constructs in the path model (Hair et al., 2017; Kock, 2018). Also, the Q^2 indicates a model's out-of-sample predictive power (Hair et al., 2017) and is usually measured through blindfolding (Kock & Gaskins, 2014). The rule of thumb specifies that values of 0, 0.25 and 0.50, respectively, depict small, medium and large predictive relevance (accuracy or validity) (Hair, Risher, et al., 2019; Kock, 2018). The Q^2 values for the endogenous variables in the current path model were FW=0.35, FRA=0.62, AA=0.28, and AI=0.67. That proves that the path model possesses acceptable predictive accuracy, predictive relevance, and predictive validity, ranging from medium (for FW and AA) to large, in the case of FRA and AI.

4.7 Assessment of Mediating Effects

Based on the literature, it was hypothesised that constructs such as fear (FW) and adaptation appraisal (AA) in the model were mediators (Grothmann & Patt, 2005; Zheng & Dallimer, 2016). This component of the analysis, therefore, assessed the mediation effects in the model to verify if the hypothesised indirect effects existed. While the direct effects have already been assessed using the path coefficients, the WarpPLS software also enables the assessment of indirect effects and total effects. Generally, a mediator variable affects the nature of the relationship between two variables in the model (Hair et al., 2017; Nitzl et al., 2016). According to Hair et al. (2017), several types of mediation relationships exist. These include:

- Direct-only non-mediation: The direct effect is significant but not the indirect effect.
- No-effect non-mediation: Neither the direct nor indirect effect is significant.
- Complementary mediation: The indirect effect and the direct effect both are significant and point in the same direction.
- Competitive mediation: The indirect effect and the direct effect both are significant and point in opposite directions.
- Indirect-only mediation: The indirect effect is significant but not the direct effect (Hair et al., 2017).

The research hypothesised several mediating relationships in the model. 'Fear' (FW) was hypothesised as a mediator of the relationship between previous flood experience (PE) and flood risk appraisal (FRA). Also, adaptation appraisal (AA) was hypothesised as a mediator

between FRA and adaptation intention (AI). By the nature of the conceptual model, FW and FRA were also seen as mediators of the relationship between 'past coping experience' (PC) and adaptation appraisal (AA). Table 33 shows the mediating effects of paths with two segments in the model.

Table 33: Indirect effects for paths with two segments

Endogenous Latent Variables	PE		PC		FW		FRA		PC*FRA	
	β	f^2	β	f^2	β	f^2	β	f^2	β	f^2
FRA	**0.35**	**0.20**	**0.12**	0.01`						
AA	**0.10**	0.04			**0.28**	**0.15**				
AI	0.02	0.01	**0.27**	0.03	0.06	0.03	**0.33**	**0.15**	**0.11**	**0.01**

NB: β is the indirect effect for the paths; f^2 is the effect size of the indirect effect. Source: Author

The indirect associations (highlighted in bold) shown in Table 34 were all significant at the 0.05 significance level. In all the instances where the indirect effects were significant, they pointed to the same direction as the direct relationships, suggesting complementary mediation (Hair et al., 2017). However, only the effect sizes (ranging between 0.15 and 0.35) of the path PE→FW→FRA, FRA→AA→AI and FW→FRA→AA were moderate (Kock, 2018). The effect sizes of the other indirect effects for paths with two segments were small, as shown in Table 34. It is important to note that the indirect effects of the relationships between PE and FRA, and FRA and AI were larger than the direct effects.

Table 34: Indirect effects for paths with three segments

Endogenous Latent Variables	PE		PC		FW	
	β	f^2	β	f^2	β	f^2
AA	**0.15**	0.06	**0.05**	0.02		
AI	**0.11**	0.04	0.01	0.001	**0.22**	**0.11**

NB: β is the indirect effect for the paths; f^2 is the effect size of the indirect effect.

Source: Author

Table 34 also reveals the indirect effects for paths with three segments (that is, multiple mediation) in the model. As seen in the table, the effect sizes for all the paths with three segments were small, except for FW→ FRA→AA→AI, which was moderate. In terms of

significance, all paths that have been highlighted bold in Table 34 were significant at the 0.05 significance level. The other associations were not significant.

The indirect effects for paths with four segments (multiple mediation) were also assessed. The results showed that there were two such indirect effects, the paths PE→FW→FRA→AA→AI (β= 0.12) and PC→FW→FRA→AA→AI (0.04). However, only the indirect effect of PE→AI was significant at the 0.0001 significance level. The indirect effect, however, had a small effect size (0.04).

PLS-SEM theorists have also recommended the assessment of total effects, which is the sum of the indirect effects and direct effect in the relationship between two variables (Kock & Gaskins, 2014; Nitzl et al., 2016). Table 35 shows the total effects, while Table 36 shows the effect sizes of the total effects.

Table 35: Total effects

	PE	PC	FW	FRA	AA	PC*FRA
FW	**0.55**	0.18				
FRA	**0.59**	0.12	**0.64**			
AA	0.25	**0.4**	0.28	**0.43**		0.14
AI	0.25	**0.32**	0.27	**0.42**	**0.78**	0.11

Source: Author

The total effects shown in Table 35 were all significant at the P<.05 level. All the total effects retained the same direction as the direct paths. The total effects were large in the instance of the paths PE→FW, PE →FRA, FW→FRA, PC→AA, FRA→AA, PC→AI, FRA→AI and AA→AI, showing that the independent variables PE, FW, PC, FRA and AA are important in explaining their corresponding dependent variables (Hair et al., 2017). As shown in Table 36, the effect sizes of the total effects ranged from moderate to large for most of the paths.

Table 36: Effect Sizes of Total Effects

	PE	PC	FW	FRA	AA	PC*FRA
FW	**0.31**	0.04				
FRA	**0.33**	0.01	**0.49**			
AA	**0.10**	**0.13**	**0.15**	**0.20**		0.03
AI	0.09	0.04	**0.14**	**0.18**	**0.64**	0.01

Source: Author

4.8 Moderation Effects Analysis

In the development of the conceptual model, it was hypothesised that past coping experience (PC) moderates the relationship between flood risk appraisal (FRA) and adaptation appraisal (AA). The results showed that the moderating link was significant, with a positive effect (B=0.14) on the path FRA→AA. However, the effect size was weak (f^2=0.03). Figure 13 is a graph showing the moderating effect.

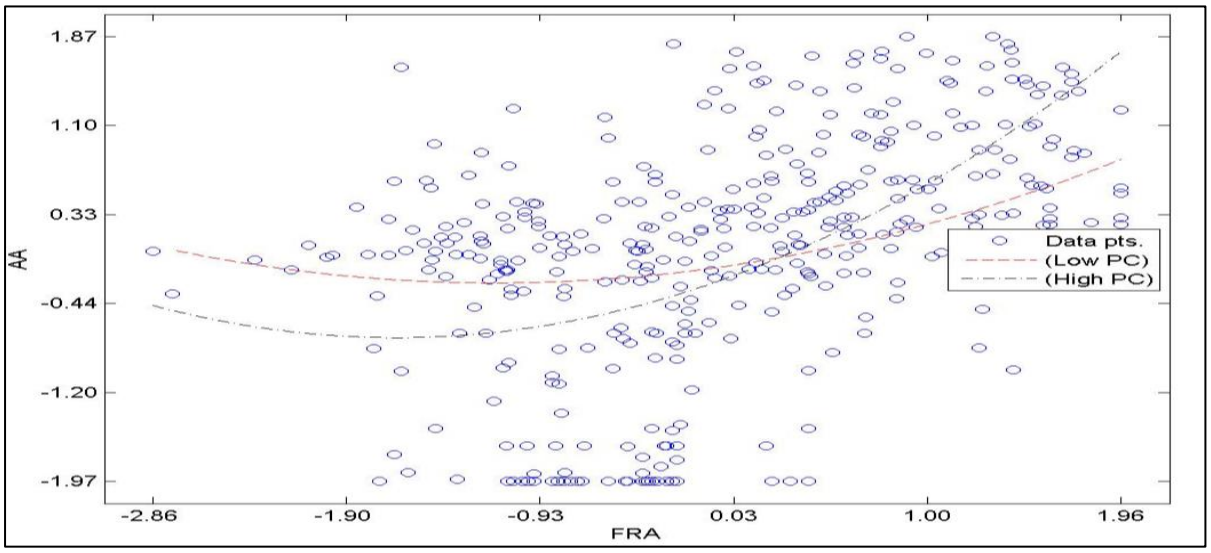

Figure 13: Graph with Low-High Values of Moderating Variable and Data Points (Standardised Scales)

Source: Author

Also, full latent growth analysis was conducted to ascertain other moderating effects in the model. The full latent growth analysis provided a comprehensive analysis of the moderating effects of all latent variables in the model, without actually adding the link in the model (Kock, 2017; Kock, 2018). It revealed the effects of variables on the paths in the model, including the links that include the latent growth variable (Kock, 2017). Using full latent growth analysis to investigate the moderation effects in the model became necessary because there was a possibility that some significant moderating effects might not have been modelled. The full latent growth analysis involved analysis of first degree (U-curve relationship) and second-degree (S-curve relationship) growth of the latent variables PE, PC and FW. Tables 37, 38 and 39 show the latent growth coefficients in the model. As Table 37 shows, 'PC' seems to have moderating effects on the paths PE→FRA, PC→FW, and PC→AA, which were significant at the 0.05 significance level (one-tailed and two-tailed). The moderating effects involving the moderating variable are an indication that the path is non-linear. It indicates a U-curve when only the first-degree growth is significant and S-curve (seen as a combination of two connected U-curves) when both first and second-degree growth are significant (Kock, 2017). However,

when these suggested moderating links were added to the model, further analysis revealed that they were not significant. All coefficients highlighted (in bold) are significant at the 0.05 level.

Table 37: Latent Growth Coefficients (First and Second Degree) of PC Moderating Effects in the Model

Variables / Degree	PE		PC		FW		FRA		AA	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
FW	-0.02	0.02	**0.3**	**-0.15**						
FRA	**-0.08**	**0.11**			-0.03	0.05				
AA			**0.4**	**-0.23**			**0.10**	-0.03		
AI							**0.09**	-0.03	0.06	-0.07

Source: Author

The moderating effects of FW on the paths in the model were also investigated. The results are shown in Table 38. The table depicts a strong (and significant) effect of FW on the paths FW→FRA, PE→FW, PE→FRA and AA→AI. As the results show, all the moderating effects involving FW are indicative of a self-moderation (non-linear relationship with a possible U-curve). The paths with significant first and second-degree growth are indications of a double moderation (similar to an S-curve) (Kock, 2017).

Table 38: Latent Growth Coefficients (First and Second Degree) of FW Moderating Effects in the Model

Variables / Degree	PE		PC		FW		FRA		AA	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
FW	**-0.21**	**0.44**	0.05	0.02						
FRA	0.06	**0.15**			**0.20**	**-0.25**				
AA			-0.02	-0.08			0.08	0.02		
AI							0.02	0.07	**-0.10**	**0.10**

Source: Author

Just as in the case of PC as a moderator, the moderating effects revealed by the latent growth analysis did not improve the model when they were added to it and further analyses were conducted. The only exception was the path FW→PE*FRA, which, although it was not significant, increased the R^2 of FRA by 4%.

The latent growth analysis also revealed that there were some moderating effects involving the variable PE on the paths in the model. As shown in Table 39, most of the moderating effects were significant (as highlighted in the table) in both the first and second-degree growth, except for the paths PE→FRA and FW→FRA.

Table 39:Latent Growth Coefficients (First and Second Degree) of PE Moderating Effects in the Model

Variables / Degree	PE		PC		FW		FRA		AA	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
FW	**-0.14**	**0.13**	**-0.37**	**-0.26**						
FRA	0.05	**-0.1**			**0.16**	-0.04				
AA			**-0.49**	**-0.25**			**-0.16**	**0.13**		
AI							**-0.15**	**0.18**	**-0.11**	**0.10**

Source: Author

These moderating relationships were added to the model to ascertain their effect on the path relationships. The results showed that only PE→FRA*AA was significant, with a negative coefficient (B=-0.30). It also improved the model, with the path coefficient of FRA→AA increasing from 0.43 to 0.48. The R^2 of AA also improved, increasing from 0.34 to 0.43. However, one of the product's indicators (PE1*PV) had a very low path loading. That indicator also had a non-significant indicator effect size and a case of Simpson's paradox. Figure 14 is a graph of the moderating effect of PE on FRA→AA.

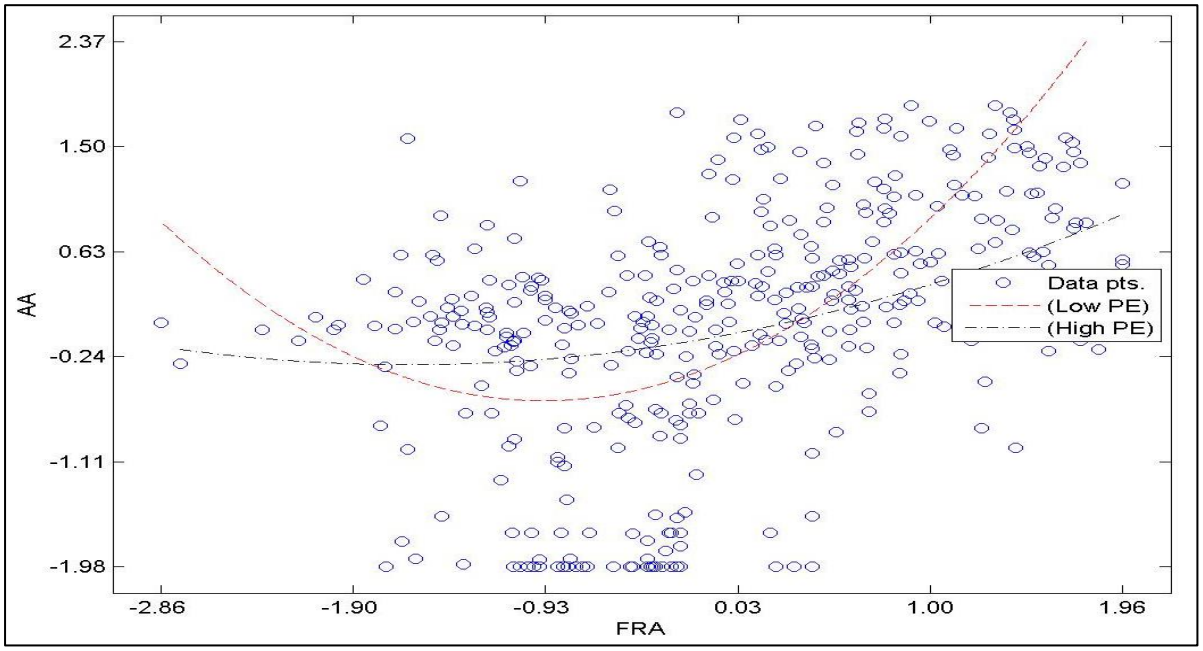

Figure 14: Graph with Low-High Moderating Variable and Data Points (Standardised Scales)

4.9 Result of Hypotheses Testing

This section reiterates the hypotheses which the researcher sought to test, and the results. It is, however, important to emphasise that some of the formulated hypotheses, such as H7, H8, H9, H10, H11, H12 and H13 were not tested in the same way as the rest. These hypotheses corresponded with the associations between PS, PV, IR, and ER with Flood Risk Appraisal (FRA), and RE, SE, and PAC with Adaptation Appraisal (AA). These constructs were

converted into indicators respectively to measure FRA and AA, through the HCM analysis. Thus, their alternate hypotheses were regarded as supported if the indicators met criteria for the assessment of the measurement model. During the measurement model assessment, the indicators IR and ER (in respect of FRA) and PAC (in respect of AA) were removed (see Table 23 for explanation). The corresponding hypotheses H9, and H10, and H13, therefore, were not supported. Table 40 lists the hypotheses (alternative) tested in this research.

Table 40: Tested Alternative Hypothesis

H1: Past flood experience (PE) positively influences residents' perception of flood risk
H2: Past flood experience (PE) positively influences residents' fear (FW) of flood risk
H3: Fear (FW) mediates the association between past flood experiences and flood risk appraisal (FRA)
H4: Experiences from past coping mechanisms have an inverse relationship with fear/worry/anxiety about future flooding and its adverse impacts
H5: Past coping experience (PC) influences adaptation appraisal
H6: Past coping experience moderates the relationship between flood risk appraisal and adaptation appraisal
H7: Perceived severity (PS) is a significant component of flood risk appraisal
H8: Perceived vulnerability (PV) is a significant component of flood risk appraisal
H9: Intrinsic rewards (IR) negatively influence the perception of flood risk
H10: Extrinsic rewards (ER) negatively influence the perception of flood risk
H11: Response efficacy (RE) is a significant component of the appraisal of adaptation capacity
H12: Self-efficacy (SE) is a significant component of the appraisal of adaptation actions
H13: Perceived adaptation cost (PAC) is a significant component of the appraisal of adaptation capacity
H14: Flood risk appraisal positively influences the appraisal of adaptation (AA) capacity
H15: Flood risk appraisal positively influences adaptation intention (AI)
H16: Adaptation appraisal positively influences adaptation intention

Source; Author

Since the criteria for determining support for the alternative hypotheses H7, H8, H9, H10, H11, H12 and H13 has been explained, the remaining alternative hypotheses were subsequently tested for support using path coefficients and P values. According to (Ned Kock, 2015; Kock, 2018), P values are acceptable for hypothesis testing and the hypothesis is generally supported if the P values for the path relationship are significant (using the criterion $P < 0.05$) and the sign of the path coefficient is the same as hypothesised. Table 41 shows the results of the hypothesis testing with path coefficients and P values. As the table shows, support was found for the hypothesised relationships, except for hypothesis H4. In the case of hypothesis H4, 'past coping experience' was hypothesised to have an inverse relationship with fear/worry about future flood risks. The results, however, showed that the relationship was positive. Thus, the hypothesis was not supported by the results.

Table 41: Support for Alternative Hypotheses

Path	Hypothesis	Path coefficients (β)	P Values	Supported?
PE →FRA	H1	0.24	<0.001	Yes
PE→FW	H2	0.55	<0.001	Yes
FW→FRA	H3	0.64	<0.001	Yes
PC→FW	H4	0.18	<0.001	No (different sign)
PC→AA	H5	0.35	<0.001	Yes
PC →FRA*AA	H6	0.14	0.002	Yes
FRA→AA	H14	0.43	<0.001	Yes
FRA→AI	H15	0.09	0.039	Yes
AA→AI	H16	0.78	<0.001	Yes

Source: Author

4.10 Summary of the Chapter

In line with objective two of the research, the results of the quantitative analyses were presented in this chapter. The analyses were in two forms, descriptive statistics, and partial least squares structural equation modelling (PLS-SEM). While the descriptive statistics were conducted with IBM SPSS, the PLS-SEM analyses were performed with WarpPLS 6.0. The demographic, social and economic characteristics of the sample population were shown using simple frequency tables and charts. The descriptive statistics, such as frequencies, means, standard errors and standard deviations of the indicators measured in the research, were also presented.

The PLS-SEM analyses, on the other hand, helped to conduct confirmatory factor analysis to assess the validity, reliability and quality of path estimates. The results helped to establish that the measurement and structural models met accepted PLS-SEM assessment criteria. Consequently, recommended criteria for measurement model assessment, such as internal consistency, convergent validity, discriminant validity and collinearity, were met. In the assessment of the structural model, collinearity was evaluated and found to be acceptable; the significance and relevance of path relationships were also assessed. The structural model assessment also involved the assessment of R-squared levels, f^2 effect size, predictive relevance (Q-squared) and coefficients of determination (R-squared). Mediation and moderation effects in the model were also analysed.

Finally, the hypotheses formulated for the research were tested for support using the path coefficients and their p values ($p<0.05$). Support was not found for hypotheses H4, H9, H10, and H13. The rest of the hypothesised relationships were supported.

CHAPTER 5: RESULTS OF QUALITATIVE DATA ANALYSIS

5.1 Introduction

Chapter 4 presented the results of the quantitative data analysis. It elaborated on the test of the hypothesised relationships among the variables in the research. The current chapter presents the analysis of the qualitative data elaborating on the perceptions of Glefe residents and National Disaster Management Organisation (NADMO) officials regarding flooding risk, flooding experience, coping, and intentions for adaptation to current and predicted floods in the study area. The analysis is in line with objective three, which sought to "examine the factors relating to household experience and appraisals influencing flood risk adaptation intentions using qualitative data," and is context-specific to the circumstances of Glefe and, to some extent, Accra.

First, the demographic characteristics of the respondents will be presented. Subsequent sections will then elucidate the history of flooding in Glefe. The chapter further presents the causes of the flood risk and residents' lived experience with the flooding (including the impacts). It also explores the coping responses during and immediately after flooding, and perceptions about proactive and long-term actions towards adapting to future floods. Deductive and abductive reasoning were applied in the analysis of the qualitative data. In this study NA1 – NADMO official at national level, LA1 – NADMO official at local government level, LGR1 – local government representative in the community, and H01, H012, etc - Community member.

5.2 Demographic Characteristics of Respondents

The demographic and socioeconomic characteristics of the population have implications for risk perception and implementation of risk reduction measures. That is confirmed by research that shows that gender, aged, income, tenancy status, household size, and educational level positively correlate with mitigation behaviour (Lechowska, 2018; Poussin et al., 2014). However, others have suggested that socioeconomic factors are not better predictors of household-level risk perception and protective behaviour (Koerth, Vafeidis, et al., 2013). Even though extant literature does not agree about the influence of socioeconomic variables on risk perception, it was still desirable to collect and analyse the socioeconomic data, as socioeconomic variables used in tandem with other variables could explain flood adaptation behaviour (Koerth et al., 2017).

The interviews involved two categories of respondents. These were residents of Glefe and Officials of the National Disaster Management Organisation (NADMO). The residents of Glefe

who were interviewed were the assembly member (local government representative) and selected household heads. In total, there were 16 household heads (8 male and 8 female) and one assembly member (male). The NADMO officials were made up of an official from the national office (male), and another official (female) from the Accra Metropolitan Assembly (the city administration). In total, there were 19 interview respondents (10 males and nine females).

The household respondents were between the ages of 28 and 68, with 11 being above age 50. The age of the respondents may influence their perception of flood risk, adaptation strategies and attachment to the community. The research by (Jansen, 2019) shows that the higher the age of residents, the stronger their attachment to the community. This may be a result of their emotional and affective attachment to the place (De Dominicis et al., 2015). Some respondents indicated that they were born and grew up in the community. The number of years each of the respondents had lived in Glefe ranged from a minimum of 10 years to 50 years. The implication is that most of the respondents had experienced multiple flood episodes in the community and, therefore, could aptly describe the risk. The above may also have implications for placement attachment, risk perception and adaptation strategies (Jansen, 2019). That is because the shared memories, feelings and ideas associated with the community may have become part of the people's broader identity (Jansen, 2019). Each of the household respondents had household sizes ranging from 5 to 18 persons. The average household size was 7.

This diversity in gender, age and length of stay in the community provided the opportunity for a diversity of opinions and lived experiences of flooding in Glefe. The NADMO officials interviewed had been in their current positions for at least three years. That meant that they were able to provide expert opinions and insights into the flood problem in Accra.

5.3 Vulnerability and Household Experience with Flooding in Glefe

5.3.1 Glefe's Flood Proneness is Rooted in its Origins

A respondent [LA1] attested that Glefe was first settled as a small fishing and farming village along the Atlantic Ocean. They opined that the area had a dense forest, mostly of palm trees, however, it was also situated between two lagoons (Gyatakpo and Gbegbu, which border parts of the community) and the ocean. They also suggested that the plain itself was a wetland, part of the ecologically important Densu river wetlands. Thus, from its beginning, the settlement was in a flood-prone area. According to one respondent [LA1], *"The original Glefe is in the sea."* They revealed that the original site where the first inhabitants settled has now been

washed out by coastal erosion, therefore the settlement had to retreat inland due to coastal erosion. At the time of the data collection in early 2019, the researcher observed signs that tidal waves were rapidly eroding the ocean front of the settlement. Figure 15 shows the settlement of Glefe and its surroundings.

Figure 15: Glefe and its surroundings
Source of map: Google maps

5.3.2 Urbanisation is a Contributory Factor to Glefe's Exposure to Flooding

From a small fishing village, Glefe has become a densely populated informal settlement, inhabited by about 10,000 people in the last census in 2010 (GSS, 2012a). Due to the urban expansion and urbanisation of the Greater Accra Metropolitan Area (GAMA), informal settlements like Glefe provide cheap accommodation (Amoako, 2016). The respondents suggested that residents have converted the original forest and swamplands into urban land for housing development. The farmlands have thus disappeared. It was also suggested by the respondents that urbanisation of the area has also led to pollution of the lagoons, which used to serve as a fishing location. They noted that the lagoons have become choked with household waste, becoming a source of flood risk and a health hazard in the community.

One NADMO official noted that *"it* (the flooding) *is triggered by urbanisation. That is the major issue about Accra floods. It is largely due to urbanisation. Whether climate change is an underlying issue or not, urbanisation is the major cause of flooding in Accra."* [NA1]. They

added that *"more urbanisation increases flood risk. Though climate change is the underlying factor, we are not planning well. People are settling in flood plains and unauthorised areas. For instance, most of the flooding that occurs is due to encroachment on water bodies.* The NADMO official further suggested *"Poverty is at the root of that* [people living in flood-prone areas]*"* and "*it is cheaper to live in those communities."* [NA1]. The interviewer also shared the opinion that "*we do not have a national buffer regulation to deter people from encroaching on water bodies. So even if people are encroaching on water bodies, they cannot be sanctioned due to the absence of a real law to deal with that* [encroachment]*."* [NA1].

5.3.3 The Weija Dam Spillage Contributes to Flood Risk in Glefe

The interviewees explained that another issue that exacerbates the flood risk in Glefe is the Weija Dam, situated on the Densu River. During the rainy season, Glefe is submerged from the Weija water spill, raising the water levels in the lagoons. When there is spillage from the Weija dam, the water flows through the main river and its tributary streams into the lagoons at Glefe. The water is, however, usually beyond the storage capacity of the lagoons, causing them to overflow their boundaries into the surrounding neighbourhoods. The municipality has also channelled several storm drains into the lagoons. These drains, therefore, deposit vast volumes of water into the lagoons during the rainy season. Figure 16 shows the lagoons in Glefe.

Below is one of the comments illustrating respondents' opinions about the causes of flooding in Glefe. *"The current threat of flooding is due to the spilling of the Weija dam."* [HO1].

Figure 16: The Lagoons Abutting Glefe
Source: Author

5.3.4 Pambros Salt Mining Ponds Increase Vulnerability to Flooding in Glefe

The respondents suggested that the presence of salt mining activity by Pambros Salt Mining Company adds to the vulnerability of the Glefe community. The Pambros Salt Mining Company has several salt mining ponds adjoining Glefe. The ponds restrict water drainage into the sea with an embankment. The water thus pushes back and inundates the community during the rainy season. Figure 17 shows the Pambros salt mining ponds.

Figure 17: The Pambros Salt Mining Ponds Abutting Glefe
Source: Author

5.3.5 Human Behaviour Contributes to Flood Risk in Glefe

The interviewees suggested that choked drains/gutters and a deplorable drainage system, siltation of the lagoons as a result of housing encroachment and indiscriminate dumping of refuse, poor refuse disposal and haphazard layout of the community were issues causing flooding in the settlement. One respondent [LAI] reiterated that *"it is the habit[s] of the people that are causing the flooding."*

A respondent [HO12] suggested that *"the lagoons fronting the community [are] filled with refuse and human excreta. Weeds have* [also] *taken over the lagoon. That is the cause of the flooding. Besides, there are inadequate waste collection points in the community."*

Another interviewee noted that the flooding is caused by "*choked drains, resulting from poor drainage systems and improper disposal of refuse*. [Also, there is] *flooding here because the laws that govern building construction and sanitation are not strictly enforced by the authorities concerned. The non-enforcement of these laws has allowed people to flout them with impunity as people end up building anywhere, causing flooding."* [HO10].

They further added that *"The reoccurring flooding in the community is due to the choked gutters. Besides that, the water in the gutter is unable to flow into the sea. Many buildings have encroached on the lagoon, resulting in the flooding issues in the community. There is no way for the water to flow into the sea since waterways have been blocked."* [HO1]. Figure 18 and Figure 19 depict some of the poor sanitary conditions in Glefe.

Figure 18: Poor Waste Disposal in Glefe
Source: Author

Figure 19:Poor Sanitary Conditions in Glefe
Source: Author

5.3.6 The Location of Informal Settlements Makes Them Vulnerable to Flood Risk

In general, respondents identified that most informal settlements in Accra are very prone to flooding. This is because their location is on lands that contribute to their exposure and vulnerability to flooding. As [LA1] notes, *"When it rains, informal settlements become victims."* Another official [NA1] of NADMO concurred that *"They will always be vulnerable*

due to the location of people in flood-prone areas. If there was affordable housing, the people could be relocated to reduce flood risk and also prevent other people from settling there."

5.4 Flooding Experience in Glefe

5.4.1 Households' Flood Experiences Influence their Perception of Flood Risk Positively

Officials of NADMO believe that flooding in Accra is usually in the form of flash floods. However, there are also cases of river flooding and coastal flooding in the city. About nine river basins drain Accra in general. As one respondent [LGR1] notes, *"As for flooding, it is seasonal. It is very much in the rainy season. It is always massive, especially in flood-prone areas."* Glefe is one of the communities that experiences seasonal flooding. Due to the terrain, the settlement quickly gets waterlogged during the rainy season.

The respondents could still remember flooding events as far back as 1989. They also remembered the years 1995, 2006, 2010, 2014, 2015, 2017 and 2018 as the years with the worst flooding in the history of the community. Out of the 16 household respondents, the majority identified 2015 flooding as the worst they had experienced. That is not surprising, as the flooding of 2015 (especially that of June 3) killed the highest number of people in recent memory (Amoako & Inkoom, 2017).

As the people narrated their experience, the sentiments were mostly negative. The informants suggested that flooding made life difficult for them. One respondent opined *"aside from the water flooding our rooms, it carries along with it waste and faeces into our homes which makes it difficult to stay."* [HO1]. What worsened the situation was that they did not receive any tangible relief or support from the government. As one respondent complains, *"we received no form of assistance from the government, NADMO or any NGO. We had to do everything ourselves from scratch."* [HO1]. Another respondent added that *"whenever it rains, we call upon NADMO and AMA to bring relief. They bring mattress, sugar, rice, milo, maize and plastic bowls. However, the relief items are not sufficient to cover the losses that people incur. People's properties are destroyed, mattresses are destroyed – what can milo, sugar and rice do to them?"* [LGR1]. Other respondents confessed to having received relief items and money from NADMO. Private sector organisations, such as MTN (a telecommunication company) and churches, also offered support to the people after previous floods. The following statements depict some of the sentiments about the after-flood support in Glefe.

- *"Usually, people volunteer to help clear up* (debris) *after the flood."* [HO4].

- *"I got assistance from my fellow market women to start up. The government gave us 300ghs and mattresses, drinks, rice and oil."* [HO10].
- *"To return to normal, I had to fall on some friends and family to borrow some money to rebuild my home. Government agencies like NADMO came to our aid with some relief items and GHS300 to support us."* [HO11].
- *"NADMO came to share blankets and student mattress to the affected people. Students were also given school supplies like bags, books, pens and pencils."* [HO13].
- *"I went for a loan at the bank to solve my problems."* [HO14].
- *"I had to seek financial assistance from relatives to rebuild my building."* [HO16].

5.4.2 Flooding has Negative Impacts on the Households

Flooding affected the community in varied ways. At the individual household and community level, the respondents noted that floods had social, economic, health and environmental impacts. While floods may have both positive and negative consequences, it was the negative impacts that captured the attention of the people. The negative impacts of flooding on the community were the death of people, damage to housing, injuries, waterborne diseases infestation, and destruction of foodstuffs and building contents. Other impacts were deterioration of roads due to deposition and accumulation of debris, disruption of transportation due to damage and inundation of roads and stalling of economic activities. People also suffered financial hardship as a result of the disruption of their economic activities and the financial requirements of recovery. There was also disruption to education in the community. In terms of impacts on the environment, the floods deposited debris and solid waste in many parts of the community, causing a nuisance. Also, due to the frequent flooding, some locations in the community became permanently waterlogged. Some respondents alluded to suffering multiple impacts on their wellbeing and livelihood. For instance, [HO16] reported that *"my home was damaged, and I experienced financial difficulties as I needed money to repair it. Also, I could not go to work as a result of one of my children's ill health. The ill-health was as a result of the flooding. I had to take care of him until he recovered. That destroyed my source of income*." [HO2] also indicated that *"We have not been able to recover from flood loses. We are still facing difficulties."* It was evident that the impacts could go beyond the immediate direct impacts, since it affected the poorest segment of the population, who could find it challenging to recover from the flood (Erman et al., 2018).

5.4.2.1 Flood had Physical Impact on Housing

The interviewees observed that one of the impacts of the successive years of flooding on the community was the loss of houses and household assets. Some houses were either fully or partially destroyed as the floodwaters led to the collapse of walls. Also, some houses, or rooms in the houses, became structurally unsound, leading to cracks in the walls. These structurally unsound dwellings became a further hazard to the occupants. The destruction of household assets was also frequently mentioned by the informants. Household assets such as television sets, refrigerators, mattress, and clothing were destroyed by flooding. Some respondents also lost the foodstuffs that they had kept on the floor of their rooms. Below are some of the responses regarding the physical impacts of flooding on housing.

- *"It breaks the walls of houses and some houses even collapse. It also destroys our mattresses, clothes, electrical appliances and more. Our things are kept on the floor, so most of them are destroyed when the rooms get flooded."* [HO1].
- *"I could not save my belongings; the floodwater took everything away."* [HO10].
- *"Properties such as television sets and other valuables were carried away by the floodwaters".* [HO13]
- *"My home was damaged."* [HO16]
- *"Everything got damaged in the flooding. I have still not been able to repair my fridge. However, I hope to get back all that I lost in the flooding, with the help of God."* [HO2].

Figure 20 shows some of the physical and environmental impacts of flooding in Glefe.

Figure 20: Physical and Environmental Impacts of Flooding in Glefe
Source: Author

5.4.2.2 There were Economic and Financial Impacts of Flooding

According to the interviewees, flooding also led to economic and financial hardship for affected residents. Some of the respondents indicated that they lost their business assets. Some people were also unable to go to work due to the inundation of roads and disruption of transportation services. Others reported that they had to use available savings due to the hardship the flooding brought. Besides the economic impacts, some of the respondents also encountered the financial challenge of recovery and rebuilding or repairing infrastructure damaged by the flooding. Some respondents had to spend money on medical treatment due to health problems resulting from the floods. While some people used available savings to finance the recovery works, others had to rely on loans from friends, neighbours, family members or financial institutions. The following are some responses from the participants regarding the economic and financial impacts of flooding on them.

- "*We experienced financial difficulty because we had to rebuild our damaged walls and buy replacements for furniture that had been destroyed."* [HO11].
- *"I could not even operate my business of selling fish because of the whole."* [HO9]
- *"All my life savings and business products got destroyed by the floods."* [HO10].
- *"The flooding brings transportation and other economic activities to a standstill."* [HO11].
- *"I could not go to work, which destroyed my source of income. I experienced financial difficulties as a result. Nevertheless, I needed money to repair it* (the house)*."* [HO16].

5.4.2.3 Flooding Inflicted Health Impacts on Respondents

As alluded to in the preceding sections, past flooding had negative health impacts on the inhabitants of Glefe. Respondents reported ill-health and injuries resulting from floods. Most of the respondents reported that they depend on water from open wells and other unsafe sources in the community. These water sources were polluted by flooding, leading to waterborne infections, such as dysentery, cholera and typhoid. Health problems among the respondents or their family members exacerbated their conditions. The health impacts also resulted in missed days of work. Below are some of the comments the respondents made regarding the health impacts of the previous flooding.

- *"Some of us got sick due to the flooding."* [HO1].
- *"Our health is also affected due to the poor sanitary conditions the flood brings."* [HO11]; and

- *"One of my young grandsons got seriously ill, and this really affected me."* [HO14].

5.4.2.4 Flooding Impacted Education in the Community

The past flooding also had negative impacts on the education of children in Glefe. Some respondents reported that their children missed some days of school due to the flooding. There were multiple reasons for the above. They advised that some of the schools in Glefe were flooded, resulting in their temporary closure. Another reason they gave for children missing one or more days of schooling was the inaccessibility of roads during and after flood. Besides, some of them lost their school supplies during the flooding. Below are the views of some of the respondents on the effects of flooding on their children's education.

- *"Even the schools were affected by the flooding. My children couldn't go to school because their school in the community was also flooded."* [HO11].
- *"Because of that (bad roads), my children could not go to school for some time."* [HO12].
- *"We even experienced difficulties in the schooling of our children. They lost their school uniforms, books and shoes. As a result, they could not go to school for some time."* [HO2].

5.5 Preparedness Towards Flooding in Glefe

5.5.1 Household Flood Preparedness was Inadequate

Preparedness mechanisms can reduce the negative impacts of flooding in communities (Rañeses et al., 2018). Preparedness plays the vital function of limiting the adverse impacts of flooding and building up the resilience of the community (Kreibich & Thieken, 2009; Onuma et al., 2017). If done adequately, preparedness may limit the need for coping actions during or after a flood (Hoffmann & Muttarak, 2017; Thieken et al., 2007). All flood-prone communities need to be purposeful about flooding and put in place advance arrangements for what can be done before, during and after a flood event. That allows for problems to be identified and proactively managed before a flooding event. As flood preparedness depends on information on the probability and severity of future flooding, it requires engagement between flood-prone communities and government departments (Bronfman et al., 2019; Hoffmann & Muttarak, 2017).

In Glefe, most respondents said they did not prepare adequately or at all before past flooding events. Only about 31% of the interview respondents indicated some form of flood preparedness. Even with these respondents, one-third of them said they were preparing to cope with the flooding. That essentially meant that they did not undertake any measures before the onset of the flooding. For example, [HO12] indicated that *"I prepared to cope with the flood."* Another respondent said, "*I was preparing to cope with the floods."* [HO14]. Respondent [HO3] made no preparations because they did not think that they would be affected by the last flooding in the community. They said *"I did nothing because I was not going to be affected by the flood. My sister, however, filled her compound with stones and sand."* [HO3]. Below are other responses on flood preparedness in Glefe.

- *"I did nothing to prepare for the previous flood. However, I am currently building a wall around my house to protect it from getting flooded."* [HO1]
- *"I was not able to protect my house adequately because I did not anticipate that the flooding could destroy my property*." [HO11]
- *"I made sand barriers to block the floodwater and also created channels for the water to flow when it rains."* [HO2].

5.5.2 Institutional Preparedness Measures were Both Structural and Non-structural

Besides the community respondents, the NADMO officials also indicated that *"We work with the Ghana Meteorological Agency to provide us with the weather forecast. We plan and prepare ahead for the floods based on their predictions and forecast. We also collaborate with other agencies, like the Fire Service and the Hydrological Services Department, who come to help us in our educational programs."* [NA1]. Another NADMO official added that *"We are being proactive and doing preparations so that when the floods occur, the impacts would not be severe."* [LA1]. The *"preparedness mechanisms* [we undertake] *include some mitigation works like dredging of river basins. During the rainy season, we make sure all these river basins are dredged. Sometimes we dredge, but the secondary drains are choked, causing flooding."* [NA1].

5.6 Dependence on Coping Measures

During and immediately after flood events, people adopt various mechanisms to reduce the impacts of the flooding on their lives and properties (Wamsler & Brink, 2014). These strategies are usually implemented to support their survival (Mensah & Ahadzie, 2020). The household

respondents took actions to ensure that their dwellings remained functional to provide shelter for them. They also undertook measures that ensured that their valuable belongings did not get destroyed by floodwaters. Figure 21 shows some of the dry-proofing measures adopted to protect houses. The images show that some households built concrete retaining walls around their buildings, while others deposited sand.

Figure 21:Dry-proofing Measures to Protect Houses from Flood Damage
Source: Author

Respondents in Glefe adopted the following strategies to cope with the recent flooding in their community.

5.6.1 Relocation from the Community Temporarily

Some households decided to relocate from the community and returned when the flooding receded. They revealed that.

- *"The first thing I did in the most recent flood was to inform my family about finding a place to move to for the time being. We moved with all our belongings to the temporary location. Most of the people in the community temporally relocated. We come back to sweep and clean the rooms when everything cools down."* [HO1].
- *"My family and I sensed the danger the flood could pose, so we evacuated from our home. If we had not done that, it would have resulted in our death.* [HO10]. *"The first thing I did was to move my family from the community to a nearby community for safety.*

5.6.2 Households Took Proper Care of their Health During the Flooding

Some respondents revealed that they took proper precautions to ensure that their health was not affected due to the flooding.

- *"After everything had subsided, we visited the hospital to check on our health. We sought medical attention for any family member who was injured or fell sick due to the flood.* [HO1].
- *"We made sure we washed items properly before cooking. With fruits, we wash them thoroughly before consumption."* [HO10].
- *"I made sure we slept under treated nets because of mosquitoes.* [HO11].

5.6.3 Erecting Physical Barriers at the Property

Some households erected physical barriers to prevent the flooding from inundating their properties, as shown by the following statements.

- *"I had to put some clothes at my entrance to soak the water from entering into my room. I had already elevated the floor of my door to lessen the amounts of water that rush into my room during flooding. I also patched some damaged parts of my compound."* [HO12].
- *"People place rocks or wood on the compounds in order to have safe spots to walk on."* [HO3].
- *I contracted someone to fill my doorsteps with heaps of sand and gravels to prevent water from entering my room.* [HO14]
- *"With my home, I had to patch and cement my floor. I also elevated the area surrounding my building."* [HO8].

5.6.4 Elevation of Portions of the Room to Place Valuable Items

Some households elevated portions of their rooms to store valuable items so that the flooding did not destroy them. The respondent [HO14] revealed that

- *"I elevated a portion of my room to put my important belongings so that floodwater does not destroy them."*

5.6.5 Creating Channels to Drain the Flood Waters Away from the Property

Some of the respondents noted that *"Sometimes, we take hoes and shovels to create channels for the water to flow away. The water did not enter my home because of its elevated nature."* [HO15]. "*Some people create channels to get the water to flow out, so their homes do not get flooded."* [HO7].

5.6.6 Scooping Water out of Flooded Homes

Some household resorted to scooping water out of their homes as these respondents said, *"Many residents had to scoop water from their flooded home."* [HO8].

5.6.7 Desilting of Gutters

Desilting of gutters was also used as a measure by some Glefe residents to cope with the flooding, as noted by these respondents.

- "*We did not do anything four years ago to cope with the flood. However, our neighbours most of the time desilt the gutters to get the water to flow, so their homes do not get flooded."* [HO9].
- *"Most of the time, they desilt the gutters to get the water to flow, so their homes do not get flooded."* [HO3].

5.6.6 Demolition of Houses in Waterways by Government Agencies

"The government also demolished some houses that were built in the waterways." [HO9].

5.6.8 Other Coping Measures Noted by Government Agencies

The NADMO officials at the local government level also indicated that *"Some people get evacuated. Others relocate and come back when the floods subside."* [LA1]. Officials at the NADMO national office added that *"People who live in flood-prone areas and are aware are coping by temporarily relocating to family and friends during the rainy season. They also adopt traditional coping methods, like putting sandbags in flooded areas. They also keep their valuables on shelves."* [NA1].

Furthermore, [LGR1] revealed that *"Before the Glefe Bridge was constructed, the people used canoes to transport them in and out whenever it flooded. Others would swim across them. Some waded through the water to go to work. It was dreadful. Cars and buses could not cross, so they parked behind the lagoon. Without that, no one could go into the city. Some people store enough food for the rainy season. Others buy from food sellers in the community so that they do not starve. People who are forced out of their homes sleep in churches or community centres. Many temporarily relocate to their relative's houses until the floodwaters recede."*

The above comments show that coping mechanisms used in the community were mainly retreating and accommodation approaches. These mechanisms led to modifications within the house, modifications to the house structure, modifications around the house, improvements at the neighbourhood level and modifications to the work and living environments of the household. Table 42 shows a summary of the coping mechanisms used in Glefe.

Table 42: Summary of Coping Strategies Used in Glefe

Type of Coping Mechanism	Actions
Retreat	• Temporarily relocate to a neighbour or family member on higher ground in the same community or a neighbouring community • Temporarily relocate valuable belongings to neighbours or family on higher ground in the community or neighbouring community • Evacuation by NADMO
Accommodation	• Move valuable belongings to shelves or cupboards on elevated platforms in the home • Elevate the entrance to the house or the entrance to the room • Place sandbags in the compound • Reinforce walls of houses • Digging of gutters to channel floodwaters away from the house • Clear gutters, drains or waterways in the community • Repair damaged roofs • Rebuild damaged walls of buildings • Scoop water out of the house or rooms
Health Strategies	• Medical check-ups after floods • Washing fruits and vegetables properly before eating • Eating well-cooked food

Source: Author

5.7 Flood Risk Appraisal

The flood risk appraisal of both household interviewees and institutional respondents was explored to investigate their perspectives about current and future probability and severity of floods, as well as their vulnerability. As recent flooding experience tends to create a heightened level of anxiety and influences how people perceive flood risk (Kreibich & Thieken, 2009), the respondents' affective reaction to recent flooding was also investigated.

5.7.1 Fear of Flood Impacts Influences Flood Risk Appraisal Positively

The experience of flooding may induce affective responses from people. The more severe recent floods are, the higher the likelihood that people may be afraid and anxious over future flooding (Ogunbode et al., 2019). Respondents confirmed that recent flooding had caused fear and anxiety among residents in Glefe. The fear was mostly associated with the level of negative impacts caused by the recent flooding. Due to that, some residents were terrified about future flooding. A majority of respondents said that they were anxious that their family members could be harmed during flooding. Below are residents' responses regarding their fear or worry about flooding in Glefe.

- *"I was scared for my family during the recent flood. I am terrified for our safety. That is because the walls of the house could collapse upon us. Even with well-built and strong walls, they can still collapse when a severe flood occurs."* [HO1].
- *"Rainy season in Glefe is frightening. All you worry about is destruction either to persons or properties. I was terrified last time. I am still afraid for my life, which is mostly under threat in the rainy season. I think my family and property could suffer harm from floods in the future if nothing is done about the flooding."* [HO10].
- *"It is very uncomfortable living here when you think about heavy rains and the flooding they bring. I fear for the safety of my family. If I do not take mitigating measures and a member of the family is inflicted with an ailment, I would have to spend more money taking him/her to the hospital, which is sometimes inconvenient."* [HO12].
- *"During recent flooding, I was terrified and still afraid because water is nature, and one cannot predict what will happen. One can do something when the rain comes during the day, but when it rains in the night or at dawn, it is difficult to protect yourself. People start to panic whenever the raining season begins. I am very much afraid for the safety of my family, especially in June and July. We experience heavy rainfall during these months. We only pray for the protection of God during these months."* [HO2].

Despite the fear that some residents had about flooding impacts, some were nonetheless positive that future flooding would not cause the same level of harm because of the mitigation measures they were putting in place. For example, [HO14] said *"The rainy season brings about a lot of fear and panic among residents. When it rains, I fear for my safety because of how the floodwater rushes into our room. Sometimes the water becomes stagnant in small gutters around my home, breeding mosquitoes. Year after year, my family suffers from health problems due to the flooding. I am thus worried about health-related issues like dysentery, cholera and*

malaria. However, I do not think my family will suffer harm in future because of the adaptation interventions I will put [in] place to avert such a situation." Table 43 summarises the reasons for respondents' anxiety about flooding.

Table 43: Summary of themes regarding why people are anxious about flooding

Themes	Examples
Destruction of lives and properties	*"Rainy season in Glefe is frightening. All you worry about is destruction either to persons or properties."* [HO10]. *"The flooding here is life-threatening."* [HO16]
The unpredictability of flooding risk	*"I was terrified and still afraid because water is nature, and one cannot predict what will happen."* [HO2].
Electrocution during flooding	*"Electrocution is my worst fear during flooding."* [HO8].
Flood-related health problems	*"Year after year, my family suffers from health problems due to the flooding. I am thus worried about health-related issues like dysentery, cholera and malaria."* [HO14]
Entrapment under collapsed buildings	*"When it rains for a more extended period, the walls of my building get weakened, so I fear that one day it might collapse on us while we are sleeping."* [HO6].
Unsafe location of their dwelling	*"I worry about it getting worse since I live close to the lagoon. Anything can happen when there is flooding."* [HO5].
No long-lasting measures have been undertaken	*"I do fear for my safety because besides coping with the situation over the years, nothing long-lasting has been done."* [HO11].
The flooding could become worse	*"The floods could become worse."* [HO5].

Source: Author

5.7.2 Flood Experience influences fear of flood risk

The respondents revealed that they were afraid of future flooding due to the experience they had with flooding in the past. Below are some perspectives from the household respondents.

- *"During recent flooding, I was terrified, and still afraid, because water is nature, and one cannot predict what will happen. I am very much afraid for the safety of my family, especially in June and July."* [HO2].
- *"Rainy season in Glefe is frightening. All you worry about is destruction either to persons or properties. I was terrified last time. I am still afraid for my life, which is mostly under threat in the rainy season. I think my family and property could suffer harm from floods in the future if nothing is done about the flooding."* [HO10].

5.7.3 Flood Experience Influences Perceptions about Flood Probability and Severity

The interviews further explored respondents' thoughts regarding flooding in Glefe.

Specifically, respondents were asked about their perceptions concerning whether the flooding could become more frequent and more severe in future. Some respondents thought that the flooding occurrence and severity could worsen in future. Other respondents were convinced that flooding occurrences and severity would not be worse than current trends. Also, residents were asked whether flooding had become part of their life. Most respondents (88%) agreed that flooding was part of their life, but the rest disagreed.

Similarly, 56% of the respondents held the perception that flooding could get worse in the community. The rest, however, were not sure, as the severity of flooding depends on the severity of the rainfall in the particular year. Below are some of the comments indicating respondents' perceptions about flooding risk in Glefe.

- *"Flooding has become part of our life. We expect to experience flood anytime the raining season begins. I cannot say whether the flooding could get worse. I believe it will depend on how heavy the rains are."* [HO1].
- *"The floods are part of life here. It happens every year, and no pragmatic step has been taken to curtail it. I think the flooding will get worse."* [HO10].
- *"I can say for a fact that floods are part of life here. I believe the problem comes from our poor attitudes, especially improper waste disposal that poses a flooding threat in the community. I think the flooding could get worse because residents are still indiscriminately throwing refuse in drains. That makes it difficult for rainwater to flow freely, causing flooding."* [HO12].
- *"The floods have become part of our life every rainy season. The floods will get worse. The issue of the lagoon must be addressed so that at least it could also partly hold the spilled water from Weija Dam. Right now, it is choked with filth and human excreta."* [HO14].
- *"Flooding has become part of our life. It mostly occurs during the raining season. It causes the lagoons to overflow their banks most of the time flooding the community and destroying stuff. However, we now have storm drains into which rainwater can flow."* [HO2].
- *"There is a great possibility for flooding to occur. The flooding could get worse if the government does not take steps to dredge the lagoons and remove all the weeds growing in the lagoon to allow it to flow freely. Also, they should stop people from dumping refuse into the lagoon."* [HO4].
- *"I would say flooding has become a part of us because basic things have not been*

addressed here. It will get worse if the poor sanitation practices are not addressed properly and the lagoon must also be dredged to allow free flow of water during the rainy season." [HO6].

It is evident from the quoted comments that many respondents perceived that flooding could become more frequent and more severe in future because flooding events have become more common in the community. Table 44 summarises the reasons some respondents gave for their views on whether flooding in Glefe could worsen or not.

Table 44: Reasons why flooding may or may not worsen in Glefe

Reasons why flooding could become worse	Reasons why flooding may not worsen
"No pragmatic step has been taken to curtail it." [HO10].	*"We now have storm drains into which rainwater can flow." [HO2].*
"Due to the absence of a proper settlement layout, coupled with the poor sanitary conditions." [HO11].	*"We have also used our little knowledge to put things in place to protect ourselves from future flooding."* [HO2].
The *"poor attitudes, especially improper waste disposal that poses a flooding threat in the community."* [HO12].	*"When the sea defence wall is completed, a storm drain would be constructed to allow the floodwaters to flow into the sea."* [HO5].
Due to *"the issue of the lagoon".* [HO14].	
"If the government does not take steps to dredge the lagoons." [HO4].	
"When it rains heavily". [HO7] and [HO9]	

Source: Author

The institutional respondents also gave their perceptions about flooding risk in Glefe specifically and Accra in general. One respondent said that *"It will be difficult for the city to avoid flooding. We are only hoping that it will minimise. Recently the rains do not come the way they used to. We do not think the floods will be severe. Reports about the potential severity of floods are only predictions."* [LA1].

Another respondent added *"The flooding here is too bad. Future flooding could be very severe. The Meteorological department has even advised us that the rainfall will be severe this year* (2019). *I think in future the flood here will be like a tsunami if nothing is done. The solution has to be found so that when it rains, the people are not affected."* [LGR1].

Furthermore, [NA1] suggested that *"The risk will be high if we do not change the way we do things and put in place serious measures, both structural and non-structural, to reduce the flood risk. Though the yearly average of rainfall could reduce, a month's worth of rainfall*

could occur only in a day or two."

5.7.4 High Trust in Public Flood Protection Infrastructure Reduces Perception of Flood Probability and Severity

Public flood protection works may take the form of levees, embankments, storm drains, and dams, among others (Attems et al., 2019; Liao, 2012). In Accra, the NADMO respondents revealed that government usually embarks on activities to dredge river channels and drains before rainy reasons. Some projects have been implemented and some are in progress to construct storm drains to ease flooding risks in parts of the city. In Glefe, the respondents advised that a sea defence wall is under construction to protect the settlement from tidal flooding and erosion. According to the community representative [LGR1] *"The sea defence wall started in 2015. Since it was built, tidal waves have not disturbed the people on the side protected by the wall. However, tidal waves still affect the area yet to be protected by the sea defence wall. If you go to the seaside, you will see people's houses that have been destroyed by tidal waves."* Research has shown that people with a high level of trust in public flood protection works often do not undertake personal flood protection (Bamberg et al., 2017). It has also been established that when trust in public flood protection works is high, risk perception is low, and vice versa (Terpstra, 2011).

It was evident that some residents in Glefe perceived that the sea defence wall being constructed was sufficient to protect them from flooding. For instance, [HO13] noted: *"I do not think that Glefe is currently under threat of flooding due to the works* [sea defence wall] *that have been done."* [HO15] also opined *"After the sea defence wall was built, the flood does not worry us again. Before the sea defence wall, the floodwaters often inundated our neighbourhood. The sea defence wall now protects our area."*

According to [HO3], *"The tidal waves used to flood parts of the community, which most of the time destroyed houses. A sea defence has been constructed along the coast to prevent the seawater from overflowing into the community. The flooding will not get worse at all because of the sea defence. Therefore, the risk of tidal flooding is now low. The sea defence wall is proving to be much help. I believe that when it is completed, everybody will feel safe in the community. "*

[HO5] also added that *"When the sea defence wall is completed everything will change. It will*

protect us from the floods. It is sufficient to prevent further flooding."

Despite the perceptions of the people about the flood protection potential of the sea defence wall, it is doubtful that it could protect the community from pluvial and fluvial flooding.

5.7.5 Coping Experience Influences the Perception of Flood Risk

The coping measures undertaken by some of the residents influenced their perception about flood risk in the community. Some residents also indicated that they were not anxious about the flooding situation since they believed that the measures they had put in place or were implementing could protect them from the negative impacts of flooding. Other residents believed that flooding risk was a major concern for them because past coping measures did not provide lasting flood protection. According to them,

- "*I am not anxious about the safety of my family because I can put in place measures to protect us. I believe the construction of a retaining wall and filling of the floodable areas in my home with sand could reduce flooding should it occur. Flooding has never inundated my home, though."*
- [HO4] further opined that *"I am secured and safe because I am on higher ground. I am only worried about my family members in the flood-prone zones."*
- *"I do fear for my safety because, besides coping with the situation over the years, nothing long-lasting has been done."* [HO11].
- *"The floods do not happen every year here. It only occurs in the years that the Weija dam is spilled. It also happens when rainfall is severe. I do not think it can happen again because we have started implementing measures to prevent it, like dredging the lagoons."* [HO13].
- *"As community members, we have also used our little knowledge to put things in place to protect ourselves from future flooding. I do not think we are likely to experience a severe flood situation again."* [HO2].
- *"People have also become alert and will put in measures to protect themselves from future floods. Flooding will not affect my family because my location in the community is on the higher ground.* [HO3].
- *"I do not think the next flooding will affect me that much because I have elevated my home and cemented the whole compound."* [HO11].

5.7.6 Lack of Information Influences Flood Risk Appraisal

Even though some residents had experienced flooding in the community, they revealed that they lacked adequate information to assess the probability and severity of future flooding. Thus, they could not use their experience to judge whether flooding could become more frequent or more severe. Below are some of the opinions.

- *"The community stands the risk of being flooded when it rains heavily. I do not think it is now part of our life here in Glefe. The community getting flooded depends on how heavily it rains in a particular year. We do not experience flooding when there are no heavy rains. I cannot tell if the flooding could get worse. Only God can tell. Regardless, I do not get affected by the flood when it occurs."* [HO7].
- *"We cannot stop the rains. It is only God who knows if we will get flooded again. I cannot tell if the community will be flooded again, unless from June when the rain becomes severe. I do not think it will be as bad as before. We can only be affected by the flood when it rains heavily. However, I do not think we will suffer any harm when it occurs."* [HO9].

5.8 Adaptation Appraisal

Adapting to current and future flood risk is needed to enable the people of Glefe to live in a resilient community. Adaptation to flooding is a growing concern in developing countries due to the high concentration of the urban poor on peripheral and flood-prone land (Jordhus-Lier et al., 2019). Individual adaptation to flooding involves a sequence of decisions that culminate with the formation of adaptation intention and performance of adaptation action or inaction (Botzen et al., 2019). This section addresses household adaptation to flooding risk in Glefe.

Flood risk adaptation appraisal is the perception of people regarding their ability to adapt to current and future flood risk to avoid harm (Weyrich et al., 2020). It involves people's perception of their self-efficacy, response efficacy and the cost (money, time, and effort) of implementing suggested adaptation measures (Bamberg et al., 2017; Rogers, 1983). It is expected that adaptation appraisal, in addition to flood risk appraisal (perception), will influence household flood risk adaptation intention (all things being equal), which motivates and sustains adaptation action (Maddux & Rogers, 1983; Rogers, 1975, 1983).

5.8.1 Self-Efficacy Contributes to Overall Adaptation Appraisal

Self-efficacy represents people's perception of their ability to carry out flood risk adaptation actions effectively (Babcicky & Seebauer, 2019; Weyrich et al., 2020). The research captured the perspective of respondents about their technical know-how to execute protection measures. If the households feel that they do not have the skillset to implement suggested adaptation measures, it may dissuade them from the intention to implement those measures, and vice versa. Thus, positive perception about self-efficacy is critical in enabling and sustaining flood risk adaptation action (Botzen et al., 2019; Hudson et al., 2020). The respondents of Glefe were asked about their ability to perform suggested adaptation measures, such as elevation of their buildings, taking out flood insurance, and relocating to less flood-prone areas, among others. The results indicate that 69% of the respondents felt they did not have the skillset to implement those adaptation measures. However, it was evident that most of the responses were regarding the structural measures. Below are some of the responses.

- *"I have no skill to perform such measures. I can only give advice and ideas on how best the flooding situation can be helped."* [HO1].
- *"I do not see myself skilled enough to perform these actions effectively. Since I have no training in undertaking such more technical works."* [HO2].
- *"I currently have a visual disability so I can only direct people who work for me on what to do to avert serious flooding in my home."* [HO6].
- *"There is nothing I can do to reduce the harm from floods."* [HO9].

Some of the responses from the participants also revealed that they had in mind structural measures at the community scale, such as dredging of the lagoon, and construction of storm drains. The response of [HO7] is a case in point.

"All I can do is to assist others with the tools they need to work. I have some wheelbarrows and shovels at home that would be useful for any flood mitigation works." [HO7].

Another component of self-efficacy was the appraisal of whether NADMO had the capacity to perform adaptation measures to reduce the harm from flooding in Accra. Below are the responses of the participants from NADMO officials at the Accra Metropolitan Assembly and the national headquarters.

- *"NADMO, as an organisation, is trying to be as proactive as possible. We have the capacity in terms of human resources. The government has to put in place the infrastructure to ensure sufficient drainage of floodwaters."* [LA1].

- *"A lack of resources hampers flood risk preparedness on our side. The country as a whole has not prioritised disaster risk management. While human resources are abundant, we have logistical and financial constraints. By law, 3% of the District Assembly Common Fund is supposed to be allocated for Disaster Risk Reduction. However, it is woefully inadequate. So, we are unable to do most of the things we have to do because of lack of financial resources. In terms of human resources, we are not 100% adequate because we have a few human resource challenges in the communities. As an agency, we have challenges. The main problem is that government has not prioritised disaster risk reduction. With adequate resources, DRR initiatives can be implemented."* [NA1]. The above responses indicate that NADMO officials generally believed that they had the human resource capability to spearhead flood risk adaptation action in Accra.

5.8.2 Response Efficacy Contributes to Overall Adaptation Appraisal

Response efficacy is the appraisal of the effectiveness of flood adaptation measures from the perspective of the people (Babcicky & Seebauer, 2019; Weyrich et al., 2020). If respondents believed that suggested flood risk adaptation measures could be useful in reducing adverse impacts, it may affect their decision to execute those measures, and vice versa. Response efficacy is, therefore, crucial in encouraging adaptation action (Botzen et al., 2019). The respondents were asked about their perception regarding the response efficacy of suggested adaptation measures. The interviews explored whether they thought adaptation measures could be effective and whether the measures were worth the time and resources. All respondents were positive that the flood risk adaptation measures were worth the time and resources and could reduce the harm from current and future flooding. Below are the perspectives of respondents regarding the efficacy of adaptation actions.

1. *"The adaptation measures will surely stop the flooding. I believe it will reduce my losses during flooding."* [HO1].
2. *"They would reduce it to some extent. I believe if it is done, it will check a lot of the mishaps in the community during flooding."* [HO10].
3. *"Adaptation measures are worth the time and resources because if you do not take actions towards solving the flood situation in the community, it will always come back to harm us. If adaptation measures are taken seriously, it will eliminate the number of properties lost during flooding because the cost of inaction is usually high. It will also*

reduce the harm, because, for instance, if early warning systems are in place community members will at least get the information and prepare themselves adequately." [HO11].

4. *"It is worth the time and resources because it will solve the problem partly, if not entirely. Adaptation measures will reduce harm from floods."* [HO12].
5. *"I do believe adaptation measures will reduce the harm that flooding causes to families and properties."* [HO3].

It is worth emphasising that some respondents considered adaptation actions highly because the cost of inaction is very high, as opined by [HO11]. [HO11] further implied that the concern was not about the effectiveness of adaptation action, but rather about whether people were willing to undertake such measures.

5.8.3 Perceived Adaptation Cost Contributes to Overall Adaptation Appraisal

The respondents also shared their perceptions about the cost of adaptation. Adaptation cost is people's perception of the monetary cost, time outlay and effort in executing adaptation measures (Bubeck et al., 2018). If respondents perceive that the cost to implement a suggested adaptation measure is too high, it may reduce their desire to undertake those actions. Also, the motivation to implement suggested adaptation measures may be dampened if the time outlay of those actions is too prohibitive for the households.

Conversely, households may be motivated to embark on adaptation measures if they perceive that the monetary cost and time are within their means. Most of the respondents believed that adaptation measures could be expensive and may involve much time. Below are some of their opinions about adaptation cost.

- [HO12] *"Adaptation measures will involve too much effort and are costly."*
- Also, [HO14] suggests that *"Adapting to floods is expensive."*
- While [HO15] said *"It will not cost much."*
- And [HO13] argued that *"I do not think it would be costly*."
- *"Adaptation measures are costly to tackle."* [HO8].
- Both [HO6] and [HO9] believed that *"It might be time-consuming."*
- [HO10] "*It is very costly when you think of adaption, but the money spent after destruction due to floods is far more than what you would use to adapt. The cost of*

dredging and building a storm drain on the lagoon could be prohibitive. However, if it is done, it will reduce the negative impacts on in the community during flooding."

Despite the general perception that adaptation cost is expensive, some respondents (HO10, HO4, HO11) yet believed that it was worth it, as money spent on disaster restoration and recovery could be even more. The respondents also believed that *"It will be worth it to spend money on adapting to be on the safer side."* [HO4]. Additionally, they perceived that *"Adaptation measures are worth the cost because if you do not take actions towards solving the flood situation in the community, it will always come back to harm us."* [HO11].

5.9 Flood Risk Adaptation Intentions

Adaptation intention represents people's motivation to perform adaptation measures. It results from the appraisal of flood risk and adaptation appraisal (Maddux & Rogers, 1983; Rogers, 1975, 1983). The formation of adaptation intention is the first indication that someone is willing and confident that they can undertake adaptation measures to adjust to current and future flooding risk (Chen, 2020; Milne et al., 2000). The interviews sought the opinions of respondents regarding their intentions to respond proactively to flooding in the community.

About 94% of the household respondents did not see permanent relocation as a viable option for adapting to flood risk. Most of them opined that they had been living in the community all their lives. It, therefore, seemed irrational for them to relocate permanently. The adaptation measures that most people intended to deploy to reduce flood risk proactively were mostly low-cost, ranging from temporary to permanent. Most of the actions were targeted at dry-proofing their houses to prevent water from entering them. However, it appears that some measures were essentially coping actions and could not be adjusted for future flood risk and build their resilience. Some respondents also suggested that they will prepare to keep their valuable belongings, such as essential documents, out of reach of floodwaters, either in their home or neighbours' homes. That meant that they were aware that adaptation was needed, but instead preferred to adopt a wait and see attitude, a behaviour that cultural theorists refer to as fatalism (Kahan, 2012; Koehler et al., 2018).

Conversely, others thought they were incapable of undertaking any adaptation measures because of their lack of technical know-how. Besides, others opined that their part of Glefe was not prone to flooding. Thus, no adaptation measures were necessary. While some respondents

were specific about the adaptation measures they intended to deploy, others were imprecise. Below are some of the themes that relate to the respondents' flood risk adaptation intentions.

5.9.1 Flood experience influences Adaptation Intention

The perspectives of some of the residents revealed that their adaptation intentions were influenced by their flooding experience in the community. For instance, [HO15] advised that *"We have been living here all my life. We will not be doing anything since the floods will not affect us again*."

5.9.2 Flood risk appraisal influences adaptation intention

The households' perceptions of the probability and severity of future flooding also appeared to influence their intentions to adapt to future flooding, as reflected in the following statements.

- *I will take precautions because it is something that I want to do to protect myself and the family."* [HO2].
- *"I do not do anything to protect myself from the flood since I am not affected by it."* [HO3].
- *"I will continue to stay here because the sea defence wall will reduce the threat of flooding."* [HO5].
- *"In terms of my home, I prefer to wait for the threat of flooding to get serious before doing something about it."* [HO7].
- *"If the flooding becomes a threat to my family, we will move out of the community temporarily and return after the floods."* [HO13].

5.9.3 Coping experience influences flood risk adaptation intention

One of the major factors that seems to greatly influence the adaptation intentions of the households was their experience gained from implementing coping measures. It appeared that the households believed that the measures that they usually implemented to cope with flooding could protect them from the impacts of floods when proactively implemented. Below are some of the household perspectives on their adaptation intentions.

- "*Firstly, I will elevate the area around my building to deter future rains from entering into my home. I will also deal with how to handle waste in my home, because poor disposal of solid waste often leads to the blocking of drains in the community, causing rainwater to become stagnant. I would take these precautions seriously to reduce the risk of flood in my home. Because if I only cope with the situation as it comes, one of these days it might destroy many things." [*HO6].
- *"My family plans to move to a relative's place to avoid being affected by the flood. For our belongings, there is a high table on which we will pack our stuff to avoid it being destroyed by the flooding."* [HO1].
- *"I will keep an adequate supply of food, candles and drinking water if we are trapped inside our home and cannot leave because of the flooding. We will also clear the debris in the drains to enhance the flow of water. I will take these precautionary measures because my family is vital to me."* [HO12].

5.9.4 Adaptation Appraisal influences flood risk adaptation intentions

Previous studies suggest that adaptation appraisal seems to influence the motivation and intention to adopt protective actions more than any other variable in the protection motivation theory (Bamberg et al., 2017). Thus, the measures that respondents intended to implement against current and future flood risk were measures that they either had the self-efficacy to perform, measures they thought were effective or measures that were low cost. Below are some of their perspectives that reflect that observation.

- *"We only have to put in measures to protect ourselves. I will begin to listen to the weather forecast and NADMO's early warning communication about flooding risk. I have also decided to join other community leaders to raise awareness of proper sanitation practices and its importance to the community. I will do them to protect myself and my family."* [HO8].
- *"All I can do is to assist people working on the lagoon with the tools they need for their work. I have some wheelbarrows and shovels at home they can use."* [HO7].
- *"My family plans to move to a relative's place to avoid being affected by the flood. For our belongings, there is a high table on which we will pack our stuff to avoid it being destroyed by the flooding."* [HO1].
- *"I will also explore options to insure my property."* [HO10].

5.9.5 Trust in Public Flood Motivation Works affects Households Flood Risk Adaptation Intentions

Further to the above, some respondents felt that the government had a more significant role to play in their flood risk adaptation intentions. They perceived that the flooding risk could be mitigated by structural measures, such as dredging of the lagoons and construction of storm drainage. Others raised the issue of the Weija Dam, which is spilled almost annually, causing flooding in downstream communities such as Glefe. As the perspectives in section 5.7.4 show, trust in public flood mitigation works seems to negatively affect the households' appraisal of flood risk. It therefore seems to influence their flood risk adaptation intentions negatively. According to the cultural theory of risk, some fatalist adopt such behaviour, believing that the government or NGOs might take action to provide flood protection (Koehler et al., 2018). Some of the respondents said.

- *"The best way to mitigate flooding in the community will be to construct storm drains that will channel floodwater away from homes. Also, the sea defence wall should be constructed such that it does not obstruct the outflow of floodwater into the sea. The government also need to construct a bridge or drain like the one that has been constructed on the Korle Lagoon. The time spent constructing it will be worthwhile as it will help mitigate flooding in Glefe. The adaptation measures will surely stop the flooding."* [HO1].
- *"A little assistance from the government will help matters. It will be difficult to put a price or value to it since it is an assistance that is being provided to the community."* [HO2].
- *"The government should come and dredge the lagoons so that it would not spill water into the homes of people."* [HO4].
- *"Government institutions who are supposed to help us find solutions to our predicaments come and ask us questions, and that is all, you will not see them again until we are faced with another flood situation. So, the problems are left unsolved. As at now, no measures have been put in place to deal with sanitation and drainage issues in the community. So, when it rains the same story might unfold. It is sad, but that is the truth."* [HO10].
- *"The issue of the lagoon must be addressed so that at least it could also partly hold the spilled water from Weija Dam. Right now, it is choked with filth and human excreta."* [HO14].

- *"Our municipal assembly is trying to make sure that the lagoons are dredged up to the sea. They are trying to build a big bridge over the lagoon so that the water can have free flow whenever it rains. So, the central government is going to support us financially. Last time the Minister for Environment and Sanitation was here to see how they can mobilise themselves and support us. So, with the new Municipal Assembly and with support from the government and donor agencies, those structural works will be done. Without that, we cannot survive the flooding. Currently, plans are afoot for a refuse dumping site to be gravelled and converted to an Astroturf park and a recreational centre for the community. The sea defence wall is also being constructed to prevent tidal waves from disturbing those located close to the sea. The lagoon is also going to be dredged to prevent overflow during the rainy season. The Municipal Chief Executive is also very aggressive and will be holding a forum with the community leaders to educate them and to discuss issues happening here."* [LGR1].

5.9.6. Self-efficacy influences Institutional Flood Risk Adaptation Intention

Apart from the Glefe residents, the officials of NADMO at the national and district level also shared their opinions about the organisation's flood risk adaptation intentions. The officials suggested that they will initiate both structural and non-structural measures to build up the resilience of the communities against flood risk. They submitted that NADMO would prioritise sensitisation of the communities to build awareness of flood risk adaptation. Below are other statements the officials made regarding flood risk adaptation intentions for Accra and Ghana.

- *"Per our reports that we have sent to the headquarters, we have made recommendations on what things should be done. We are hoping that the right people will get to work. We are hoping that people will relocate."* [LA1].
- *"Some of the solutions are structural, and the mandate lays with other agencies. NADMO can only advocate. In terms of the non-structural measures, like education and the plans to deal with floods, they are all in place. Early warning systems that will help the people to organise and put their valuables in safe locations are also in place."* [NA1].

5.10 Adaptation Measures to Respond to Current and Future Flood Risk

Flood risk adaptation measures help individual households and communities to proactively adjust to current and future flood risk to eliminate or reduce adverse impacts (UNDRR, 2017). That is critical, as some households suggest that the short-term and reactive approaches have not had much success in mitigating the flooding risk. Flood risk adaptation measures could range from semi-permanent to permanent (Attems et al., 2019). They could also vary from simple modifications to complete overhaul of housing and people's way of life and perceptions. In the previous section, the intentions of the respondents (both households and institutions) to implement flood risk adaptation measures were discussed. In the present section, the actual flood risk adaptation measures that Glefe residents and NADMO (representing the Government of Ghana) have implemented to respond to current and expected flooding will be discussed.

5.10.1 Some Households are Currently Undertaking Adaptation Measures

The responses from the interviews reveal that Glefe residents have undertaken some measures which could be considered proactive and focused on the long term. The comments below confirm the above assertion.

- *"I am currently building a wall around my house to prevent my home from being affected by flooding should it occur."* [HO1].
- *"Some people have been relocated out of the waterlogged areas."* [HO3].
- *"I have already elevated my house. My house is also on higher ground."* [HO4].
- *"I have been filling my house with sand and gravels so that heavy rains could soak, and also I have patched some parts of my building."* [HO12].

Notwithstanding, some of the measures the residents suggested they were implementing could be classified as temporary. Further analyses of some of these measures also show that they could lead to other environmental problems and, therefore, be maladaptive. The following comments reveal the maladaptive nature of some of the adaptation measures being implemented.

- *"I have constructed a short wall around my house to block the water from entering my home and redirect it somewhere else."* [HO2].
- *"I have not performed any measures personally."* [HO5].

5.10.2 Institutional Flooding Risk Adaptation Measures Are Mainly Incremental

The adaptation measures that NADMO officials suggested they were implementing seem to be incremental in nature. It was also evident that more effort was being put into educational and awareness-creation measures. Thus, the perceptions and intentions of the households revealed in this research could therefore be crucial to their effectiveness. NADMO officials suggested that, *"With the little education we have done, we have been able to minimise the effects of flooding. Because we have intensified education of communities about flood risk, we hope the risk will be minimised, and the flood risk will be less than it is now. When there are floods, we also write reports and present recommendations to the government about things that should be done. The least we can do as an organisation is the education and sensitisation of communities on flooding.*

Everything is about education and communication. So, we try our best. We go to the marketplaces and homes to talk to them about the causes of flooding and how they can contribute to flooding risk reduction. We also tell people what they should do before, during and after flooding to avoid adverse impacts. We have even informed them about what to do to adapt to floods completely. We try to have programs in the communities to remind people of flood risk. Just that people are forgetful." [LA1].

"We do a lot of education and sensitisation. These are the non-structural measures we have put in place. We also have put in place flood contingency plans. When it comes to structural measures, we can only advocate with the government. There have been several projects in the past to help promote adaptation. One of such projects was the CREW (Community Resilience through Early Warning) Project, which helped communities to adapt." [NA1]. The Community Resilience through Early Warning (CREW) project, which began in 2013, developed a multi-hazard Early Warning System (EWS) and EWS Master Plan for Ghana. Early Warning communication equipment was also installed at the NADMO headquarters and 20 other subnational offices.

According to officials at the NADMO headquarters, several plans and policies have also been formulated to aid disaster management and climate change adaptation in Ghana. These include the:

- National Disaster Management Plan.
- National Disaster Management Policy.
- National Disaster Management Organization (NADMO Law) Act 927.

- National Contingency Plan.
- National Climate Change Policy.
- National Plan for Disaster Risk Reduction.
- National Standard Operating Procedures.
- National Disaster Management Regulations (Currently being developed to support Act 927).
- Flood Contingency Plan (in progress).

The NADMO officials were confident that with adequate resources from the central government and the full implementation of the plans and policies, current and future flooding could be mitigated.

5.11 Summary of Emergent Themes on Factors Influencing Flood Risk Adaptation

In this chapter, the perceptions of Glefe residents and NADMO officials regarding flooding risk, adaptation appraisal and flood risk adaptation intentions were analysed. The current section summarises the major themes that were evident in the chapter.

- Glefe's flood risk is rooted in its physical location.
- Human behaviour is a major contributor to flooding risk in Glefe.
- Urbanisation is a contributory factor to Glefe's exposure to flooding.
- Non-enforcement of planning and sanitation regulations is a bottleneck to flood risk reduction in Glefe.
- Relief and recovery efforts from the government are inadequate to build the resilience of the community after flooding.
- Flood preparedness measures are inadequate to proactively equip communities against adverse flooding impacts.
- High dependence on coping measures could be a setback to flood risk adaptation.
- Fear influences flood risk perception positively (that is, the perception of flood probability and severity).
- People's flood experience influences their perception of flood risk positively.
- Coping experience influences the perception of flood risk.
- Trust in public mitigation works reduces the perception of flood risk.
- Most community members perceive their self-efficacy as low. However, low self-efficacy does not appear to negatively influence adaptation intention.

- Adaptation cost may be prohibitive. However, the perception of adaptation response efficacy negates adaptation cost concerns.
- There exists a high level of flood risk adaptation intention.
- Intentioned flood risk adaptation measures lack high protection capacity.

Having identified the factors influencing flood risk adaptation in Glefe, the next chapter will synthesise the quantitative and qualitative results into a coherent whole. The qualitative findings will be used to collaborate, support, and triangulate the quantitative results.

CHAPTER 6: SYNTHESIS AND DISCUSSION OF THE FINDINGS

6.1 Introduction

Chapter 4 presented the results of the quantitative data analysis, including the descriptive analysis and Partial Least Squares Structural Equation Modelling (PLS-SEM). The PLS-SEM analysis revealed that the measurement and structural models satisfied the rules of thumb in the PLS-SEM literature. Following this, Chapter 5 presented the results of the interviews with selected households/opinion leaders and National Disaster Management Organisation (NADMO) officials. The results revealed the perceptions of the respondents regarding causes of flooding, their flood experiences, flood risk appraisal, adaptation appraisal and adaptation intentions. In the current chapter, the different results are synthesised into a coherent whole to collaborate, triangulate, and confirm the results of Chapter 4 (quantitative analysis) based on the QUAN + QUAL design. This synthesis chapter answers objective four of the research, which sought to "synthesise the quantitative and qualitative results to explain how household experience and appraisals influence flood risk adaptation intentions."

6.2 Factors Contributing to Flood Risk in Informal Settlements

The qualitative results revealed that flood risk in Glefe persisted due to situational factors that were contributing to the residents' vulnerability and exposure. According to Bradford et al. (2012), situational factors relate to the individual's physical location in a flood-prone area. The situational factors may also include the individual's past flooding experience (Fuchs et al., 2017). While the study focuses on the flood experiences of informal settlements and how they interact with cognitive factors to shape the flood risk perception and adaptation intention of the households, it is also critical to understand the related factors that cause their vulnerability and exposure (Williams et al., 2019).

The results revealed that Glefe was vulnerable to flood risk due to its location. The community is located amid a wetland. It is thus surrounded by lagoons, salt mining ponds and the ocean. The physical location, coupled with torrential seasonal rainfall, made the community highly vulnerable to flooding. NADMO officials aptly suggested that poverty was at the root of the problem, indicating that people settled in flood-prone areas due to their inability to afford homes in better locations.

Glefe's flood risk is further compounded by the yearly spilling of the Weija Dam at the height of the rainy season. According to the household respondents, the Weija Dam is spilled every year without sufficient notice. This results in the flooding of Glefe and other downstream

communities. NADMO officials also suggested that Glefe and other informal settlements were victims of the heavy rainfall in Accra.

The results further revealed that pressures of urbanisation have led to encroachments on the lagoons surrounding Glefe. People have thus reclaimed parts of the banks of the lagoons for housing development. The people observed that the lax enforcement of land use and zoning regulations, and sanitation laws, have also bred poor attitudes. NADMO officials concurred that urbanisation and the resultant encroachments on water bodies for housing development were the leading causes of flood risk in Accra.

The indiscriminate dumping of refuse in the lagoons was also mentioned as a contributory factor to Glefe's flood risk. This has led to siltation of the lagoons, reducing their water holding capacity. The residents further revealed that weeds have taken over vast portions of the lagoons. The lagoons, with their reduced capacity to hold stormwater from the surrounding areas, spill over into homes during the rainy season. The few drains in the community have also become choked because of poor waste disposal. Run-off rainwater is therefore unable to flow away quickly due to this blockage, causing flooding. These issues cause the localised flooding in Glefe. The findings confirm the results of other studies into the causes of flood risk vulnerability in informal settlements (Twum & Abubakari, 2019; Williams et al., 2019), and flood vulnerability in Accra (Amoako & Frimpong Boamah, 2014; Frick-Trzebitzky et al., 2017; Ofosu et al., 2020), and provide the context within which the households' experiences, appraisal of flood risk and adaptation capacity, and their adaptation intentions may be understood.

6.3 Strategies Used to Respond to Flooding Risk

Because flooding has become a significant problem in many parts of the world (Mensah & Ahadzie, 2020), people have adopted many strategies to respond to it in order to avoid or reduce the impacts. The results of this research show that the Glefe community mostly adopted coping measures to respond to flooding. Such measures were regularly implemented during and immediately after flooding events. Coping strategies refer to short term (often reactive) approaches in response to flooding events, while adaptation measures are proactive and long term in nature (Lavell et al., 2012). Such a distinction is essential for policy development (Islam et al., 2018). In Glefe, the coping measures were adopted for the immediate survival of household members and the protection of their valuable property. The coping measures mentioned by households in the qualitative results also intersect with the coping measures

indicated in the quantitative strand of the research. The following quotes describe some of the coping measures that the interview respondents have adopted during past flooding events.

"In my house, I filled up the water entry points with gravel. I also organised other community members to help me. Right now, I have blocked the water from coming into the house. My neighbours also had to take similar measures to cope with the flood." [HO5].

"I temporarily relocated my children to a safe place. I also put our belongings on higher platforms in the rooms. When it came to the health of the family, I did nothing because our health was not affected. I filled the floodable areas in my house with sand. I have also built a wall around my house to block the flow of the water to my home. Some people create channels to get the water to flow out, so their homes do not get flooded." [HO7].

Table 45 shows the different structural and non-structural coping measures implemented in Glefe.

Table 45: Structural and Non-structural coping Measures used in Glefe

Type of Coping Approach	**Quantitative Results**	**Qualitative results**
Structural	• Rebuild damaged walls of buildings • Remove water from the inside of the house • Create water barriers in flooded areas • Clear gutters, drains or waterways in the community • Channel water away from the house • Repair damaged roof	• Elevate the entrance to the house or the entrance to the room • Place sandbags in the compound • Reinforce walls of houses with concrete • Digging of gutters to channel floodwaters away from the house • Clear gutters, drains or waterways in the community • Rebuild damaged walls of buildings
Non-Structural	• Transfer valuables to a safe place • Temporary relocation to another community • Temporary relocation to higher ground in this community • Store important documents in safe places	• Move valuable belongings to shelves or cupboards on elevated platforms in the home • Scoop water out of the house or rooms • Medical check-ups after floods • Washing fruits and vegetables properly before eating • Eating well-cooked food • Temporarily relocate to a neighbour or family member on higher ground in the same community or a neighbouring community. • Temporarily relocate valuable belongings to neighbours or family on higher ground in the community or neighbouring community • Evacuation by NADMO

Source: Author

As the above examples show, the measures were taken without recourse to the impacts that they may have on other members of the community. There is a high probability that measures such as those in the quoted responses may lead to maladaptation, as they are not sustainable and may endanger nearby properties (Schaer, 2015). The coping measures were both structural and non-structural. Some of the measures were implemented with individual efforts, while others required the help of neighbours. As the community had experienced flooding over many years, the coping measures had evolved. The people had therefore built repositories of knowledge on how to survive flooding events. Also, some of the measures did not require many resources or a financial outlay. The people also made use of social connections and the goodwill of family and friends to cope with the floods, especially during severe events during which they had to relocate temporarily.

The strategies used to respond to flooding risk at the individual property or community level may be permanent, semi-permanent or temporary, designed to avoid or reduce the impacts of current or future floods (Attems et al., 2019; Botzen et al., 2019). In Glefe, some of the structural measures taken (as shown in Table 45) were temporary, semi-permanent or permanent. The measures were undertaken using current or past flood heights as a guide. For this reason, they may be unable to protect the people and their properties from future floods higher than the reference flood heights. Immediate survival and preservation were the primary goal of such coping measures. The findings of this research corroborate previous research into the flood coping responses of informal settlements (Danso & Addo, 2017; Hooli, 2016; Islam et al., 2018; Mensah & Ahadzie, 2020; Ogunbode et al., 2019; Twum & Abubakari, 2019).

6.4 Factors influencing Flood Risk Adaptation Intention in Informal Settlements

This section discusses the factors that influence flood risk perception and the intention to take adaptive measures to respond to flood risk in Glefe based on the protection motivation theory. In Chapter 2, a model was developed that specified the components of perceived flood risk and adaptive capacity, and how these factors motivate the intention of individual households to respond to flood risk proactively. Based on the structural equation modelling in Chapter 4, it was revealed that the model satisfied the rules of thumb in the PLS-SEM literature. The current section discusses the implications of these results. It will discuss each of the hypotheses in relation to the path coefficients of the structural model. The findings in Chapter 5 shall then be used to corroborate, confirm, and elucidate the determinants of flood risk adaptation intention. Figure 22 depicts the model's path relationships and their coefficients and P-values.

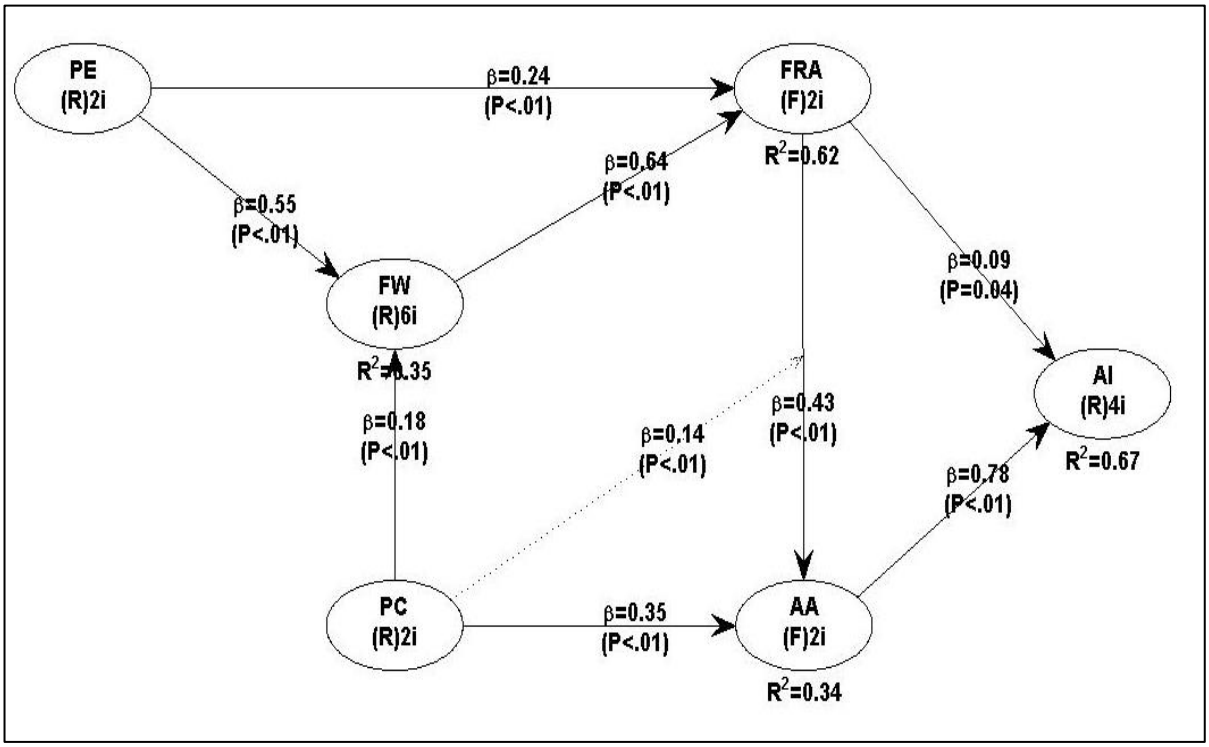

Figure 22: Structural Model showing Coefficients of Path Relationships

Source: Author

6.4.1 Past Flood Experience (PE) Positively Influences Residents' Perception of Flood Risk

The research hypothesised (H1) that past flood experience positively influences flood risk appraisal. The results of the quantitative and qualitative data show that the respondents had anxiety and fear about flood risk. The descriptive statistics for the quantitative data revealed that most respondents had experienced flooding in the study area. The quantitative results further show that a majority of respondents agreed or strongly agreed that they were afraid, worried or anxious over flood risk. The results of the SEM analysis also show that past flood experience has a significant and positive relationship with flood risk appraisal (β=0.24), with a medium effect size (f^2=0.13). The hypothesis H1 was, therefore, supported by the model. The results further show that past flood experience, together with fear, explained 62% of the variance of flood risk appraisal. Also, past flood experience and past coping experience explained 35% of the variance of fear. In terms of total effects, past flooding experience had a large influence on flood risk appraisal (B=0.59, f^2=0.33). These quantitative results show the significant role of flooding experience in the residents' perception of future flooding risk. It also shows that when past experiences with flooding are very bad, people perceive that future flooding will be, as well.

The moderation analysis further shows that past flood experience has a strong and negative moderating effect (B=-0.30, f^2=0.08) on the relationship between flood risk appraisal and adaptation appraisal. The graph of the moderating effect shows that when PE is closer to zero, its effect on the flood risk appraisal-adaptation appraisal relationship is low. But the influence rises as PE moves away from zero, either to the left or right. The coefficient of the path FRA→AA increased from 0.43 to 0.48, and the R^2 of AA increased by 10% when the moderating effect of PE was highlighted in the model. It is important to clarify that this moderating effect was not hypothesised.

The qualitative results further corroborate the results of the quantitative data. That is because most residents in the study area expressed fear, worry or anxiety over flooding in their community. The fear was mostly based on their perception that future flooding and its impacts could be worse than those experienced in the past. Thus, their flooding experience influenced their perception of future flood risk. It further serves as an information source that helps people to appraise the severity and probability of flooding hazards, as the literature suggests (Arthur & Quester, 2004; Ogunbode et al., 2019; Osberghaus, 2017). For example, some residents opined that:

"People start to panic whenever the raining season begins. I am very much afraid for the safety of my family, especially in June and July. We experience heavy rainfall during these months. We only pray for the protection of God during these months. "[HO2].

"The floods could become worse. I worry about it getting worse, since I live close to the lagoon. Anything can happen when there is flooding. When the floodwaters enter into the room, it spoils things. Last year it spoilt my TV and my children's belongings. If the water enters into the room, it becomes difficult to prevent damage." [HO5].

The results confirm previous research that shows that previous experience of hazards influences how people perceive hazard risk (Amoako, 2017; Kammerbauer & Minnery, 2019; Koerth, Vafeidis, et al., 2013; Ogunbode et al., 2019; Weyrich et al., 2020). The findings further support research that shows that feelings of worry about future flood events and their impacts are the most important source of information that a threat exists (Cvetković et al., 2019). Table 46 summarises the synthesised results of the hypothesis H1.

Table 46: Synthesis of the Relationship between Past Flood Experience and Flood Risk Appraisal

Hypothesis	Theme	Key Qualitative Quote
Hypothesis (H1): Past flood experience (PE) positively influences flood risk appraisal. PE→FRA B=0.24 P-value<0.001 f^2=0.13 H1=supported	Flood experience influences the perception of future flood risk.	*"People start to panic whenever the raining season begins. I am very much afraid for the safety of my family, especially in June and July. We experience heavy rainfall during these months."* [HO2]

6.4.2 Past Flood Experience (PE) Positively Influences Residents' Fear (FW) of Flood Risk

Research reveals that when people experience bad disaster events, either directly or indirectly, they tend to develop fear about the hazard (Cvetković et al., 2019). It is understood that such fear may include worries about their personal safety and the safety of their family and loved ones. The literature supports the findings in the current research that shows that when residents expressed fear about current and future flooding, it was usually due to their concerns that their personal lives, family, and property were not safe. These concerns were born out of their experiences of bad flooding events and their adverse impacts in the immediate past. For instance, one resident said *"I do fear for my safety. The flooding here is life-threatening."* [HO16]. Another added *"People start to panic whenever the raining season begins. I am very much afraid for the safety of my family, especially in June and July. We experience heavy rainfall during these months."* [HO2].

These findings from the qualitative research confirm and reinforce findings of the quantitative research. Past flooding experience was significant and positively correlated (B=0.55) with fear of flooding. It also had a large effect (f^2=0.31) on fear. Thus, the hypothesis H2 was supported by the results. The mediation analysis seems to suggest that the relationship between past flooding experience and fear could be non-linear (similar to a U-curve). Thus, the strength of the influence of flooding experience on fear drops to some extent and rises again. The path was associated with a significant latent growth coefficient (first-and second-degree growth), in the case of both PE and FW as moderating variables. That indicates that both PE and FW self-moderate their relationship. Table 47 shows a synthesis of the relationship between past flooding experience and fear.

Table 47: Synthesis of the Relationship between Past Flood Experience and Fear

Hypothesis	**Themes**	**Key Qualitative Quote**
Hypothesis (H2): Past flood experience (PE) positively influences residents' fear (FW) of flood risk. PE→FW B=0.55 P-value<0.001 f^2=0.31 H2=supported	Flood Experience influences fear of flood risk	*"Rainy season in Glefe is frightening. All you worry about is destruction either to persons or properties. I was terrified last time. I am still afraid for my life, which is mostly under threat in the rainy season. I think my family and property could suffer harm from floods in the future if nothing is done about the flooding." [HO10].*

6.4.3 Fear (FW) Mediates the Association Between Past Flood Experience and Flood Risk Appraisal (FRA)

Research shows that people may rely on cognitive heuristics to make decisions when they do not have all the information regarding risks (Carp & Shapira, 2018). Regarding fear and how it influences the appraisal of flood risk, two cognitive biases and heuristics are particularly relevant. These are the availability heuristic, where people make decisions about risk based on past events, and affect heuristics, where decisions are made based on their emotions and feelings (Nouri et al., 2018; Wang et al., 2017). It was, therefore, hypothesised (H3) that fear (FW) mediates the relationship between past flooding experience (PE) and flood risk appraisal (FRA).

The results of the quantitative analysis revealed that fear had a significant direct positive influence (β=0.64) on flood risk appraisal, with a large effect size (f^2=0.49). The results, therefore, supported the hypothesised mediating role of fear in the model. The structural model estimates further show that the constructs past flooding experience (PE), and fear (FW) explained 62% of the variance of flood risk appraisal. Past flood experience showed a significant and positive indirect effect (B=0.35, f^2=0.20) on flood risk appraisal. This influence was mediated by fear. Thus, fear may be the factor that transforms people's direct and indirect experience and horror about the negative impacts of flooding hazards into appraisal about future flooding probability, severity and their exposure and vulnerability to determine if they need to take any mitigative decisions about the risk.

Beyond fear's direct influence on flood risk appraisal, it also showed indirect effects on adaptation appraisal (B=0.28, f^2=0.15) and adaptation intention (B=0.22, f^2=0.11). Fear further had strong total effects on both adaptation appraisal ((B=0.28, f^2=0.15) and adaptation intention ((B=0.27, f^2=0.14). In terms of moderating effects, fear showed significant effects, through the latent growth analysis, on flood risk appraisal. As this effect was on the same path as the direct effect, it indicated that fear might have a non-linear relationship (similar to an S-curve) with flood risk appraisal. These direct effects, mediating effects, and moderating effects exhibited by fear testify to its strong influence on flood risk perception, perception of adaptive capacity and formation of intentions to undertake flood risk adaptation.

The qualitative results further prove that there is a positive correlation between fear and flood risk appraisal. The results revealed that people who expressed intense fears or anxiety over the impacts of flood risk perceived that future flood risk could be severe. This suggests that the perception of the severity and probability of future flooding could either be higher or lower based on the level of fear about flood risk and its impacts generated in the population. Research shows that fear about flood risk results from awareness of the harmful impacts of flooding events (Raaijmakers et al., 2008; Zheng & Dallimer, 2016), thus reinforcing the findings of this study. Table 48 summarises the synthesised results of the hypothesis H2.

Table 48: Synthesis of the Intermediary Role of Fear (FW) in Flood Risk Appraisal

Hypothesis	**Theme**	**Key Qualitative Quote**
Hypothesis (H3): Fear (FW) mediates the association between past flood experiences and flood risk appraisal (FRA). FW→FRA B=0.64 P-value<0.001 f^2=0.49 H3=supported	• Flood Experience influences fear of flood risk • Fear of Flood Impacts Influences Flood Risk Appraisal Positively	*"Rainy season in Glefe is sombre. All you worry about is destruction, either to persons or properties. I was terrified last time. I am still afraid for my life, which is mostly under threat in the rainy season. I think my family and property could suffer harm from floods in the future if nothing is done about the flooding."* [HO10].

6.4.4 Past Coping Experience has a Negative Relationship with Fear of Future Flooding

Flood risk management is not the exclusive purview of public institutions (Santoro et al., 2019). Individual coping mechanisms are an essential aspect of how individuals and communities respond to flooding events. Coping strategies have been used over the years (Amoako, 2017;

Balgah et al., 2019), mostly because they are a low-resource means to survive and preserve lives and valuable property during and immediately after flooding (Koerth, Vafeidis, et al., 2013), as revealed by the qualitative results. If coping mechanisms failed to prevent the adverse impacts of flooding in the past, it could lead households to feel that flooding is uncontrollable (Hudson et al., 2020). That may trigger a sense of trepidation and feelings of helplessness about future flood risk. Conversely, people may be less fearful about future flood risk if past coping measures were effective. The hypothesis (H4) sought to establish that experiences from past coping mechanisms has an inverse relationship with fear/worry/anxiety about future flooding and its adverse impacts. Table 49 summarises the synthesised results of the hypothesis H4.

Table 49: Synthesis of the Relationship between Past Coping Experience and Fear

Hypothesis	**Theme**	**Key Qualitative Quote**
Hypothesis (H4): Experiences from past coping mechanisms have an inverse relationship with fear/worry/anxiety about future flooding and its adverse impacts. PC→FW B=0.18 P-value<0.001 f^2=0.04 H4=not supported	Coping Experience Influences the Perception of Flood Risk	*"I got scared due to the way the floodwater quickly filled up my room and started moving up to my knee level. I do fear for my safety because, besides coping with the situation over the years, nothing long-lasting has been done."* [HO11] *"As community members, we have also used our little knowledge to put things in place to protect ourselves from future flooding. I do not think we are likely to experience a severe flood situation again."* [HO2].

The findings of the PLS-SEM analysis reveal a significant and positive association (β=0.18) between past coping experience (PC) and fear (FW). However, the effect size was relatively small (f^2=0.04). The results show that if past coping mechanisms were successful, people had greater feelings of fear about future flooding. The finding is contrary to expectations that highly effective coping mechanisms could lessen people's worry and anxiety about the impacts of flooding. It is also contrary to research that suggests that if past coping mechanisms were successful, people's feelings of helplessness and fear would be lower, and vice versa (Hudson et al., 2020). Some of the qualitative results supported the hypothesis that the higher the coping experience, the lower the fear of flood risk. This is reflected in the following opinions.

"I do not think my family will suffer harm in future because of the adaptation interventions I will put [in] place to avert such a situation." [HO14].

"As community members, we have also used our little knowledge to put things in place to protect ourselves from future flooding. I do not think we are likely to experience a severe flood situation again." [HO2].

Nevertheless, some of the qualitative findings explain why the quantitative findings do not conform to the hypothesis H4. A majority of the respondents in the interviews confirmed that they had implemented coping measures to prevent damage during past flooding events. It was also revealed that flooding had caused much disruption to their lives, despite the coping mechanisms. It seems that the short-termism of coping actions may be one reason why the quantitative findings suggest that the higher the coping experience, the higher the fear of flood risk. As this respondent notes *"I got scared due to the way the floodwater quickly filled up my room and started moving up to my knee level. I do fear for my safety because, besides coping with the situation over the years, nothing long-lasting has been done."* [HO11]. Thus, fear of flood risk may still have a significant and positive correlation with coping experience, because coping actions (which could have been effective) were not long-lasting.

The analysis of indirect effects also revealed that PC had large total effects on both adaptation appraisal (B=0.40, f^2=0.13) and adaptation intention (B=0.32, f^2=0.04). However, the size of the effect was stronger on adaptation appraisal than adaptation intention. The latent growth analysis also showed that PC had large moderating effects on fear and adaptation appraisal, suggesting a non-linear relationship (similar to an S-curve) with both variables. These results are an indication that the influence of past coping experience on fear or anxiety about future flood risk is unpredictable and not the same for all households. However, it also reveals that the effectiveness of past coping mechanisms may be critical in whether the household forms the intention to adapt to future flooding or not.

6.4.5 Past Coping Experience (PC) Influences Adaptation Appraisal

It has been suggested that coping mechanisms could influence adaptation capacity appraisal (Weyrich et al., 2020). Hudson et al. (2020) suggest that the failure of coping mechanisms could lead to a feeling of helplessness and the perception that flooding is uncontrollable. The hypothesis (H5), therefore, sought to establish the relationship between coping experience and a household's appraisal of their adaptation capacity (self-efficacy, response efficacy and

response cost). Table 50 is a synthesis of the influence of coping experience on adaptation appraisal.

Table 50: Synthesis of the Influence of Coping Experience on Adaptation Appraisal

Hypothesis	**Theme**	**Key Qualitative Quotes**
Hypothesis (H5): Past coping experience (PC) influences adaptation appraisal (AA) PC→AA B=0.35 P-value<0.001 f^2=0.11 H5=supported	Experience gained from coping with previous flooding events influences people's perception of their self-efficacy, response efficacy and cost of adaptation measures	• *"The adaptation measures will surely stop the flooding. I believe it will reduce my losses during flooding."* [HO1]. • *"I do not see myself skilled enough to perform these actions effectively. Since I have no training in undertaking such more technical works."* [HO2]. • *If I only cope with the situation as it comes, one of these days it might destroy many things."* [HO6]

The PLS-SEM analysis revealed a significant and positive correlation (β=0.35) between past coping experience and adaptation appraisal. The effect size of the association was also moderate (f^2 =0.11). The results support the hypothesised relationship. Furthermore, PC had a small significant indirect effect (B=0.05, f^2=0.02) on adaptation appraisal through the path (PC→FW→FRA→AA). Thus, the total effect of PC on adaptation appraisal was substantial (B=0.40, f2=0.13). The substantial total effect of PC on AA indicates that coping experience is an important variable in adaptation appraisal.

One reason for the positive influence of past coping on adaptation appraisal could be the fact that successful years of coping with flooding built repositories of knowledge about how to respond to flooding, as existing research suggests (Amoako, 2017). Another reason could be the permanency of measures to respond to flooding. The qualitative results revealed that even when discussing adaptation measures, respondents still focused on short-term measures. They could, therefore, have perceived that their accumulated knowledge on coping with flooding could lead to a successful implementation of adaptation measures. Though self-efficacy was low and adaptation cost perceived to be high, response efficacy seems to have negated the effect of these components on the overall adaptation appraisal. That confirms the suggestion by Poussin et al. (2014) that response efficacy is a significant factor in households' flood risk adaptation intention.

6.4.6 Coping Experience (PC) Moderates Relationship Flood Risk Appraisal (FRA) and Adaptation Appraisal

Previous studies have emphasised that people's experiences determine their appraisal of flood risk (Lechowska, 2018). As preceding sections have noted, other studies (Hudson et al., 2020; Ogunbode et al., 2019; Weyrich et al., 2020) have suggested the influence of coping mechanisms on cognitive appraisals. The hypothesis (H6), therefore, sought to establish how coping experience influences the relationship between flood risk appraisal and adaptation appraisal. The assumption was that, depending on the effectiveness of past coping mechanisms, flood risk appraisal could result in a lower or higher appraisal of adaptation capacity (especially self-efficacy and response efficacy). Table 51 shows a synthesis of the results of the influence of past coping experience on the flood risk appraisal-adaptation appraisal relationship.

Table 51: Synthesis of the Influence of Coping Experience on Flood Risk Appraisal-Adaptation Appraisal Link

Hypothesis	**Theme**	**Key Qualitative Quotes**
Hypothesis (H6): Past coping experience moderates the relationship between flood risk appraisal and adaptation appraisal. PC*FRA→AA B=-0.14 P-value=0.002 f^2=0.03 H6=supported	Experience gained from coping with previous flooding events influences the strength of the relationship between flood risk appraisal and adaptation appraisal.	*"I am secured and safe because I am on higher ground. I am only worried about my family members in the flood-prone zones."* [HO4] *"The floods are part of life here. It happens every year, and no pragmatic step has been taken to curtail it. I think the flooding will get worse."* [HO10]. *"If I only cope with the situation as it comes, one of these days it might destroy many things."* [HO6]

The PLS-SEM analysis results indicate that coping experience has a positive effect (B=0.14) on the relationship between flood risk appraisal and adaptation appraisal, supporting the hypothesis. However, the effect size was weak (f2=0.03). When the moderating link was removed from the model, the path coefficient of FRA→AA reduced by half. That indicates that coping experience has a crucial influence on the strength of the relationship. The graph of the moderating effect indicates some form of non-linear relationship (similar to a J-curve pattern) (Kock, 2018), as the focused graph below shows.

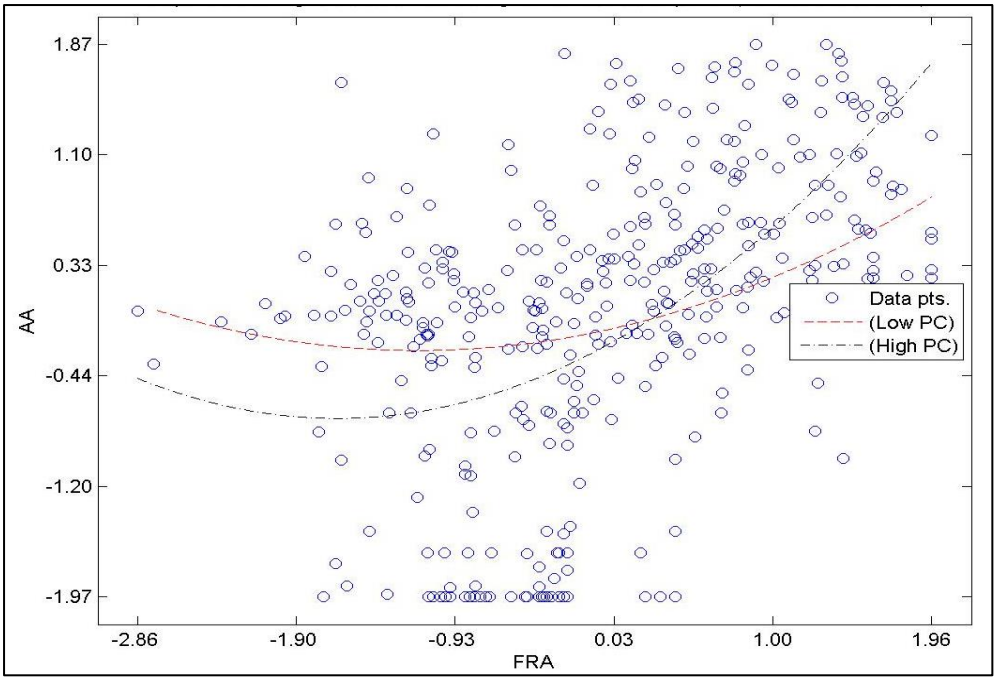

Figure 23: Graph of the moderating effect of coping experience on FRA→AA

Source: Author

As the focused graph shows, the effect of PC on the path FRA→AA results in a drop that is followed by a gradual rise. It shows that as PC interacts with FRA→AA, the influence of FRA on AA drops but quickly rises and continues to rise.

The qualitative findings also support the findings of a significant effect of PC on the relationship between FRA and AA. As [HO5] notes *"The floods could become worse. I worry about it getting worse, since I live close to the lagoon. Anything can happen when there is flooding. When the floodwaters enter the room, it spoils things. Last year it spoilt my TV and my children's belongings. If the water enters the room, it becomes difficult to prevent damage."* [HO4] further opined that *"I am secured and safe because I am on higher ground. I am only worried about my family members in the flood-prone zones."* It is, therefore, evident that when coping responses fail to prevent flood damage, a household's perception of flood severity, probability, and their vulnerability increases, influencing their appraisal of adaptation capacity.

The findings discussed above provide further scope for establishing the factors that influence flood risk perception. It is unknown whether previous studies have examined the moderating effects of coping experience on the flood risk appraisal and adaptation appraisal relationship. The findings of the current study may, therefore, be a theoretical pacesetter.

6.4.7 Essential Features of Flood Risk Appraisal

The proponents of the protection motivation theory suggest that the essential components of threat appraisal include perceived severity, perceived probability (vulnerability), and extrinsic and intrinsic rewards (Maddux & Rogers, 1983; Rogers, 1975, 1983). The hypotheses H7, H8, H9 and H10 thus proposed that these elements were significant components of flood risk appraisal.

The PLS-SEM analysis results reveal that perceived severity and perceived vulnerability were the only significant elements of flood risk appraisal. The extrinsic rewards and intrinsic rewards failed to satisfy recommended rules of thumb for measurement model assessment and were therefore removed. The hypotheses H9 and H10 were, therefore, not supported by the results. This was not surprising, as research has shown that extrinsic and intrinsic rewards did not play a significant role in adaptive responses (Grothmann & Reusswig, 2006). The meta-analysis of Floyd et al. (2000) did not evaluate the rewards (intrinsic and extrinsic) because only a few studies using the protection motivation theory included them. The meta-analysis of Bamberg et al. (2017) also did not evaluate maladaptive responses, which include rewards (intrinsic and extrinsic). These studies, therefore, confirm the current findings that extrinsic and intrinsic rewards may not have a significant influence on flood risk appraisal. The findings also prove that perceived severity and perceived vulnerability form the main elements of flood risk appraisal.

Furthermore, the results of the household interviews suggest extrinsic and intrinsic rewards did not affect the respondents' perceptions of flood risk. However, other maladaptive responses were evident, such as trust in public works (e.g. *"The sea defence wall will protect us"*), and fatalism (*"There is nothing I can do to reduce the harm from floods.").* Since these variables did not form part of the model, it is not possible to test their significance on flood risk appraisal. However, Terpstra (2011) reveals that a high level of trust in public works reduces flood risk perception and the likelihood of the household undertaking preparedness and mitigation measures.

6.4.8 Essential Features of Adaptation Appraisal

The protection motivation theory proponents explain that three subcomponents comprise adaptation appraisal (AA). These include Response Efficacy (RE), Self-Efficacy (SE) and Adaptation Cost (PAC) (Bamberg et al., 2017; Grothmann & Patt, 2005; Rogers, 1975, 1983). In adaptation appraisal, a person or household evaluates their ability to avert harm from

flooding, including the cost of taking the necessary measures (Grothmann & Patt, 2005). The result of the adaptation appraisal gives the entity an idea of their specific adaptive capacity. It was, therefore, hypothesised (H11, H12 and H13) that these three factors were significant in appraising flood risk adaptation action.

Due to the complexity of the postulated model, each of these variables, Response Efficacy (RE), Self-Efficacy (SE) and Perceived Adaptation Cost (PAC) was converted to a new standardised indicator that measured the construct adaptation appraisal (AA). The perceived adaptation cost, however, did not meet the recommended criteria for measurement model assessment. It was consequently concluded that adaptation cost was not a significant variable in adaptation appraisal. Thus, the hypothesis H13 was not supported, corroborating Bubeck et al. (2018), who found mixed results for response cost. It is also in line with the findings of Botzen et al. (2019) and Bubeck et al. (2013), who found that perceived response cost had no significant effects on the adoption of protective measures. The descriptive statistics for the variable (PAC) shows that the majority (64.7%) of respondents disagreed (includes strongly disagreed) that they would prefer spending their money on other things than adaptation. Also, 40.8% of respondents disagreed (only) that adaptation was too time-consuming, while 40.3% agreed (only) that it was time-consuming. The results point to the fact that close to half of respondents did not agree with the adaptation cost propositions.

Furthermore, the interview responses suggest that although the households were concerned that adaptation cost could be expensive, and time-consuming, the desire to avert flood risk and its adverse impacts outweighed those concerns, as the following perspectives show. *"It is very costly when you think of adaption, but the money spent after destruction due to floods is far more than what you would use to adapt. The cost of dredging and building a storm drain on the lagoon could be prohibitive. However, if it is done, it will reduce the negative impacts on in the community during flooding."* [HO10].

"Adaptation measures are worth the cost because if you do not take actions towards solving the flood situation in the community, it will always come back to harm us." [HO11].

These qualitative results therefore confirm why perceived adaptation cost does not appear to be a significant factor in residents' appraisal of their adaptation capacity, as the quantitative results indicate. Response Efficacy and Self-Efficacy satisfied recommended PLS-SEM criteria for measurement model assessment. It was consequently concluded that they were significant components of adaptation appraisal, supporting hypotheses H11 and H12. The qualitative results also confirm that these variables influenced households' adaptation

appraisals. The results clearly showed that most of the respondents believed in the efficacy of adaptation measures. However, they had less trust in their ability and capacity to perform adaptation measures.

6.4.9 Flood Risk Appraisal Positively Influences the Appraisal of Adaptation (AA) Capacity

The protection motivation theory postulates that threat appraisal precedes and influences adaptation appraisal (Grothmann & Patt, 2005; Rogers, 1975, 1983). As Grothmann and Patt (2005) and Botzen et al. (2019) suggest, adaptation appraisal only takes place when flood risk appraisal exceeds a specific threshold. The flooding threat must be perceived to be highly probable, and its impacts severe, before the households begin assessing possible benefits of proactive actions and their competence to perform them (Bubeck et al., 2018). The hypothesis (H14) was, therefore, postulated to confirm whether that relationship was significant and positive in the current research context.

The findings of the PLS-SEM analysis show that there is a significant positive correlation (β=0.43) between flood risk appraisal and adaptation appraisal, with a moderate effect size (f^2=0.20). The hypothesis H14 thus was supported by the results. The findings also show that flood risk appraisal, together with coping experience, explain 34% of the variance of adaptation appraisal. When the moderating effect of flood experience is accounted for, the explained variance increases to 43%. The results also show that the relationship is direct only. That confirms the literature, which shows that flood risk appraisal precedes and influences adaptation appraisal (Grothmann & Patt, 2005). The strength of the relationship also suggests that awareness of flooding risk is crucial for engaging residents in the exploration of their ability and capacity to adapt to future flooding risk.

The results of the qualitative research also support the influence of flood risk appraisal on adaptation appraisal. As the following responses prove, perceived severity and vulnerability (probability) influence a household's judgement on flood risk adaptation. *"Adaptation measures are worth the time and resources because if you do not take actions towards solving the flood situation in the community, it will always come back to harm us. If adaptation measures are taken seriously, it will eliminate the number of properties lost during flooding, because the cost of inaction is usually high."* [HO11]. "*It is very costly when you think of adaption, but the money spent after destruction due to floods is far more than what you would use to adapt*." [HO10].

The above findings confirm extant literature that risk appraisal precedes and influences the appraisal of adaptation (Bubeck et al., 2018; Grothmann & Patt, 2005; Maddux & Rogers, 1983; Rogers, 1975, 1983). The findings also extend the application of the protection motivation theory to disaster risk reduction and adaptation, as it has been established that coping experience and flooding experience influence the strength of the relationship between flood risk appraisal and adaptation appraisal. Table 52 synthesises the key results on the influence of flood risk appraisal on adaptation appraisal.

Table 52: Synthesis of the Influence of Flood Risk Appraisal on Adaptation Appraisal

Hypothesis	**Theme**	**Key Qualitative Quotes**
Hypothesis (H11): Flood Risk Appraisal (FRA) Influences the Appraisal of Adaptation capacity (AA) FRA→AA B=0.43 P-value<0.001 f^2=0.20 H14=supported	Household's flood risk appraisal influences their adaptation appraisal.	*"The flooding here is too bad. Future flooding could be very severe. I think in future the flood here will be like a tsunami if nothing is done. The solution has to be found so that when it rains, the people are not affected."* [LGR1]. *"Adaptation measures are worth the time and resources because if you do not take actions towards solving the flood situation in the community, it will always come back to harm us."* [HO11].

6.4.10 Flood Risk Appraisal (FRA) Influences Adaptation Intention (AI)

The current research sought to investigate the influence of flood experience, coping experience and cognitive appraisals on the intention of households to adapt to flood risk. Some existing research (Bagagnan et al., 2019; Bamberg et al., 2017) suggests that flood risk appraisal (threat appraisal) leads to the intention to implement protective measures. However, some studies (Babcicky & Seebauer, 2019; Bubeck et al., 2012; Koerth, Vafeidis, et al., 2013) found only a weak effect or negative relationship between risk appraisal and protection motivation (adaptation intention). It was hence hypothesised (H15) that flood risk appraisal has a significant and positive association with adaptation intention, and thus influences it.

The findings of the PLS-SEM analysis confirm that flood risk appraisal (FRA) has a significant and positive correlation (β=0.09) with adaptation intention (AI). However, the effect size was weak (f^2=0.04). The results support the hypothesis H15. This is consistent with other studies (Bamberg et al., 2017; Chen, 2020; Grothmann & Reusswig, 2006; Reynaud et al., 2013) that

found the relationship between flood risk (threat) appraisal and adaptation intention (motivation) to be statistically significant. The findings are also consistent with studies (Bagagnan et al., 2019; Bamberg et al., 2017) that suggest a weak effect of risk appraisal on intentions to adapt.

The mediation analysis also revealed that flood risk appraisal had a substantial total effect (B=42) on adaptation intention, with a moderate effect size (f^2=18). Thus, the mediated relationship between flood risk appraisal and adaptation intention is stronger than the direct effect. In terms of the moderating effects, the latent growth analysis revealed that both PE and FW showed some influence on the flood risk appraisal-adaptation intention relationship. However, the effect was relatively small. Besides, the addition of those links to the model did not yield any significant coefficients. The effect size was also relatively small (f^2=0.068). Thus, both the direct and indirect effects of the path were significant and positive, showing complementary mediation. The mediated path was, however, more robust than the direct path. The total effect of flood risk appraisal on adaptation appraisal was moderate (β=0.23), while the effect size was small (f^2=0.109). The moderation analysis for the path FRA→AI yielded non-significant coefficients. The relationship between flood risk appraisal and adaptation intention was therefore found to be non-linear (similar to a U-curve), as shown in Figure 24.

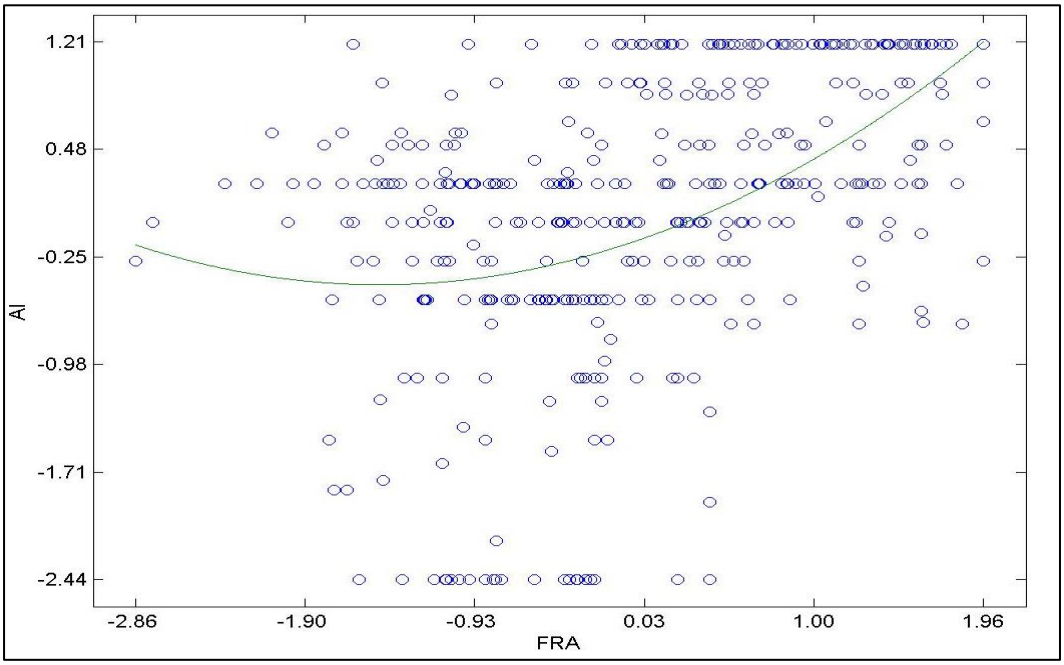

Figure 24: Best Fitting Curve of the Bivariate Relationship between FRA and AI

Source: Author

The qualitative results also agree with the above findings that flood risk appraisal influences adaptation intention. Households with a low perception of flood severity and their vulnerability also had little or no intention to adapt to flooding. For instance, [HO15] opined *"We have been living here all my life. We will not be doing anything since the floods will not affect us again*." Conversely, households with a high appraisal of flood severity, probability and their vulnerability had a higher adaptation intention. For example, [HO6] suggested that *"I will elevate the area around my building to deter future rains from entering into my home. I will also deal with how to handle waste in my home because poor disposal of solid waste often leads to the blocking of drains in the community, causing rainwater to become stagnant. I would take these precautions seriously to reduce the risk of flood in my home. Because if I only cope with the situation as it comes, one of these days it might destroy many things."* Table 53 shows a synthesis of the key findings on the influence of flood risk appraisal on adaptation intention.

Table 53: Key Findings on the Influence of Flood Risk Appraisal on Adaptation Intention

Hypothesis	**Theme**	**Key Qualitative Quotes**
Hypothesis (H15): Flood risk appraisal positively influences adaptation intention (AI). FRA→AI B=0.09 P-value=0.039 f^2=0.04 H15=supported	Flood risk appraisal influences adaptation intention.	*"I will elevate the area around my building to deter future rains from entering into my home. I will also deal with how to handle waste in my home because poor disposal of solid waste often leads to the blocking of drains in the community, causing rainwater to become stagnant. I would take these precautions seriously to reduce the risk of flood in my home. Because if I only cope with the situation as it comes, one of these days it might destroy many things." [HO6].*

6.4.11 Adaptation Appraisal (AA) Positively Influences Adaptation Intention (AI)

Like Hypothesis (H15), the hypothesis (H16) postulated that adaptation appraisal influences adaptation intention. The hypothesis was consistent with research (Bamberg et al., 2017; Chen, 2020; Floyd et al., 2000; Rogers, 1983) suggesting a significant association between adaptation appraisal and protection motivation (intention). It has also been suggested that adaptation appraisal has a comparatively more significant influence on adaptation intention than flood risk appraisal (Bubeck et al., 2012; Bubeck et al., 2018; Weyrich et al., 2020).

The results of the PLS-SEM analysis revealed that adaptation appraisal (AA) has a significant and positive correlation (β=0.78) with adaptation intention (AI), indicating support for hypothesis H16. The effect size (f^2=0.64) of the relationship was also substantial. The findings are consistent with the literature that a significant and positive correlation exists between adaptation appraisal and protective intention (Babcicky & Seebauer, 2019; Bagagnan et al., 2019; Weyrich et al., 2020). It also supports research findings that adaptation appraisal has a strong influence on protection intention (Babcicky & Seebauer, 2019; Grothmann & Reusswig, 2006; Poussin et al., 2014). The analysis of the indirect effects also revealed that the relationship was direct only. The analysis further shows that adaptation intention has a substantial explained variance (R^2=0.68). It, therefore, suggests that the model has a substantial predictive or explanatory power. Also, the latent growth analysis revealed that the relationship between adaptation appraisal and adaptation intention might be non-linear, as significant latent growth coefficients were found regarding the moderating effect of FW on the AA→AI link. Consequently, the best-fitting curve of the AA→AI relationship confirms that it is non-linear. As the graph shows in Figure 25, adaptation intention increases as adaptation appraisal increases.

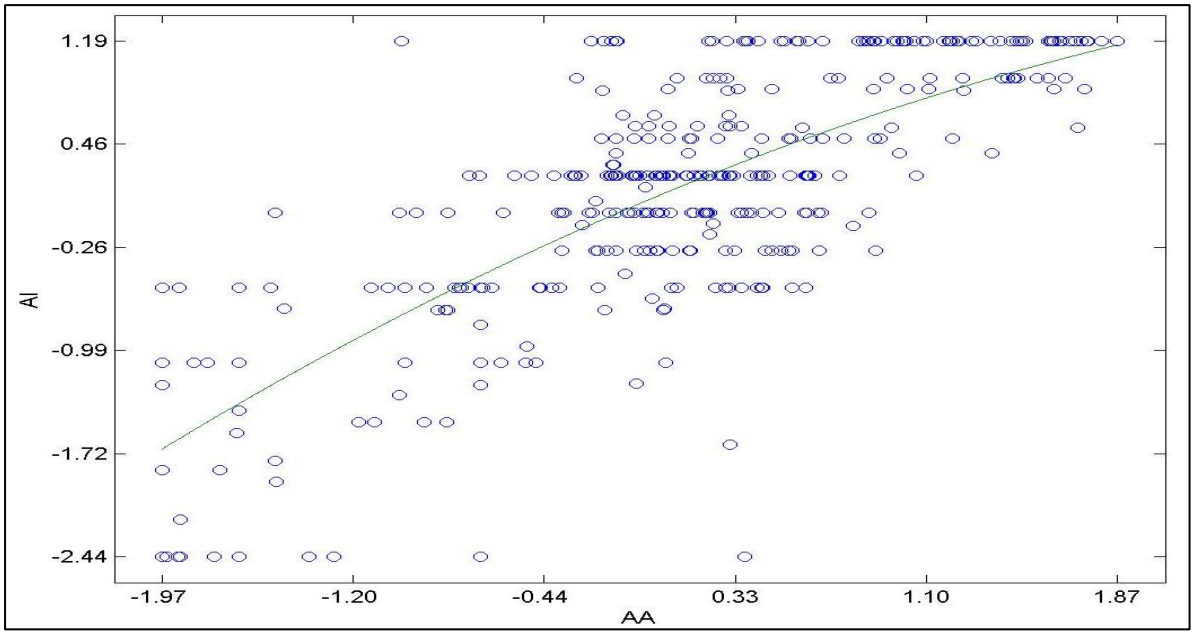

Figure 25: Best Fitting Curve of the Relationship between Adaptation Appraisal and Adaptation Intention

Source: Author

The qualitative results also reveal that households' adaptation intentions were influenced by several factors, including response efficacy, self-efficacy, and adaptation cost. Response

efficacy was the adaptation appraisal indicator that seems to be contributing more to adaptation intention. For example, [HO6] said about their self-efficacy *"I currently have a visual disability so I can only direct people who work for me on what to do to avert serious flooding in my home."* With regards to the response efficacy of suggested structural measures, they said that *"We know it helps in many situations. The adaptation measures will surely stop the flooding."* They also thought that *"Adaptation cost is prohibitive."* Despite the low appraisals of self-efficacy and high appraisal of adaptation cost, households still made the intention to adapt, saying that *"Firstly, I will elevate the area around my building to deter future flooding from entering into my home. I will also deal with how to handle waste in my home because poor disposal of solid waste often leads to the blocking of drains in the community, causing rainwater to become stagnant. I would take these precautions seriously to reduce the risk of flood in my home. Because if I only cope with the situation as it comes, one of these days it might destroy many things."* [HO6]. The above supports earlier suggestions that response efficacy seems have a larger effect on flood risk adaptation intention in the study area. Table 54 shows key findings on the influence of adaptation appraisal on flood risk adaptation intention.

Table 54: Key Findings on the Influence of Adaptation Appraisal on Adaptation Intention.

Hypothesis	**Theme**	**Key Qualitative Quotes**
Hypothesis (H16): Adaptation Appraisal (AA) Influences Adaptation Intention (AI) AA→AI B=0.78 P-value<0.001 f^2=0.64 H16=supported	Adaptation Appraisal influences flood risk adaptation intentions.	*"I do not see myself as skilled enough to perform adaptation actions effectively, since I have no training in undertaking such more technical works. I also think they involve much money. However, they will surely reduce flooding. A little assistance from the government will help matters."* [HO2]. *"Adaptation measures will go a long way to reduce the harm and properties lost during flooding. Though they are costly to tackle, we only have to put in measures to protect ourselves. I will begin to listen to the weather forecast and NADMO's early warning communication about flooding risk. I will also try as much as possible to dig a canal in front of my house to make floodwater drain easily. I have also decided to join other community leaders to raise awareness of proper sanitation practices and its importance to the community. I will do them to protect myself and my family."* [HO8]

6.5 Revised Model of Factors Influencing Flood Risk Adaptation Intention

The synthesis and discussions have revealed the factors that influence the flood risk adaptation intention of households and residents of Glefe. While the findings generally confirm the hypothesis formulated for the study, there were a few incongruities that called for a revision of the conceptual model. Figure 26 shows the revised model. Broken lines in the diagram show moderating effects. Red broken line shows non-hypothesised moderating effect.

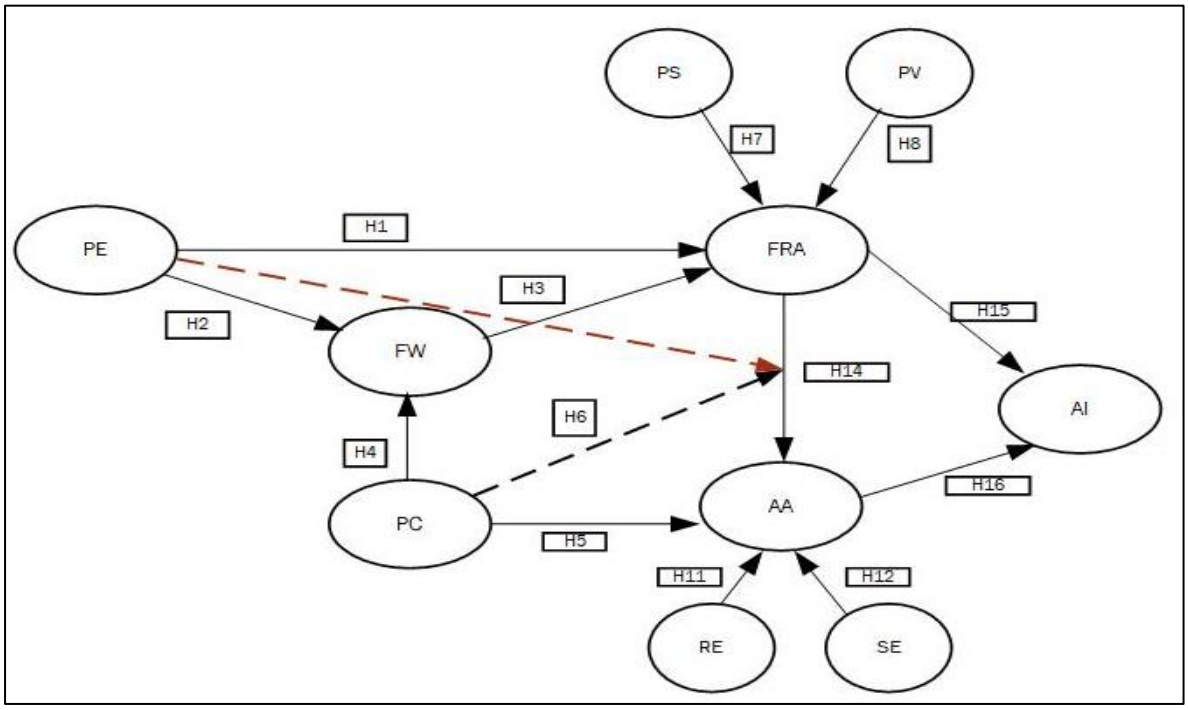

Figure 26: The Revised Structural Model

Source: Author

The revised model, as shown in Figure 26, reflects the findings of the quantitative and qualitative study. The findings revealed that intrinsic rewards, extrinsic rewards, and perceived adaptation cost did not have statistically significant effects on flood risk appraisal and adaptation appraisal, respectively. The qualitative findings further revealed that trust in public mitigation works and fatalism could negatively influence flood risk appraisal. However, these variables need to be tested to establish whether they have statistically significant correlations with flood risk appraisal and adaptation appraisal.

Furthermore, the findings revealed that flooding experience influences the strength of the relationship between flood risk appraisal and adaptation appraisal. It further shows that experience gained from past coping mechanisms also influences the strength of the relationship

between flood risk appraisal and adaptation appraisal. These results indicate that both coping experience and flood experience are crucial to the formation of adaptation intention. As the model only hypothesised the moderating effects of PC, it is, therefore, critical to revise the structural model to reflect the moderating effects of PE, as shown in Figure 26.

As shown in the extended structural model in Figure 26, extrinsic rewards, intrinsic rewards and perceived adaptation cost were removed from the model because the hypotheses postulating that these variables were significant were unsupported. The finding is consistent with existing research (Bamberg et al., 2017; Grothmann & Reusswig, 2006; Terpstra, 2011). Figure 27 also depicts the simplified model (HCM), in line with the revisions.

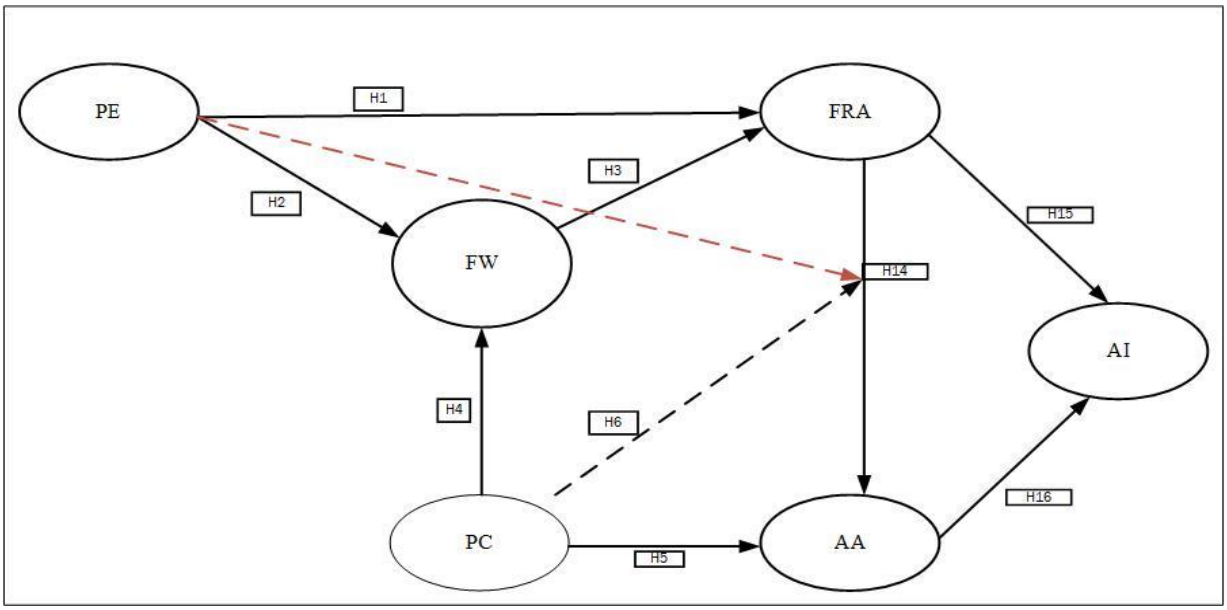

Figure 27: Simplified Revised Structural Model Showing Moderating Effects

Source: Author

6.6 Key Paths towards Adaptation Intention

It is evident from the analysis that flood experience and coping experience play a critical role in the household appraisals. The discussions have revealed that flood experience is critical in households' appraisals of flood risk and their adaptive capacity, because it serves as a heuristic for people to assess future flooding severity and their vulnerability to it. As research shows, heuristics help decision-makers to understand complicated and unclear information (Cossette, 2014; Osmani, 2016). Because the people cannot make technical predictions on the probability and severity of future flooding, they have relied on events or occurrences that immediately

came to mind (Carp & Shapira, 2018; Kuhn, 2007; Wang, 2016). Flood experience then provides the awareness that creates a sense of fear and anxiety about the severity and vulnerability to future flooding. It may be essential for policymakers to design programmes that incorporate information on people's lived flood experience (whether direct or vicarious), to encourage proactive flood risk adaptation. The analysis reveals that flood experience has a substantial direct effect and indirect effect on fear and flood risk appraisal. It also has a substantial moderating effect on the strength of the relationship between flood risk appraisal and adaptation appraisal.

In addition, coping experience exhibited substantial total effects on adaptation appraisal and adaptation intention. It also showed a small moderating effect on the strength of the relationship between flood risk appraisal and adaptation appraisal. The analysis has confirmed the importance of coping experience in flood risk adaptation intention formation. The literature has suggested coping in the past builds repositories of knowledge for future coping actions (Amoako, 2017). Under the current results, it can be deduced that the experience gained from past coping actions can lead to a positive perception of response efficacy, influencing households' adaptation intentions. However, Hudson et al. (2020) suggest that the failure of coping mechanisms could lead to a feeling of helplessness and the perception that flooding is uncontrollable. Thus, when the effectiveness of past coping actions is low (or high), the influence of that experience on adaptation appraisal and adaptation intention would be negative (or positive).

Adaptation appraisal had the most substantial total effect on adaptation intention. However, flood risk appraisal also had substantial total effects on adaptation intention. Also, flood experience and fear exhibited a strong total effect on flood risk appraisal. Figure 28 shows the paths (direct) (highlighted in cyan) with substantial influences on Adaptation Intention. The structural paths with significant coefficients higher than 0.20 were regarded as substantial (Lowry & Gaskin, 2014). The moderating links were also seen as crucial to adaptation intention.

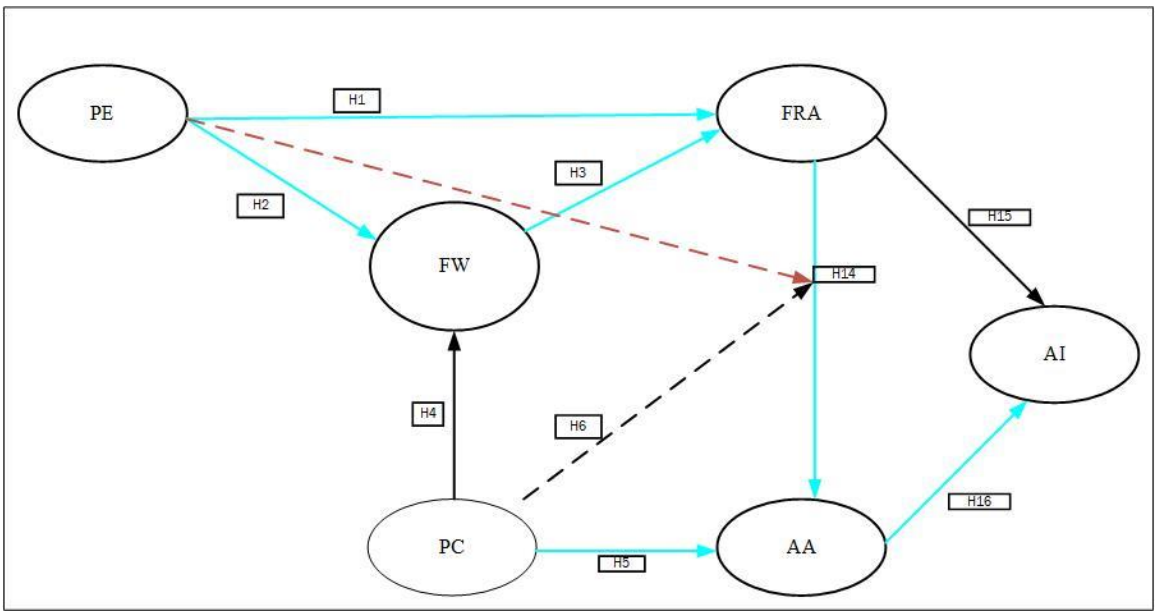

Figure 28: Paths with substantial Influences on Adaptation Intention

Source: Author

6.7 Summary of the Chapter

The chapter has highlighted the fact that flooding experience, coping experience, fear, flood risk appraisal and adaptation appraisal all have a critical influence on households' flood risk adaptation intentions. The analysis has also revealed that while the effect size of the total influence of coping experience on adaptation intention is weak, it does have a substantial influence on adaptation appraisal. It, therefore, contributes to adaptation intention through its influence on adaptation appraisal.

Also, flooding experience is an essential factor in the formation of adaptation intention, as it has shown large direct effects on fear and flood risk appraisal. Based on its total effects and moderating effects, flood experience is crucial to adaptation intention.

Furthermore, since fear contributes tremendously to flood risk appraisal, it can be concluded that it is an important factor in the formation of adaptation intention. The results further provide enough grounds to conclude that flood risk appraisal is crucial to adaptation through its direct effect on adaptation appraisal and total effect on adaptation intention. Also, fear, flood risk appraisal and adaptation appraisal play major mediating roles between flood experience and coping experience, and adaptation intention. Based on these findings and discussions, the next chapter will elaborate on the theoretical and practical implications of these finding, and make appropriate conclusions to the study.

CHAPTER 7: CONCLUSIONS

7.1. Introduction

This chapter concludes the study by presenting a summary and main finding along with the theoretical and methodological implications of the research. Moreover, the findings relating to factors affecting flood risk adaptation intentions are discussed in the context of designing policies and possible actions towards flood risk adaptation in informal settlements. The chapter will also highlight areas that need further research.

7.2. Summary of the Research Background

Flooding has become a nightmare in many parts of the world (Balgah et al., 2019; McElwee et al., 2017). The worst affected are usually the poor and vulnerable (Amoako, 2012; de Coninck et al., 2018), not because the events are more severe in their locations, but rather because of inherent conditions of vulnerability and exposure (UNDRR, 2017; Wisner, 2016). There is concern that climate change could worsen the situations of vulnerable populations, especially those in informal settlements in developing countries, due to predictions of an increase in the intensity of precipitation and resultant flooding in many locations (Christensen et al., 2013; Collins et al., 2013; IPCC, 2012; Shaw et al., 2015). Extensive flood risks are particularly a great concern in some places. These are low-severity, high-frequency harmful events that are usually, but not exclusively, linked to very localised hazards (UNDRR, 2017). An example of extensive risk is localised annual flooding in urban Ghana. While the impacts might not be so extreme as to demand international assistance, their repeated occurrence erodes the inhabitants' capacity to respond and exacerbates conditions of vulnerability and poverty (Erman et al., 2018; UNDRR, 2017).

In order to deal with the existing flood risk, informal settlements have habitually adopted coping measures (Chatterjee, 2010; Fenton et al., 2017). These are reactive, short-term measures and are unable to provide long-term resilience (Lavell et al., 2012; Porter et al., 2014). Adaptation measures could ensure proactive and long-term adjustments to existing and future flooding risks that would enhance their resilience. Yet, such measures are not currently given the urgent attention they require. In addition, the intentions of informal settlements towards adaptation to future flooding risks are not known.

Empirically, few studies exist, especially in the Ghanaian context, about informal settlements' adaptation intentions. That is against the backdrop of progressive increases in flood damage and losses for households, especially in Accra (Abeka, 2014), and predictions of heavier precipitation in the wet seasons for the next three decades (World Bank & GFDRR, 2011). This research, therefore, sought to investigate informal settlements' flood risk adaptation intentions, with the view to understanding how flood experience, coping experience and cognitive appraisals influence those intentions. This aim was facilitated by the literature, which suggested that household experience and appraisals could influence the perception of flooding risk and adaptive capacity. Once they perceive the risk of future flooding to be high enough to require protective actions, and their capacity sufficient enough to enable the successful implementation of protective measures, the literature suggests that households will form the intention or be motivated to undertake protective measures proactively.

The protection motivation theory underpinned the research. A new conceptual model was therefore developed based on the Protection Motivation Theory (PMT) to focus on how flood experience, fear, coping experience and cognitive appraisals influenced flood risk adaptation intention. A set of hypotheses were further formulated to test the statistical significance and effect of flood experience, fear, coping experience and cognitive appraisals of households' flood risk adaptation intentions. Philosophically, the research was underpinned by the pragmatic paradigm, with the quantitative research being guided by positivism while the qualitative research was guided by interpretivism. As the mixed methods design was adopted, there was a concurrent collection of quantitative and qualitative data in the study. The data was collected in Glefe, an informal settlement in Accra Ghana, and analysed with SPSS, WarpPLS and NVivo to address the objectives of the study. The findings of the study are discussed below in accordance with the research objectives.

7.3. Addressing the Research Objectives of the Study

7.3.1. Addressing Objective One

Objective one of this research sought to *"conduct a literature review to establish a theoretical model supported with hypotheses relating to factors influencing flood risk adaptation intentions."* Chapter 2 of this thesis reported on the literature review. The chapter discussed the concepts of hazards, risks and disasters. It further elaborated on informal settlements and the inherent conditions that make them vulnerable to flooding risks. The chapter further

discussed vulnerability and resilience, establishing that the research needed to be positioned with the objective of making informal settlements resilient to climate change and disaster risk. Thus, a resilience lens was preferred for the study. It was also important to discuss flood disaster risk reduction. There was a need to differentiate between coping and adaptation, as these terms were commonly confused and used interchangeably in the literature. The chapter further expounded on the protection motivation theory, a theory that was first propounded by Rogers (1975) to clarify how fear appeals influenced protective intentions. It was discovered that the theory has become versatile and is becoming popular in disaster risk and climate change disciplines to study households' intentions to undertake protective actions against disaster or climate change risks. It was, however, necessary to modify the theory to fit the current study, especially as there was a need to measure the influence of flood experience and coping experience on the flood risk adaptation intentions of households in informal settlements. An application of the protection motivation theory that focuses on the flood risk adaptation intentions of households in informal settlements has not been previously attempted. This research, therefore, attempted an innovative application of the protection motivation theory in an informal settlement context. Based on the modified theoretical framework, a set of hypotheses were formulated, and the underlining assumptions were also discussed in Chapter 2. The literature review, and the subsequent conceptual model and hypotheses, therefore, addressed objective one of this research.

7.3.2. Addressing Objective Two

Objective two sought to "*test hypotheses about the relationship between the constructs representing household experience and appraisals, and the flood risk adaptation intentions using quantitative data."* The research, therefore, collected quantitative data through a survey of 392 households in Glefe to test the hypotheses formulated under objective one. The survey data were analysed with SPSS and WarpPLS. The Partial Least Squares Structural Equation Modelling (PLS-SEM) analysis was conducted using the WarpPLS to test the significance of the hypothesised relationships in the conceptual model. The variables included in the model were 'past flood experience' (PE), 'past coping experience' (PC), fear (FW), flood risk appraisal (FRA), adaptation appraisal (AA) and adaptation intention (AI). The ultimate purpose of this model was to establish whether the independent variables could predict the dependent variable, adaptation intention. Several relationships among the variables were tested that had not been previously tested in the studies applying the PMT. One of these relationships was the influence of coping experience on fear and adaptation appraisal. Another novel hypothesis was

the moderating effect of coping experience on flood risk appraisal and the adaptation appraisal relationship. As there is a high reliance on coping against flooding in informal settlements, these novel hypotheses provided the opportunity to reveal the nuances in the factors influencing the households' flood risk adaptation intentions.

As the discussions in Chapter 6 portray, the tested model was sufficient to predict adaptation intention. There was a positive and significant relationship between flood experience and flood risk appraisal. There was also a positive relationship between flood experience and fear. Though the moderating effects of flood experience were not hypothesised, the analysis, however, revealed that the variable had a significant negative effect on the relationship between flood risk appraisal and adaptation appraisal. Rather than decrease the strength of the relationship, it increased the path coefficient of the association and a corresponding increase in the explained variance of adaptation appraisal. The best-fitting curve of the moderating effect showed that there was a drop and subsequent increase in the strength of the relationship. Both flood experience and fear exhibited significant total effects on flood risk appraisal, with an explained variance of 62%. Also, flood experience and coping experience explained 35% of the variance of fear. Fear, on the other hand, exhibited a positive relationship with flood risk appraisal. Fear was found to be a mediator of the relationship between flood experience and flood risk appraisal.

Coping experience also exhibited a positive relationship with fear. However, the finding was contrary to the hypothesised relationship between the two variables. Also, the effect of coping experience on fear was weak. Coping experience further exhibited a positive relationship with adaptation appraisal. The effect size of the total effect of coping experience on adaptation appraisal was moderate, showing that it was an important factor in adaptation appraisal. Coping experience also positively influenced the strength of the relationship between flood risk appraisal and adaptation appraisal. Coping experience and flood risk appraisal explained 34% of the variance of adaptation appraisal. The explained variance increased to 43% when flood experience moderated the relationship between flood risk appraisal and adaptation appraisal.

Furthermore, flood risk appraisal exhibited a positive total effect on both adaptation appraisal and adaptation intention, with moderate effect sizes. However, the direct effect between flood risk appraisal and adaptation intention was weak. The strongest positive relationship and effect size was shown between adaptation appraisal and adaptation intention. The explained variance of adaptation intention was 68%, showing that the model possessed a substantial predictive

power. The model also exhibited substantial predictive relevance, as a Q^2 of 0.67 was found for adaptation intention.

Based on the results of the PLS-SEM analysis, the hypotheses were established with the path coefficients and their p-values. The result showed that there was support for the hypothesised relationships, except hypotheses H4, H9, H10 and H13. Also, the structural paths with the most substantial influence on adaptation intention were through PE→FW→FRA→AA→AI, using the total effects.

As the first study to statistically analyse flood risk appraisals, adaptation capacity appraisals and flood risk adaptation intentions in an informal settlement context in Ghana, these quantitative results highlight the issues that the informal settlements may take into consideration in their attempt to implement flood risk adaptation measures. As the results highlight, households' flood experience and coping experience have a major influence on their flood risk and adaptation capacity perceptions. These factors collectively influence the households' flood risk adaptation intentions.

7.3.3. Addressing Objective Three

Objective three sought to *"examine the factors relating to household experience and appraisals influencing flood risk adaptation intentions using qualitative data."* The results of the qualitative research were presented in Chapter 5 and synthesised with the quantitative results in Chapter 6. The qualitative results revealed that Glefe is vulnerable to flooding due to its location within a flood-prone area. The settlement is encircled by the sea, two lagoons and salt mining ponds. The community is also situated in the lower reaches of the Weija Dam. Due to these locational factors, the community becomes inundated in the rainy season when torrential rainfall and the spillage of the Weija Dam occur in tandem. Other factors that were perceived to be causing flooding in Glefe include improper solid waste management, unauthorised housing developments at the edges of the lagoons, absence of proper drainage infrastructure and lax enforcement of planning and building regulations. NADMO officials were particularly adamant that communities like Glefe will always be prone to flooding risk until issues of poverty and housing have been addressed.

Even though the community annually experiences flooding during the rainy season, only about 31% of the key informants in Glefe reported that they had adopted preparedness measures against previous flooding. The residents also described how previous floods had had adverse impacts on their health, finances, jobs, housing and other household properties, education of

their children and transportation. The emotional and physical burden of these impacts translated into fear and anxiety over future flooding risks. The impacts of the flooding were severe for some households, even though most households in the community adopted coping measures during or immediately after the flooding. It was evident that the impacts from past flooding had also influenced their perception of future flooding risks. Thus, 88% of the key informants suggested that flooding was now part of the life of the community. These households, therefore, had the perception that they will experience severe future flooding unless protective measures are undertaken. Also, 56% of the respondents perceived that future flooding would be worse than it is currently. Thus, there was a high perception of future flood probability and severity. There was also a general perception that most residents were vulnerable to future flooding if current conditions remained.

Furthermore, the residents assessed their self-efficacy to undertake adaptation measures, and the response efficacy and perceived cost of those measures. Generally, most residents perceived that they possessed a low technical ability to undertake adaptation measures. Most of the residents also perceived that adaptation measures could be expensive and time-consuming. However, they also perceived that adaptation measures could reduce or eliminate the adverse impacts of future flooding in the community. It appeared that the response efficacy of the measures carried more weight in their adaptation appraisal than self-efficacy and perceived cost. For instance, residents who thought they lacked the technical ability to undertake adaptation measures said they could hire people or ask their neighbours for help.

The interviews further revealed that structural measures were considered to be the most effective adaptation measures. Thus, when the respondents were asked about their adaptation intentions, most of them mentioned that they would undertake structural measures at the property level. It appears, however, that most of these measures were not too different from the coping measures they had been implementing. The only difference was the timing of the measures, as most of them intended to undertake the measures before flooding. Some residents also perceived that the government should play a major role in reducing their exposure to flooding. It was indicated that the government should address the issue of the lagoons by desilting them and construct drainage infrastructure in the community. Conversely, NADMO officials indicated that they would continue to employ educational campaigns and early warning to educate the residents and provide information on flooding probability. The officials also indicated that NADMO would continue to desilt the major drainage channels in Accra at the start of the rainy season to reduce flooding.

These results provided a novel opportunity to not just understand the flood experiences and coping actions of the informal settlement households, but also to produce a nuanced understanding of the feelings, opinions, and meanings households attach to their actions and intentions against flooding risks. Previous research in the Ghanaian context on flood risk reduction was lacking in this respect, as they only addressed the past coping actions of households without due consideration for their future actions and adaptation intentions.

7.3.4 Addressing Objective Four

The purpose of objective four was to *"synthesise the quantitative and qualitative results to explain how household experience and appraisals influence flood risk adaptation intentions."* Chapter 6 of this thesis was, therefore, presented in line with this objective. Thus, the results of the research were discussed, using the qualitative findings to confirm, collaborate and triangulate the quantitative findings. The findings revealed that flood experience, fear, coping experience, flood risk appraisal and adaptation appraisal had a significant and positive relationship with adaptation intention. About 68% of the variance in adaptation intention was attributable to the factors flood experience, fear, coping experience, flood risk appraisal and adaptation appraisal.

7.3.4.1 Synthesised findings relating to how flood experience influences households' fear and flood risk appraisal

When synthesised, the quantitative and qualitative results reveal that the households in the informal settlement have experienced adverse flooding. The flooding experience has led to a general fear and anxiety about future flooding and its impacts in the settlement. The flooding experiences have further contributed to the households' perceptions that there is a high chance of flooding occurrence, with its associated severe impacts, becoming worse in the community. These results imply that when the severity of flood experience is high, it results in an adverse emotional response from the residents when they think about both existing and future flood risk. It also suggests that the experience may lead to households assuming that future flooding could be severe, that it could affect them and that the impacts could be harmful. The emotional response (fear, anxiety, and worry) thus serves as the intervening variable that informs the perception of flooding risks.

7.3.4.2 Synthesised findings relating to how coping experience influences households' adaptation appraisal, flood risk appraisal and fear

Furthermore, both the quantitative and qualitative results revealed that the households have been adopting coping measures to deal with the recurring flooding events in the community. Due to the implementation of coping measures over the years, the residents have built up a repository of knowledge and experience on implementing measures during and after a flood event. The experience (and knowledge) gained from coping with flooding was revealed to have a substantial influence on the households' adaptation appraisal and their flood risk perception. Perhaps because coping measures are implemented for their ability to provide temporary protection during or immediately after a flood event, residents believed that the efficacy of an adaptation measure was the most important consideration in their adaptation capacity perception. Self-efficacy and adaptation cost, while being important considerations in the households' adaptation appraisal, were superseded by their need for efficacious adaptation measures. The coping experience also seems to have increased their fear of flooding risks. These findings imply that when past coping measures are perceived to have been successful, it leads to a corresponding perception that adaptation measures could also be effective to reduce flooding risks. It also appears that the more coping mechanisms were perceived as successful, the more people were afraid about future flood risks. The reason for this unusual relationship was that people became worried that they were not implementing or could not implement long-lasting measures.

7.3.4.3 Synthesised findings relating to how households' flood risk appraisal influences their adaptation appraisal and adaptation intentions

What these findings also mean is that when people perceive that future flooding could be severe, that it could affect them and that the impacts could be harmful, they begin a process of appraising their capacity (including their skills, resources and the potential of adaptation of measures) to implement adaptation measures that will eliminate or reduce the flood or its impacts. There is a small chance that some people may by-pass this critical step and begin making plans to undertake adaptation measures. Nevertheless, the majority of people will appraise their adaptive capacity before deciding to implement adaptation measures. The results of this research reveal that the critical factor that influences the intention to undertake adaptation actions is the efficacy of the adaptation measures. When the person is certain that the measures will be successful, they make a firm decision to undertake them. Some persons may seek the help of neighbours or hire skilled people to help them to implement the measures

they decided to undertake. The quantitative results, together with the qualitative findings, therefore, provided empirical justification to conclude that household experience and appraisals influenced their flood risk adaptation intention.

This comprehensive and innovative assessment of the factors influencing flood risk adaptation intentions of informal settlements in the Ghanaian context provides valuable findings towards understanding flood risk perception, flood risk exposure, flood risk communication and flood risk management (Siegrist & Árvai, 2020), enabling the flood risk management authorities and agencies to improve their capacities regarding the communication and implementation of measures towards flood risk adaptation in these contexts.

7.4 Theoretical Contribution of the Study

7.4.1 Incorporation of Coping Experience in Protection Motivation Theory

The research adopted a novel approach to the application of the protection motivation theory in flood risk reduction research. A neglected area in the protection motivation theory is the fundamental issue of experience from past coping actions. The theory seems to have been formulated without consideration of the fact that the receivers of risk information and appeals to fear might have undertaken actions in the past to reduce or eliminate the risk/threats they faced. Thus, the experience gained from coping actions has been overlooked in the models applying the theory until now. The current research therefore operationalised an innovative modification to the protection motivation theory to encompass the additional element of the coping experience of households. Coping mechanisms are crucial to the survival of most residents in flood-prone communities in developing countries. Some of these communities are informal settlements and therefore have been neglected by their governments. Coping mechanisms are therefore crucial to the reduction of the impacts of the extensive and intensive flood risks they face. The research has revealed that considerable knowledge and experience have been built up from the successive years of coping with these risks, and any attempt to encourage flood risk adaptation must take into consideration such knowledge and experience. Thus, research applying the protection motivation theory in contexts such as the current one must model the influence of experience gained from coping mechanisms on adaptation intentions. This research has shown that coping experience has a direct and non-linear relationship with adaptation appraisal. As research on the coping responses of residents in developing countries continues, it is crucial to move from just enumerating the types of coping

actions and their effectiveness to a more distinct understanding of how coping experience can help efforts towards adaptation to flooding risk under the changing climate. This research therefore serves as a good starting point for discussions on the influence of coping mechanisms on flood risk adaptation intentions and actions in informal settlements.

7.4.2 Consideration of the Moderating Effects of Flood Experience on Cognitive Appraisals

Another novel contribution to theory is the revelation that flood experience has significant moderating effects on the strength of the relationship between threat (flood risk) appraisal and adaptation appraisal. Previous scholarship applying the protection motivation theory have often focused on the direct and indirect relationships between threat (flood risk) appraisal and coping (adaptation) appraisal, underscoring the importance of people's perception of risk on their perceived capacity to moderate the risk. The effects of experience on risk appraisal (perception) have also been previously acknowledged in the literature. While that is indisputable, this research has added a unique dimension to the application of the PMT in flood risk reduction research by investigating the effects of households' flood experiences on the direction and strength of the relationship between flood risk appraisal and adaptation appraisal. As the current research shows, the moderating effects of flood experience on the flood risk appraisal–adaptation appraisal relationship can lead to increases in the strength of the relationship and the explained variance of adaptation appraisal. It means that it is not only the flood risk appraisal but also the flood experience that determines the minimum level of flood risk that must be present before households begin to consider their capacity and ability to implement flood risk adaptation measures and the benefits of such measures. This is crucial, as it helps to more fully conceptualise the factors that influence perceived adaptative capacity and adaptation intentions.

7.4.3 Novel Application of the Protection Motivation Theory in an Informal Settlement Context

The research has provided further scope for the application of the protection motivation theory in disaster risk research. The application of the protection motivation theory in disaster risk research is not new. However, this research adds a new dimension to the theory through its application to an informal settlement where conditions and cultures are quite different from the origins of the theory. This proves that with novel modifications the theory can be applied to varied geographical and research contexts.

7.4.4 Pioneering Research into Flood Risk Adaptation Intentions in the Ghanaian Context

Furthermore, as one of the first studies to investigate the adaptation intentions of residents in flood-prone communities in Ghana, this research has made a pioneering contribution to protective/adaptation intentions research in the country. Disaster risk and climate change adaptation targets in global frameworks, such as the Sustainable Development Goals, the New Urban Agenda, and the Sendai Framework, have all underscored the crucial role of local knowledge in the planning and implementation of adaptation action. The results of this research therefore provide a springboard for knowledge generation on the flood risk adaptation of residents in flood-prone communities in the Ghanaian context.

7.4.5 New Insights into Factors Influencing Fear in Protective Behaviour Formation

Until now most of the frameworks on behavioural intentions, including the Protection Motivation Theory, have conceptualised fear as arising from threat appraisal and fear appeals communication. While that seems to be plausible, an important aspect that this research has considered is the emotional response of households to flood experience and coping experience. The fear arising from flood experience and coping was considered a crucial factor affecting flood risk appraisal in the present research because concerns have been raised in the literature about how harmful experiences from flooding or failure of coping mechanisms influence people to either assess their risk to future threats or adopt denialism and fatalistic behaviour. Despite the crucial nature of this issue for flood risk protective and adaptation behaviour, it does not appear that any attempt has been made in the past to establish if there exists a statistically significant relationship between flooding experience and fear, on the one hand, and coping experience and fear on the other hand. The current research has found a significant positive correlation between flood experience and fear. Likewise, a significant positive correlation has been found between coping experience and fear. What the results mean in the instance of flood experience is that the higher the experience, the higher the fear provoked, and this was expected. Surprisingly, the results also revealed that the higher the coping experience, the higher the fear stimulated. This was unexpected, as it suggests that when households experience a higher success rate in their coping actions, it tends to stir up fear of future flooding. These results augment the theory on factors stimulating emotional responses and fear about flood risks.

7.4.6 Theorising the Variables Influencing Flood Risk Adaptation Intentions

As previous research has highlighted, and has been duly acknowledged in this research, adaptation appraisal seems to have a more substantial direct influence on protective intentions than flood risk appraisal. This research has consequently established that adaptation appraisal has a statistically significant and positive relationship with adaptation intention. The relationship showed a larger correlation coefficient and effect size than the relationship between flood risk appraisal and adaptation intention, validating the literature and reinforcing the importance of adaptation capacity appraisal to households' flood risk adaptation intentions.

7.5 Practical Contribution of the Study

The results of this study have practical relevance to policymakers, disaster risk management practitioners and other cognate professionals. It has provided context-specific data on the adaptation intentions of residents in a flood-prone community in Ghana. It will therefore give officials in charge of disaster risk reduction and climate change adaptation information on how to encourage residents in flood-prone communities to adapt to flood risks in the changing climate.

Also, the cooperation of residents is crucial to risk reduction, and this research proves that there is willingness on the part of residents in the current context to reduce exposure and vulnerability to flooding risks. It will therefore help policy makers and practitioners to understand the perceptions of the residents and the level of support they need to enable them to undertake adaptation measures. The research also underscores the importance of engaging flood-risk-prone communities to understand their risk perceptions, adaptive capacity, and perceptions about their role in reducing existing and future flood risk. In addition, it provides knowledge that can be leveraged for the purposes of implementing flood risk reduction and preparedness measures in the flood-prone informal settlements.

Moreover, the evidence from this research indicates that flood experience, coping experience, flood risk appraisal (perception) and adaptation appraisal are the crucial factors shaping households' flood risk adaptation intentions. Policymakers may succeed in encouraging residents to undertake proactive, prospective, corrective, and compensatory flood risk adaptation measures if they incorporate these factors into enabling programs.

Additionally, the research has revealed that the most powerful influence on flood risk adaptation intention comes from adaptation appraisal. More specifically, it has been found that

response efficacy is one of the components of adaptation appraisal that influences people's intentions to undertake adaptation action. Thus, it will be beneficial to flood risk adaptation action if policymakers and disaster risk managers put in place measures to enhance the efficacy of adaptation measures. As most residents perceived their ability to implement adaptation measures and technical knowledge as low, it will also be crucial to flood risk adaptation action if measures are implemented to build the capacity of residents to implement proactive, prospective, corrective, compensatory and long-term measures to avoid new or increased disaster risks, eradicate or lessen existing disaster risk, and strengthen the economic and social resilience of individuals and the community against flooding risks.

7.6 Methodological Contribution of the study

The research has made a unique contribution to the application of protection motivation theory in research by adopting a mixed-method design to operationalise the research. Previous studies using the protection motivation theory either adopted a wholly qualitative (Birkholz, 2014) or quantitative research design. This research, therefore, expands the methodological choices available to researchers applying the protection motivation theory. It is also a good example of how purely quantitative models can be investigated using mixed-method designs.

7.7 Directions for Future Research

This research has made great theoretical, practical, and methodological contributions that enrich the understanding of flood risk adaptation intentions in informal settlements in the Ghanaian context. Even so, the research highlighted the need for additional research into other specific areas. It is therefore expedient for future research to address the following specific areas.

7.7.1 Influence of Trust in Public Mitigation Works on Adaptation Intentions of Informal Settlements

The qualitative results of this research revealed that some residents placed too much trust in public mitigation works, resulting in the neglect of their personal responsibility to reduce or eliminate flooding risks. It will be crucial to understand how such trust in public works influences flood risk appraisal, adaptation appraisal and adaptation intentions in the Ghanaian context. The qualitative results show that trust in public works may have a negative correlation

with these variables. However, it needs to be statistically tested to ascertain if there exist any statistically significant relationships between trust in public mitigation works and these variables.

7.7.2 Validation of the Results of the Research by a Larger Sample

The current research is one of the first studies to investigate the flood risk adaptation intentions of residents in an informal settlement in Ghana. However, due to the limited geographical scope of the case study, the research problem needs to be replicated in a larger population to enable statistical generalisation. The results of this research are encouraging and should therefore be validated by a larger sample. This research should also serve as a basis for future research into the adaptation intentions of flood-prone communities (not just informal settlements). Future research could also consider a comparison of the adaptation intentions of residents in affluent communities to the adaptation intentions of informal settlements.

7.7.3 Extension of the Research to Cover Other Adaptation Intentions

The current research focused exclusively on the adaptation intentions of residents in a flood-prone informal community. However, the effects of climate change are felt in diverse areas. In Ghana, the agricultural sector could be adversely affected by climate extremes. It will therefore be interesting to understand the adaptation intentions of farmers in Ghana. With a context-specific modification, the model used in the current research could be easily applied in such research.

7.7.4 How Culture Influences Flood Risk Perceptions and Adaptation Intentions

It was evident from the qualitative results that the flood risk perceptions and adaptation intentions of the residents could have been influenced by culture. It seems that the NADMO officials and residents perceived flood risk based on different worldviews. It will therefore provide further scope for understanding the flood risk perceptions and adaptation intentions of flood-prone communities to study how culture and differing worldviews influence their perceptions. Such research could apply an innovative amalgamation of the cultural theory of risk and the protection motivation theory to investigate the influence of cultural perspectives on protective intentions.

7.7.5 How Place Attachment Influences Flood Risk Perception

The qualitative results of the current research showed that most of the residents were unprepared to relocate from the community, even if the flooding risk was life-threatening. It seems that their attachment to the community was the reason for their stance. A future study is therefore needed to establish how placement attachment influences the behaviour and risk perceptions of residents of flood-prone communities in Ghana.

7.8 Conclusion

The research identified that continued dependence on coping mechanisms in informal settlements could be problematic in the changing climate as the mechanisms lacked the ability to provide adequate protection and resilience against predicted climatic extremes. The research therefore explored factors that could facilitate the transition beyond coping to adaptation in the informal settlements in Ghana. The research explored the literature and developed a model encompassing an innovative modification of the protection motivation theory to incorporate flooding experience and coping experience. The research was operationalised by the concurrent collection of quantitative and qualitative data in Glefe, in Accra, Ghana. The results of the quantitative data analysis revealed that there were statistically significant correlations between flood experience, fear, coping experience, flood risk appraisal, adaptation appraisal and flood risk adaptation intentions, emphasising that these factors could stimulate and sustain flood risk adaptation intentions among households in the informal settlements. The qualitative results provided further insights into these factors, confirming, and validating the results of the quantitative data. Therefore, the research has made significant contributions to the body of knowledge regarding protection motivation and findings on flood risk adaptation intentions in informal settlements. Practically, the present research may be useful for efforts towards adaptation to flooding risk in the changing climate, as the findings could help policy makers and disaster risk management agencies in Ghana to design programs that enable flood risk adaptation.

Finally, a few limitations of the research need to be highlighted. Given that the results of the research are based on data from a single case study, the findings may not be statistically representative of all informal settlements in urban Ghana. Another potential limitation lies in the fact that the ratio of females to males who participated in the quantitative survey was higher than exists in the general population, a result of the fact that the questionnaires were

administered during the week day when the male household heads might have travelled outside the community for work. Despite these few limitations, the research has highlighted the relevance of household experiences and appraisals to flood risk adaptation intentions in informal settlements, which may be crucial to aid transition beyond coping to adaptation in the changing climate.

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APPENDICES

Appendix 1: Human Research Ethics Committee Approval

HUMAN RESEARCH ETHICS COMMITTEE

Notification of Expedited Approval

To Chief Investigator or Project Supervisor:	**Associate Professor Thayaparan Gajendran**
Cc Co-investigators / Research Students:	**Doctor Kim Maund** **Mr Jerry Tasantab** **Doctor Jason Von Meding**
Re Protocol:	**BEYOND COPING: HOW FLOOD EXPERIENCE AND COGNITIVE PROCESSES INFLUENCE ADAPTATION TO FLOOD RISK IN INFORMAL SETTLEMENTS**
Date:	**04-Feb-2019**
Reference No:	**H-2018-0415**
Date of Initial Approval:	**04-Feb-2019**

Thank you for your **Response to Conditional Approval (minor amendments)** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to the above protocol.

Your submission was considered under **Expedited** review by the Ethics Administrator.

I am pleased to advise that the decision on your submission is **Approved** effective **04-Feb-2019**.

In approving this protocol, the Human Research Ethics Committee (HREC) is of the opinion that the project complies with the provisions contained in the National Statement on Ethical Conduct in Human Research, 2007, and the requirements within this University relating to human research.

Approval will remain valid subject to the submission, and satisfactory assessment, of annual progress reports. *If the approval of an External HREC has been "noted" the approval period is as determined by that HREC.*

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval* will be available upon request. Your approval number is **H-2018-0415**.

If the research requires the use of an Information Statement, ensure this number is inserted at the relevant point in the Complaints paragraph prior to distribution to potential participants You may then proceed with the research.

Conditions of Approval

This approval has been granted subject to you complying with the requirements for *Monitoring of Progress*, *Reporting of Adverse Events*, and *Variations to the Approved Protocol* as detailed below.

PLEASE NOTE:
In the case where the HREC has "noted" the approval of an External HREC, progress reports and reports of adverse events are to be submitted to the External HREC only. In the case of Variations to the approved protocol, or a Renewal of approval, you will apply to the External HREC for approval in the first instance and then Register that approval with the University's HREC.

- ***Monitoring of Progress***

Other than above, the University is obliged to monitor the progress of research projects involving human participants to ensure that they are conducted according to the protocol as approved by the HREC. A progress report is required on an annual basis. Continuation of your HREC approval for this project is conditional upon receipt, and satisfactory assessment, of annual progress reports. You will be advised when a report is due.

- ***Reporting of Adverse Events***

1. It is the responsibility of the person **first named on this Approval Advice** to report adverse events.
2. Adverse events, however minor, must be recorded by the investigator as observed by the investigator or as volunteered by a participant in the research. Full details are to be documented, whether or not the investigator, or his/her deputies, consider the event to be related to the research substance or procedure.
3. Serious or unforeseen adverse events that occur during the research or within six (6) months of completion of the research, must be reported by the person first named on the Approval Advice to the (HREC) by way of the Adverse Event Report form (via RIMS at https://rims.newcastle.edu.au/login.asp) within 72 hours of the occurrence of the event or the investigator receiving advice of the event.
4. Serious adverse events are defined as:
    - Causing death, life threatening or serious disability.
    - Causing or prolonging hospitalisation.
    - Overdoses, cancers, congenital abnormalities, tissue damage, whether or not they are judged to be caused by the investigational agent or procedure.
    - Causing psycho-social and/or financial harm. This covers everything from perceived invasion of privacy, breach of confidentiality, or the diminution of social reputation, to the creation of psychological fears and trauma.
    - Any other event which might affect the continued ethical acceptability of the project.

5. Reports of adverse events must include:
    - Participant's study identification number;
    - date of birth;
    - date of entry into the study;
    - treatment arm (if applicable);
    - date of event;
    - details of event;
    - the investigator's opinion as to whether the event is related to the research procedures; and
    - action taken in response to the event.

6. Adverse events which do not fall within the definition of serious or unexpected, including those reported from other sites involved in the research, are to be reported in detail at the time of the annual progress report to the HREC.

- ***Variations to approved protocol***

If you wish to change, or deviate from, the approved protocol, you will need to submit an *Application for Variation to Approved Human Research* (via RIMS at https://rims.newcastle.edu.au/login.asp). Variations may include, but are not limited to, changes or additions to investigators, study design, study population, number of participants, methods of recruitment, or participant information/consent documentation. **Variations must be approved by the (HREC) before they are implemented** except when Registering an approval of a variation from an external HREC which has been designated the lead HREC, in which case you may proceed as soon as you receive an acknowledgement of your Registration.

Linkage of ethics approval to a new Grant

HREC approvals cannot be assigned to a new grant or award (ie those that were not identified on the application for ethics approval) without confirmation of the approval from the Human Research Ethics Officer on behalf of the HREC.

Best wishes for a successful project.

Associate Professor Helen Warren-Forward
Chair, Human Research Ethics Committee

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RIMS website - https://RIMS.newcastle.edu.au/login.asp

Linked University of Newcastle administered funding:

Funding body	Funding project title	First named investigator	Grant Ref

Appendix 2: Household Survey Questionnaire

DOCTORAL RESEARCH: BEYOND COPING TO ADAPTATION

HOUSEHOLD SURVEY

Jerry Chati Tasantab

Thank you for taking the time to participate in this survey.

We want to understand what you think, how floods are affecting various aspects of your life and how you would respond to the floods if you had the capacity so that the authorities can better look after your community in future.

In this survey you will see terms like coping and adaptation. Below is what they mean

Coping is about the REACTIVE ACTIONS you perform with short term focus (Hooli, 2016):

- **(a) to deal with immediate risk when a flood is occurring**
- **(b) to survive the flood**
- **(c) to prevent your property from being destroyed by flooding**

Adaptation is about PROACTIVE and LONG TERM FOCUS actions (UNISDR, 2009):

- **(a) you perform to moderate the harm from flood and related impacts, or**
- **(b) exploiting any opportunities for beneficial outcomes against possible harm from floods and related impacts.**

For most of the questions, just tick/cross the box (or boxes) most applicable to you. **There are no correct or incorrect responses, we just want your personal opinion.**

We assure you that any information or opinion you give us will be used purely for academic purposes and will be treated with utmost confidentiality.

This survey should take approximately 30 minutes to complete.

Again, thank you for participating

HOUSEHOLD SURVEY

Date:

Time:

SECTION 1: SOCIO-ECONOMIC INFORMATION. Tell us about yourself and your household

1a. Please tick a box where appropriate and write your response in the space provided

1. Gender
   ☐[1] Male ☐[2] Female
2. Age
   ☐[1] 18 - 29 ☐[2] 30 -39 ☐[3] 40 -49 ☐[4] 50 -59 ☐[5] 60 - 69 ☐[6] 70 +
3. Highest Level of Education
   ☐[1] Primary ☐[2] Middle/JHS ☐[3] SHS ☐[4] Vocational/Technical ☐[5] University undergraduate
   ☐[6] Polytechnic diploma ☐[7] Postgraduate ☐[8] No formal education
4. Marital Status
   ☐[1] Single ☐[2] Married ☐[3] Separated ☐[4] Divorced ☐[5] Widowed
5. Number of people in the household Over 12 years……. 12 years of age and under

6. Type of employment

☐[1] Unemployed ☐[2] Schooling ☐[3] Self-employed ☐[4] Public sector employee ☐[5] Private sector employee

7. For the purpose of this study, please indicate your total monthly income after tax in Ghana Cedis (¢)

☐[1] 1-500 ☐[2] 501-1000 ☐[3] 1001-1500 ☐[4] 1501-2000 ☐[5] 2001-2500 ☐[6] 2501-3000 ☐[7] 3001+

8. Total monthly net income of all other household members (in GHS)

☐[1] 1-500 ☐[2] 501-1000 ☐[3] 1001-1500 ☐[4] 1501-2000 ☐[5] 2001-2500 ☐[6] 2501-3000 ☐[7] 3001+

9. Type of dwelling you live in
   ☐[1] Separate house ☐[2] Semi-detached house ☐[3] Flat/Apartment ☐[4] Room(s) in a compound ☐[5] Tent
   ☐[6] Improvised home (kiosk, container) ☐[7] Living quarters attached to an office/shop ☐[8] Uncompleted building
10. Type of dwelling tenure/holding arrangement
    ☐[1] Owner occupied ☐[2] Renting ☐[3] Rent free ☐[4] Perching ☐[5] Squatting

11. How long you have lived (in years) in this community ……..

SECTION 2. PAST EXPERIENCE ***(FLOOD EXPERIENCE AND COPING RESPONSES)****. We just want to know your experience with past floods, their effects and the measures you took to react to them)*

2a. With regard to your experience with Past floods please rate the following statements: (Tick Only One Answer Per Statement)

1. **The physical damage to my house was**
☐1 None ☐2 Very mild ☐3 Moderate ☐4 Severe ☐5 Very Severe

2. **The impact on my friends/relatives was**
☐1 None ☐2 Very mild ☐3 Moderate ☐4 Severe ☐5 Very Severe

3. **The loss of my valuable belongings during recent floods was**
☐1 None ☐2 Very mild ☐3 Moderate ☐4 Severe ☐5 Very Severe

4. **Past floods had negative effects on my well-being**
☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

5. **I am still suffering from the impact of past floods**
☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

6. **Someone in the household suffered health problems due the floods.**
☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

7. **Someone in the household is still suffering an ongoing injury or illness**
☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

8. **Coping actions reduced the impacts of past floods**
☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2b. Please tell us if you adopted any of these actions to cope with past floods (Tick applicable)

1. Rebuild damaged walls of buildings
☐1 Yes ☐2 No
2. Remove water out from inside house
☐1 Yes ☐2 No
3. Store Important documents in safe places
☐1 Yes ☐2 No
4. Create water barriers in flooded areas
☐1 Yes ☐2 No
5. Clear gutters, drains or water ways in the community
☐1 Yes ☐2 No
6. Transfer valuables to a safe place
☐1 Yes ☐2 No
7. Temporary relocation to another community
☐1 Yes ☐2 No
8. Temporary relocation to higher ground in this community
☐1 Yes ☐2 No
9. Channel water away from the house
☐1 Yes ☐2 No
10. Repair damaged roof
☐1 Yes ☐2 No
11. other (please state)

2c. Would you say these coping measures you implemented in the past to reduce impact of floods on your own home as successful? (Tick Only One Answer Per Statement)

1. **Rebuild damaged walls of buildings**
☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

2. **Remove water from inside house**
☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

3. **Store Important documents in safe places**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

4. **Create water barriers in flooded areas**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

5. **Clear gutters, drains or water ways in the community**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

6. **Transfer valuables to a safer place**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

7. **Temporary relocation to another community**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

8. **Temporary relocation to higher ground in this community**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

9. **Channel water away from my house**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

10. **Repair damage roofs**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree ☐6 Not Applicable

SECTION 3. FUTURE FLOODS *(FLOOD RISK APPRAISAL)*: *We want you tell us your opinion about future floods. Will they occur? Would they be severe? Tell us how you feel and what you think about it.*

3a. Please tell us how feel about future flood risk (Tick Only One Answer Per Statement)

1. **I fear for the safety of the people in my household**

☐1 Strongly Disagree ☐2 Slightly Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly agree

2. **Rate your level of concern/worry about future flooding**

☐1 None ☐2 Low ☐3 Moderate ☐4 High ☐5 Very high

3. **I am concerned for my house (building)**

☐1 Strongly Disagree ☐2 Slightly Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly agree

4. **I am worried about the loss of peoples' jobs**

☐1 Strongly Disagree ☐2 Slightly Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly agree

5. **I am concerned for the safety of people in my community**

☐1 Strongly Disagree ☐2 Slightly Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly agree

6. **I am concerned for the safety of houses in my community**

☐1 Strongly Disagree ☐2 Slightly Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly agree

7. **Floods don't happen often enough to make them a high priority**

☐1 Strongly Disagree ☐2 Slightly Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly agree

3b. Please tell us about how you PERCEIVE the SEVERITY of future floods *(Just questions, not how things will be – we just want your thoughts).* (Tick Only One Answer Per Statement)

1. **Future flooding will be more severe**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2. **Future flooding will be more frequent**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3. **If the floods occur, it could be that the destruction will be great**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

4. **The problems caused by floods in the future will take longer to rectify**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

5. **I need more information about the severity of future floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

6. **I need more information about the potential risk of future floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

7. **I think I am likely to experience a serious future flood**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

You are almost Half Way through. Thank You SO MUCH. You are doing a GREAT JOB

3c. We want you to tell us how you PERCEIVE your VULNERABILITY to future floods? (Tick Only One Answer Per Statement)

1. **My location is prone to flooding**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2. **I think my house will be flooded**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3. **My house often gets flooded**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

4. **Flooding causes health problems in my household**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

5. **Flooding can lead to people in my household being out of work**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

6. **Flooding in my area damages houses**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

7. **Flooding will financially cost my household a lot**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

MALADAPTIVE RESPONSE REWARDS *(perceived intangible recognitions or sense of achievement motivation that prevent people from undertaking flood risk adaptation).*

Please TELL US if you could allow the following to prevent you from doing something proactive or long term about future floods or taking advantage of beneficial opportunities (Tick Only One Answer Per Statement)

3d. Intrinsic rewards (Your own excuses and maybe benefits)

1. **Flood risk adaptation is NOT something important to be concerned about.**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2. **NO NEED to adapt because future floods will not bring any big changes.**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3. **I can still live here in the future WITHOUT adaptation**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

4. **OTHER PRIORITIES to think about instead of floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

5. **Thinking about flood risk will make me FEEL INSECURE**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3e. Extrinsic rewards (OTHER people's opinions, actions or inactions)

Please rate your agreement with the following statements: (Tick Only One Answer Per Statement)

1. **People will laugh at me if I take actions to adapt to future floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2. **None of my friends/my family are taking any adaptation actions**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3. **The people in this community are not interested in adaptation**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

SECTION 4: ADAPTATION APPRAISAL

Your Opinion about whether you are able to perform proactive, long term actions or take advantage of beneficial opportunities to reduce impacts of future floods. We also want to know if you think the actions could really reduce impacts of future floods.

The following are some of the things you could do to reduce the impacts of future floods or take advantage of the beneficial opportunities they provide (Tick yes if you agree)

1. Strengthen the physical structures of my home ☐1 Yes ☐2 No
2. Elevate my home ☐1 Yes ☐2 No
3. Take out Insurance on my home ☐1 Yes ☐2 No
4. Permanently relocate out of this community ☐1 Yes ☐2 No
5. Move to a less flood risk prone area in this community ☐1 Yes ☐2 No
6. Learn about adaptation options to apply ☐1 Yes ☐2 No
7. Follow weather warnings ☐1 Yes ☐2 No
8. Lobby the government to improve stormwater networks ☐1 Yes ☐2 No
9. Advocate for restrictions on development in flood-prone areas ☐1 Yes ☐2 No
10. Involve myself in volunteer activities intended to adapt the community to floods ☐1 Yes ☐2 No
11. Do you know of any other (please tell us)

THANK YOU SO MUCH FOR YOUR TIME. YOU HAVE BEEN SO HELPFUL. A FEW MORE PAGES TO GO.

4a. SELF-EFFICACY: Please tell us YOUR THOUGHTS. Can you take proactive or long term actions TO REDUCE IMPACTS OF FUTURE FLOODS or TAKE ADVANTAGE OF BENEFICIAL OPPORTUNITIES? (Tick Only One Answer Per Statement)

1. **I can take proactive actions to reduce future flood impacts**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2. **I can take long term actions to reduce future flood impacts**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3. **I can take advantage of beneficial opportunities brought by future floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

4. **I have the skills to undertake adaptation measures**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

5. **I know what to do to adapt to future floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

6. **It is too difficult to adapt to floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

7. **I am creative in finding solutions to flood risks**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

4b. RESPONSE-EFFICACY: Tell us your opinion, whether you think the proactive, long terms actions or beneficial opportunities will really reduce impacts of future floods? (Tick Only One Answer Per Statement)

1. **Proactive measures will reduce future flood damage to my house.**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2. **Proactive measures will increase the safety of my household from floods**.

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3. **For me, long term actions will reduce my chances of being seriously flooded**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

4. **Beneficial opportunities will make us strong against future flood impacts**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

5. **Adaptation actions will make this community a safe place to live in the rainy season**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

6. **Adaptation actions will prevent future losses due to floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

7. **Adaptation actions will increase the value of my property**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

4c. PERCEIVED ADAPTATION COSTS : What do you think about the cost, time and effort of implementing proactive, long term actions or taking advantage of beneficial opportunities to reduce future flood impacts? (Tick Only One Answer Per Statement)

1. **Adaptation costs are less than the costs of inaction.**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2. **I prefer spending my money on something else rather than adaptation.**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3. **Adaptation is too time-consuming.**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

4. **Adaptation measures are too expensive**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

5. **Adapting to floods is inconvenient**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

6. **Adaptation measures will involve too much effort**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

SECTION 5: ADAPTATION INTENTION: Do you think you will actually adopt proactive, long term actions or take advantage of beneficial opportunities to reduce future flood impacts? Tell us what you will do.

5a. Please tell us about your intentions concerning adaptation to flood risk (Tick Only One Answer Per Statement)

1. **I will engage with actions so that future floods do not have impacts on my household**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2. **I will protect my house from damages due to future floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3. **I think government should take the greater responsibility to protect us from future floods**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

5b. Please rate your INTENTION to adopt the following proactive, long term measures or beneficial opportunities to reduce future flood impacts (Tick Only One Answer Per Statement)

1. **I will strengthen the physical structures of my home**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

2. **I will elevate my home**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

3. **I will take out Insurance on my home**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

4. **I will permanently relocate out of this community**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

5. **I will move to a less flood prone area in this community**

☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

6. **I will learn about adaptation options to apply** ☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree
7. **I will follow weather warnings more keenly** ☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree
8. **I will begin to lobby the government on improvements to stormwater networks** ☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree
9. **I will advocate for restrictions on development in flood-prone areas** ☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree
10. **I will involve myself in volunteer activities intended to adapt the community to floods** ☐1 Strongly Disagree ☐2 Disagree ☐3 Neutral ☐4 Agree ☐5 Strongly Agree

THE END.

THANK YOU SO MUCH FOR YOUR TIME AND THOUGHTS

WE ARE VERY GRATEFUL!

Appendix 3: Interview Guides

INTERVIEW GUIDE- HOUSEHOLDERS

Thank you for taking the time to participate in this interview.

We want to understand what you think, how floods are affecting various aspects of your life and how you would respond to the floods if you had the capacity so that the authorities can better look after your community in future.

In this interview you will see terms like coping and adaptation. Below is what they mean

Coping is about the REACTIVE ACTIONS you perform with short term focus (Hooli, 2016):

to deal with immediate risk when a flood is occurring

to survive the flood

to prevent your property from being destroyed by flooding

Adaptation is about PROACTIVE and LONG TERM FOCUS actions (UNISDR, 2009):

you perform to moderate the harm from flood and related impacts, or

exploiting any opportunities for beneficial outcomes against possible harm from floods and related impacts.

There are no correct or incorrect responses, we just want your personal opinion.

We assure you that any information or opinion you give us will be used purely for academic purposes and will be treated with utmost confidentiality. This interview should take approximately 30 minutes to complete.

Again, thank you for participating

Jerry Chati Tasantab

University of Newcastle

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

QUESTIONS GUIDE

Part 1 - Introduction and Context

1. Age
2. Gender
3. Number of persons in household
4. How long have you been living here?

5. Do you see yourself staying here in the next 5-10 years?

Part 2 – Experience/Coping with Flooding in Glefe

6. When the rainy season comes, how is it like living here?

7. Severe flood experience
    a. Do you remember any year in which the floods were very severe?

    b. Could you tell me what happened during the flooding…?

8. Threat of flooding
    a. Could you tell me what you know about the current threat of flooding here?

    b. What are the causes of or reasons for this threat? (Where does it come from, what is causing it?)

9. Could you tell me what you did during the most recent flood?
    a. What was your first priority, what was most important to do?
    b. How did you protect your belongings?
    c. How did you keep yourself and your family healthy?
    d. How did you protect your house?
    e. Did you evacuate?
    f. What would have to happen for you to choose to leave/evacuate?
    g. Were you scared at any time?
    h. What frightened you most?
10. *Looking back were you preparing to cope with the floods?*

11. Could you tell me what other people in your community had to do?

12. Could you tell me what happened after the flood?
    a. What difficulties did you face after a flood?
    b. What did you have to do to be able to return to normal?
    c. How did the government or NGOs help you after the flood?

Part 3 – Cognitive Appraisals

A. Flood Risk Appraisal

13. Would you say that floods are part of life here? Can you explain why (or why not)?

14. Do you think they will get worse? Can you explain why (or why not)?

15. Do you fear for your safety here? Can you explain why (or why not)?

16. What is your worst fear during a flood?

17. Do you think you or your family and property will suffer harm from floods in the future? Can you explain why (or why not)?

B. Adaptation Appraisal

18. Measures to adapt to floods
    a. What are the actions you can or have performed to reduce the harm from floods and related impacts?

    b. Do you consider yourself skilled enough to perform the actions effectively? Can you explain why (or why not)?

19. What is your view on the time that it will take to implement adaptation measures?

    a. Are adaptation measures worth the time the taken to adapt?

20. What is your view about the cost of implementing adaptation measures?
    a. What is your view on the value for money of the adaptation measures?

21. Do you think the adaption measures will reduce the harm to family and property from floods? Can you explain why (or why not)?

Part 4 - Adaptation Intention

22. Tell me about your intention to take precautions to protect you and your family from future flooding?
    a. Tell me what you and your family will do to protect yourself: house, livelihood, food, health/sanitation, safety of belongings, overall safety
    b. Do you think you would take such precautions? Explain Why

THE END

THANK YOU SO MUCH FOR YOUR TIME AND THOUGHTS IN THIS INTERVIEW

INTERVIEW GUIDE – ORGANIZATIONS (LG REPRESENTATIVE)

Thank you for taking the time to participate in this interview.

We want to understand what you think, how floods are affecting various aspects of this city and how you would respond to the floods if you had the capacity so that our communities can become better in future.

In this interview you will see terms like coping and adaptation. Below is what they mean

Coping is about the REACTIVE ACTIONS you perform with short term focus (Hooli, 2016):

(a) to deal with immediate risk when a flood is occurring

(b) to survive the flood

(c) to prevent your property from being destroyed by flooding

Adaptation is about PROACTIVE and LONG TERM FOCUS actions (UNISDR, 2009):

(a) you perform to moderate the harm from flood and related impacts, or

(b) exploiting any opportunities for beneficial outcomes against possible harm from floods and related impacts.

There are no correct or incorrect responses, we just want your personal opinion.

We assure you that any information or opinion you give us will be used purely for academic purposes and will be treated with utmost confidentiality. This interview should take approximately 30 minutes to complete.

Again, thank you for participating

Jerry Chati Tasantab

University of Newcastle

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

QUESTION GUIDE

1. Official title of interviewee
2. Number of years in position
3. Age

4. Gender
5. Can you describe the nature of flood risk in Glefe?
6. How are the residents of Glefe adapting to flood risks?
7. Is the city authorities worried about future flood risk in Glefe?
8. Do you think future floods in Glefe will be severe? If yes, explain. If No, explain

9. Do you think future floods are likely to cause damage to lives and properties in Glefe? If yes, explain. If No, explain
10. Does the severity of past floods in Accra influence your perception about future flood risk?
11. What actions can the city perform to moderate the harm from flood and related impacts?
12. Did you think floods bring beneficial opportunities that can be taken advantage?

13. Does the city have the capability to implement adaptation measures to reduce future flood damages

14. re there any plans in place to reduce Glefe's exposure to damaging future floods?

    - What are measures are you intending to take?

15. When was the sea defense wall in Glefe built?

*********END OF INTERVIEW**********

THANK YOU SO MUCH FOR PARTICIPATING IN THIS INTERVIEW

INTERVIEW GUIDE – ORGANIZATIONS (NADMO)

Thank you for taking the time to participate in this interview.

We want to understand what you think, how floods are affecting various aspects of this city and how you would respond to the floods if you had the capacity so that our communities can become better in future.

In this interview you will see terms like coping and adaptation. Below is what they mean

Coping is about the REACTIVE ACTIONS you perform with short term focus (Hooli, 2016):

(d) to deal with immediate risk when a flood is occurring

(e) to survive the flood

(f) to prevent your property from being destroyed by flooding

Adaptation is about PROACTIVE and LONG TERM FOCUS actions (UNISDR, 2009):

(c) you perform to moderate the harm from flood and related impacts, or

(d) exploiting any opportunities for beneficial outcomes against possible harm from floods and related impacts.

There are no correct or incorrect responses, we just want your personal opinion.

We assure you that any information or opinion you give us will be used purely for academic purposes and will be treated with utmost confidentiality. This interview should take approximately 30 minutes to complete.

Again, thank you for participating

Jerry Chati Tasantab

University of Newcastle

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

QUESTION GUIDE

1. Official title of interviewee:
2. Number of years in position:

3. Age:

4. Gender:

5. Can you describe the nature of flood risk in Accra?

6. How are the residents in the informal settlements adapting to flood risks?

7. Is the city authorities worried about future flood risk?

8. What are your perceptions about the severity of future floods?

9. Your perception about the vulnerability of informal settlements (especially Glefe) to damaging future floods

10. How does past floods in Accra influence your perception about future flood risk?

11. What actions can NADMO perform to moderate the harm from floods and its impacts?

12. Are there any opportunities for beneficial outcomes NADMO can explore from flood risk in Accra?

13. Does NADMO have the capability to implement adaptation measures to reduce future flood damages? Explain your answer.

14. Are there any intentions to take adaptive measures to reduce exposure to future floods (especially in informal settlements). Explain your answer.

    - What are measures are you intending to take?

**********END OF INTERVIEW**********

THANK YOU SO MUCH FOR PARTICIPATING IN THIS INTERVIEW