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INDIGENOUS KNOWLEDGE AND RESILIENCE IN CLIMATE VARIABILITY AND CHANGE: CHEREPONI DISTRICT (GHANA) AND OTI DISTRICT (TOGO)

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DEDICATION

To God Almighty, for the strength, wisdom and encouragement He gave me to finish this course.

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ABSTRACT

The Chereponi district (Northern Ghana) and Oti district (Northern Togo) along River Oti experience similar potential floods. Local people have indigenous knowledge which is very important in climate change adaption. This case study is interested in how the communities could build their resilience using indigenous knowledge. Data collection approaches included household interviews, focus group discussions and field observations. Secondary data were sourced from SRTM imagery and maps of study areas. The data were analysed with SPSS 16 and ArcGIS10.0 used for the maps. Normalized indicators for coping and adaptive capacities using indigenous knowledge were scaled and used in mapping. Both districts had 3 biophysical indicators for flood anticipation. Chereponi district has low resilience score from the standard deviation of the mean value of the indicators while in Oti district has moderate to high resilience score for both absorptive capacity and adaptive capacity. The local knowledge was more relevant in Chereponi district than in Oti district. The indigenous knowledge is limited in crop loss reduction, arrives late and affected by climate change. The good strategies can be transfer from Oti district to Chereponi district to build their resilience. Integration of indigenous knowledge in climate change adaptation is critical for human security.

KEY WORDS

Resilience. Indigenous Knowledge. Adaptive capacity. Absorptive Coping capacity, Ghana, Togo, Indicators.

RESUME

Situé se long du fleuve Oti, les préfectures de Chereponi (nord du Ghana) et de l'Oti (nord du Togo), expériencent des inondations potentielles similaires. Les communautés locales ont une connaissance autochtone qui est très utile pour l'adaptation aux changements climatique. Cette étude de cas s'est intéressée à la manière dont les communautés pourraient renforcer leur résilience en utilisant les connaissances autochtones. Les données primaires ont été obtenues par l'administration de questionnaires, des discussions de groupe et des observations. Les données secondaires proviennent des images de SRTM et les cartes de zones d'étude. Les données ont été analysées avec SPSS 16, et ArcGIS10.0 pour les cartes. Les indicateurs normalisés pour les capacités d'absorption et d'adaptation, utilisant les connaissances autochtone, ont été réduit et utilisé pour la cartographie. Les deux préfectures avaient 3 indicateurs biophysiques pour la prévision des inondations. Le préfecture Chereponi a faible résilience de tandis que dans le préfecture l'Oti a résilience modéré à haute pour la capacité d'absorption et la capacité d'adaptation. Les connaissances autochtone a été plus pertinent dans le préfecture de Chereponi que dans le préfecture l'Oti. . La connaissance autochtone est limité dans la réduction de perte de récolte, arrive en retard et affectee par le changement climatique. Les bonnes strategies a l'Oti peuvent être transferer du Chereponi de construire leur résilience. Intégration des connaissances autochtone dans l'adaptation au changement climatique est essentielle pour la sécurité humaine.

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MOTS CLES

La résilience, la connaissance autochtone, l'Oti, le Chereponi, la capacité d'adaptation, la capacité d'absorption

ABBREVIATIONS/ ACRONYMS

AC: Absorptive Capacity

AD: Adaptive Capacity

CRED: Centre for Research on Epidemiology of Disasters

EM-DAT: Emergency Events Data Base

FGD: Focus Group Discussion

DFID: Department For International Development

HHI: Household Interview

IK: Indigenous Knowledge

IPCC: Intergovernmental Panel on Climate Change

MERF: Ministère de l'Environnement et des Ressources Forestières

NADMO: National Disaster Management Organization of Ghana

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

UNISDR: United Nations International Strategy for Disaster Reduction

UNU-IAS: United Nations University Institute of Advanced Studies

USAID: United States Agency for International Development

1. CHAPTER 1: INTRODUCTION

According to the annual disaster statistical review, hydrological disasters (floods and wet mass movements) made up 48.2% in natural disaster occurrence in 2013 worldwide. They caused 33.2% (32 million victims) of total disaster victims, and were responsible for 46.5% of the total reported number of people killed and 44.9% of total damages (Guha-Sapir et al, 2014, p 22). The number of hydrological disasters which was 159 in 2013 increased slightly compared to 2012 which was 154. The damages in 2013 alone accounted for US$ 53.2 billion which were 90.4% above to their decade's annual average (2013 US$ 27.9 billion), hence increasing costs and vulnerability globally.

Different kinds of floods in Africa constitute one of the most common types of disastrous events that account for the biggest losses inflicted by natural disasters. According to the UN Office for the Coordination of Humanitarian Affairs (OCHA), the year 2010 recorded the largest number of people affected and dying from flooding as compared with previous years. This is consistent with the dramatic rise in flood events recorded around the world, including West African countries.

Literature suggests that flood risks will not subside in the future, and the onset of climate change, flood intensity and frequency will threaten many regions of the world (Sadiq, 2011, p. 85). According to the Intergovernmental Panel on Climate Change (IPCC, 2013), projections indicate an increase in the number of extreme wet rainfall days for 2041–60 under a midline emissions forcing scenario over West Africa and the Sahel. The growing uncertainty concerning global environmental changes calls for the need to look for new ways to increase the capacity of communities and individuals to cope with these changes and making livelihoods more resilient to these threats.

The widespread usage of the word "resilience" to floods in political discourse has left out some important components adopted by IPCC in scientific papers. Equally the resilience to natural hazards in many of the existing papers lacks a comprehensive view on resilience and therefore unable to reveal its multiple dimensions in a climate change context. Therefore, due to the complexity of the concept of resilience, a case study research is best suited to reveal all the dimensions which serve as the background with regards to floods in the context of climate change using indigenous knowledge.

1.1.PROBLEM STATEMENT

Globally river floods affect 21 million people in the world every year, according to the World Resources Institute. In 2030, that number could rise to 54 million, with climate change driving the increase the frequency and intensity of future floods. This will lead to two thirds of the total increase by 2030 in addition to urbanization putting more people in harm's way (Tanvi, 2015)

Additionally, Dankers et al (2013) stated that with climate change, floods are expected to increase the frequency and intensity of rainfall globally. Therefore river floods are likely to occur more frequently in many parts of the world due to the intensification of climate change resulting from heavy rainfalls causing the flood hazard increases at the majority of locations. However, they also noted that not everywhere will experience this, as some areas show a consistent decrease in extreme river flows. The chapter on human security of IPCC (2012) states that there is an increasing incidence and changing intensity of extreme weather events such as floods due to climate change which will lead directly to the risks of increased levels of displacement. In West Africa, floods have significant impacts on the lives and livelihood of the people. However, the people along the rivers are not willing to move because of the cultural linkages to the place posing a challenge for human security experts whose major concern is to save.

At a country level, Ghana and Togo have been experiencing vulnerability from floods. The floods of 2007 that swept through Upper West, Upper East and Northern Regions affected 307,127 persons with some deaths recorded in the three regions (31 in Upper East; 10 in Upper West) [1]. According to Disaster Relief Emergency Fund Report (DREF, 2013), the rainstorms in March 2013 affected 16 districts (out of 20 districts), in the Northern Region alone with five people dead.

Togo, a country with a population of over 6 million people has recorded 60 urban and rural floods that caused damages and casualties from 1925 to1992 (MERF, 2013, p. 13). Flood disasters, a frequently recurring problem that occurs mainly between July and October inflict significant environmental, social, and economic damages and affects population safety. According to the Emergency Events Database of the Centre for Research on the

[1] Webpage of National Disaster Management Organization of Ghana (NADMO), 2007

Epidemiology (CRED), Togo has experienced flooding almost every year during the last 20 years. However, floods have been particularly devastating over the past few years especially in 2007, 2008 and 2010, with 127,880 people (about 2% of the population) affected and 23 casualties in 2007 floods alone. The 2010 flooding affected 83,000 people who constituted about 1.38% of the entire population, 21 persons were reported to have lost their lives and 85 were injured, 12,382 houses have been impacted, 774,424 hectares of land have been destroyed resulting in over US$38 million in damages and losses (Global Facility for Disaster Reduction and Recovery GFDRR, 2013).

Indigenous knowledge (IK) has been emphasised as a source of resilience in both theory and practice, as it is built upon learning from past experiences of natural hazards (Hiwasaki et al, 2014, Hooli, 2015). The wealth of local knowledge based on predicting weather and climate can add value to the development of sustainable climate change adaptation strategies and policies. These strategies and policies are rich in local content, cost-effective, participatory, and sustainable and planned in conjunction with local people (Nyong et. al 2007)

There is a gap in the current understanding in how people who experience river flooding use indigenous knowledge to anticipate, cope and recover from the flood and how they deploy indigenous knowledge to handle flood events in other words how do they prepared for it, bounce back after flooding and adapt and learn. This research attempts to bridge the gap between the potential of indigenous knowledge for resilience building towards floods in West Africa and existing climate change adaptation strategies and existing disaster risk reduction strategies. Most research on river flooding did not look at and compare how villages that share the same river and experience potentially similar flooding are building resilience to the floods. Also, studies that measure the effectiveness of the indigenous knowledge in resilience building to floods are yet to be done.

1.2. STUDY OBJECTIVE

The overall objective of this thesis is to assess how the communities considered in this paper could build their resilience, using indigenous knowledge.

Specific Objectives

The specific objectives are to:

1. Identify biophysical indicators that communities use to anticipate or predict the floods.
2. Find out how the communities cope, recover, adapt and learn using indigenous knowledge.
3. Identify the effectiveness and limits of indigenous knowledge in resilience building.

1.3.RELEVANT QUESTIONS OF THE STUDY

In an attempt to elucidate the value of indigenous knowledge in flood management and resilience building which is important for climate change research, the proposed research will seek to answer some questions that will serve as guidance below:

1. What are the biophysical indicators that communities use to anticipate or predict the floods?
2. How are the communities' coping, recovering, adapting and learning using indigenous knowledge?
3. What is the effectiveness and limits of indigenous knowledge in resilience building?

1.4.ORGANIZATION OF THE STUDY

The thesis is structured around 5 chapters as follows; Chapter One states the problem, objectives, significance of the study and the scope of the study. Chapter two is a review of related literature on resilience, indigenous knowledge and identify gaps in literature. Chapter three presents material and methods and provides an overview of the study area, the research methodology and data collection process. Chapter four presents results and discusses the empirical findings on the capacities of the communities to anticipate, predict buffer or bounce back reorganize and learn based on the indigenous knowledge. Chapter five is the conclusion and policy recommendation.

2. CHAPTER TWO: LITERATURE REVIEW

2.1. DEFINITIONS

Resilience originated within ecology and was used to address persistence and change in ecosystems. It was subsequently expanded to address socio-ecological system (SES) and ultimately penetrated the natural hazards communities of the social sciences (Turner II, 2010). Applied to SES, Resilience has at least three meanings: (i) response to disturbance; (ii) capacity to self-organize; and (iii) capacity to learn and adapt (Folke et al. (2002a, b). The Resilience Alliance defines it as the capacity of a system to absorb disturbance and reorganize while undergoing change. Resilience is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures (UN/ISDR, 2009). The Inter-governmental Panel on Climate Change IPCC WG2 (2007b) defines resilience as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change (IPCC WG2 2007b). The current definition of resilience has some new additions. In 2012, IPCC in its Summary for Policymakers defined resilience as "the ability of a system to anticipate, absorb, cope with and recover from a hazard and maintain its essential functions, structure and interactions". This definition has been built upon to include the capacity to learn and innovate which brings about change.

Indigenous knowledge (IK) is the local knowledge that is unique to a given culture or society. Indigenous knowledge contrasts with the international knowledge system generated by universities, research institutions and private firms, and as Warren (1991) stated, it serves as the basis for local-level decision making in agriculture, health care, food preparation, education, natural resource management, and a host of other activities in rural communities.

2.2. REVIEW OF CONCEPTS ON RESILIENCE, INDIGENOUS KNOWLEDGE, AND OTHER RELATED CONCEPTS

2.2.1. Resilience as a concept

More than the ability to maintain or return to a previous state, resilience is about adapting and learning to live with changes and uncertainty. This is a more recent definition of resilience. It involves three types of capacities, namely absorptive capacity, adaptive capacity and transformative capacity as illustrated in figure 2.1 below (Béné et al, 2013). The classical definition of resilience stated above and have been further developed and transformative capacity goes beyond this definition. However, this research is focussed on the capacity to anticipate, buffer/bounce back, reorganize, learn and adapt.

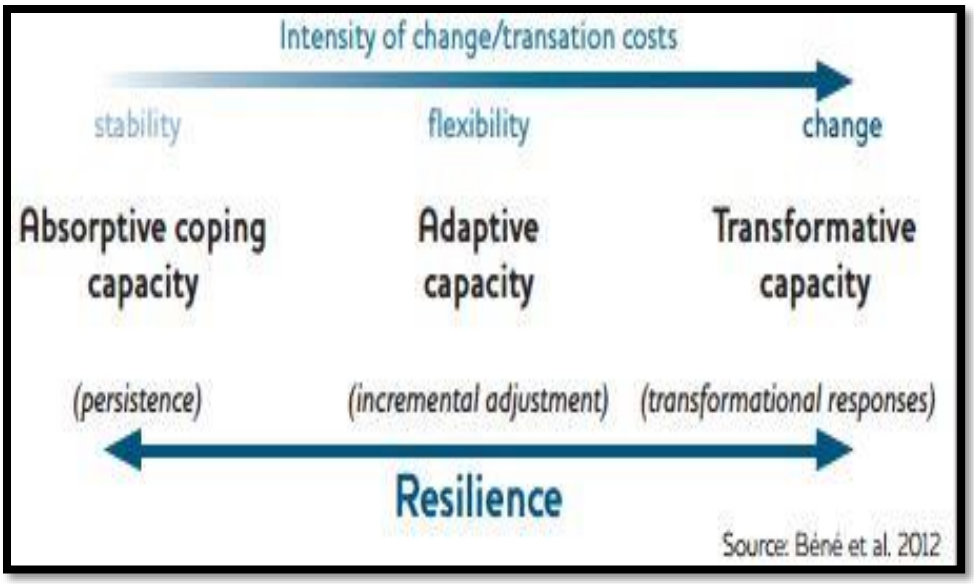

Figure 2.1 Three capacities in resilience

Source: Béné C., Godfrey-Wood R., Newsham A., and Davies M. 2012.

Absorptive coping capacity is the ability of a system to prepare for, mitigate or prevent the impacts of negative events, using predetermined coping responses in order to preserve and restore essential basic structures and functions (Béné et al., 2012). Adaptive capacity is the ability of a system to adjust, modify or change its characteristics and actions to moderate potential, future damage and to take advantage of opportunities, all in order to continue functioning without major qualitative changes in function or structural identity (Inter-governmental Panel on Climate Change, 2012; Béné et al., 2012). Transformative capacity is the ability to create a fundamentally new system when ecological, economic or social structures make the existing system untenable (Walker et al., 2004). It must be noted that the transformative capacity goes beyond the scope of this research. Transformation is really comprehensive and goes beyond learning and adaptation.

Resilience literature also focuses on institutions, social capital, leadership, learning and how to manage and govern the SES in a sustainable way. In this way, it does not end at identifying the degree of resilience but is usually very much targeted towards managing resilience and eventually transformation (Kloos et. al, 2015). Resilience is a multi-faceted concept adaptable to various uses and contexts (in the social, technical, physical and psychological fields), but in different ways as shown in figure 2.2 below. It cuts across fields of climate change adaptation, disaster risk reduction, sustainability science and other hazards and risks. As a concept, resilience shows promise in that it encourages the researcher to bridge the "shear zone" between adaptation which is dynamic and resistance which is static (Alexander, 2013).

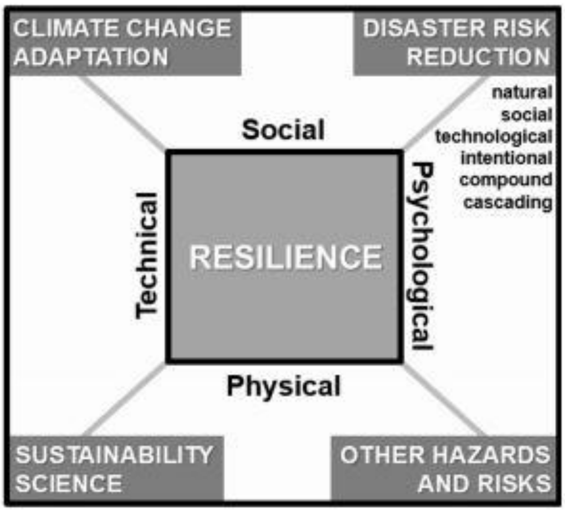

Figure 2.2 Summary of the position of resilience studies in the sciences

Source: Alexander (2013)

Dixon et al (2014) linked resilience and vulnerability concepts through adaptive capacity and coping capacity with the concepts from adaptation literature though the concept of transformation is also included in the definition as shown in figure 2.3 below.

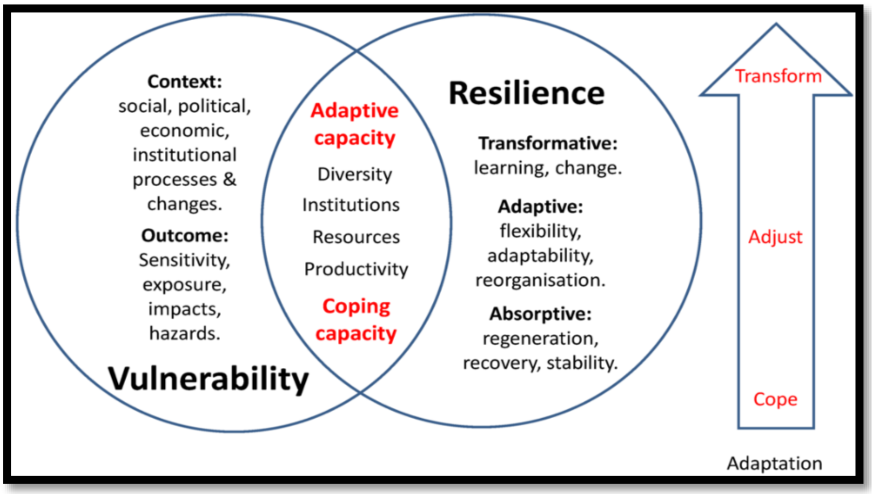

Figure 2.3 : Interception of concept of resilience and vulnerability

Source: Dixon et. al (2014)

Alexander (2013) asserted that the concept has acquired a degree of common orthodoxy in social studies which may be a good thing if it promotes cross-disciplinary work between the natural and social sciences, and management studies. On the other hand, some may argue that there is a strong element of "new wine in old bottles", and merely adding a new term did not change the ability to understand and tackle problems connected with poverty, vulnerability, marginalisation and the riskiness of life. One person's resilience may be another's vulnerability, and one would not want the concept to be used as a means of reinforcing unethical practices or hegemonies

There are generally three (3) ways to measuring resilience, namely the amount of change a system can undergo and still maintain the same controls on structure and function; **degree to which the system is capable of self-organization**; and the ability to build and increase the capacity for learning and adaptation (Folke et al. 2010). However, indicators have been drawn to measure it.

2.2.2. The Characteristics of Indigenous Knowledge

Nakashima and Roué (2002) asserted that indigenous knowledge is characterized by knowledge that are location specific, acquired through long-term observation and transferred through oral traditions from one generation to the next. According to Ifejika-Speranza et al (2010), indigenous knowledge is time, place and culture specific, they equally hold that indigenous knowledge is not general knowledge but is related to the length of time a person has been living in an area, direct experience and the socio-cultural embedment of the persons. Indigenous information systems are dynamic, and are continually influenced by internal creativity and experimentation as well as by contact with external systems.

2.2.3. Indigenous Knowledge and Risk Reduction in Disasters

Arguments for the inclusion of local and indigenous knowledge in disaster risk reduction policies are based on the reasoning that indigenous knowledge can be transferred and adapted to other communities in similar situations (Shaw et al., 2008; Mavhura et al, 2013). The incorporation of indigenous knowledge encourages community participation, empowers communities in reducing disaster risk, provides invaluable information about the local context and serves as a model for education about disaster risk reduction (Shaw et al., 2008; Mavhura et al, 2013). Nyong et. al, (2007) emphasised that indigenous knowledge adds value to climate change studies by identifying a person within a cultural context.

Indigenous knowledge systems are an indispensable component of disaster resilience building. These systems played a significant role in reducing the impact of floods in Muzarabani district in Zimbabwe, though the extent to which indigenous knowledge enhanced resilience to floods was influenced by geophysical locations, exposure to flooding and socio-economic abilities (Mavhura et al, 2013). The IPCC chapter twelve on human security argues indigenous, local and traditional forms of knowledge as a major resource for adapting to climate change. Researchers agree that involving local people and their indigenous forms of knowledge in decision-making is critical for ensuring human security (Nakashima and Roué, 2002).

2.3. INDIGENOUS KNOWLEDGE AS CLIMATE INDICATORS IN GHANA AND TOGO.

In 2014, a national project on risk reduction of catastrophes and adaptation to climate change by the joint cooperation of Togo Red Cross and Germany Red Cross has been able to document local climate indicators that are used to predict rainfall and drought (Togo Red Cross, 2014). Documentation included different types of birds, the croak of frogs, snails, snakes, ants and certain species of plants, among others. However, the indicators collected have not been proven with scientific knowledge and climate data to confirm it. With regards to the perception of the local people to climate change in Ghana, Gyampoh and Asante (2011) stated that the local people in the Northern Ghana provided evidence to support their claim for each climatic observation as well as early, short term and long term responses to these changes. However, some of the useful indicators that used to and continue to help the people know changes in their environment and adapt their livelihoods accordingly are threatened with extinction due to the enormous changes in the environment. Habitats of plants, animals, birds and insects which have played significant roles as climatic indicators are being lost or modified, resulting in most of these indicators either migrating or dying.

2.4. KNOWLEDGE GAPS: IMPACTS OF INDIGENOUS KNOWLEDGE IN CLIMATE CHANGE STUDIES

2.4.1. Anticipating hazards/Preparedness

UNEP Environmental Emergencies News (2007) stated that the Banyala community in Kenya used their indigenous knowledge to anticipate and prepare for flood by the Lake Victoria. They had elders who were experts in rainfall prediction and early warning. They also used biophysical indicators such as the laying of crocodile eggs on river banks at higher ground as an anticipatory sign of impending floods. With regards to preparedness in times of foods, those who lived on the highlands were expected to accommodate neighbours displaced by the floods in the lowlands because of the high social capita in the society. Also, each homestead had a dugout canoe ready for transport in case of heavy flooding and the communities fished during the April-August rainy period when fish was plentiful (UNEP, 2007). This help the communities to better prepare for the floods.

The same report continued that as biophysical indicators, the height of the nests of the emahlokohloko bird (*Ploceus spp*.) on trees was used in Swaziland. When they were very high up on the trees by river banks, it was a sign to predict floods. The Swazis also used the noise of certain birds to predict rain, and yields of certain wild fruit plants to predict famine. Other indigenous methods used by the Swazis to predict natural hazards include wind direction, the shape of the crescent moon and the behaviour of certain animals (UNEP, 2007).

From the publication by Togo Red Cross, Mango fomboro also used the snail as a biophysical indicator to predict the occurrence of a flood in Northern Togo. However, the level of preparedness of the study areas using the indigenous knowledge is yet to be identified. The way the indigenous people use their available knowledge to prepare for the floods remains problematic here, whether they see these signs and therefore take corresponding actions is questionable.

2.4.2. Coping/buffer/reorganization

Kangalawe et. al, (2011) stated that in Great Ruaha River Catchment Area, the Riparian communities had devised coping strategies such as the practice of irrigation to provide supplementary water to crops, using drought tolerant crop varieties, rationing of irrigation water in farmlands, wetland cultivation, and diversification to non-agricultural activities. However, despite the existence of many indicators used for local climate forecasting, there were limitations to local adaptation, poverty, institutional aspects and limited integration of climate adaptation in various sectors.

McNamara and Prasad (2013) explored how three communities in Fiji and three communities in Vanuatu have adapted to flooding by building their houses on stilts about 20cm above ground level. Any new houses were built on higher grounds, to avoid the risk of flooding. At a household level, families have relocated their gardens further inland, and invested in more tanks to collect rainwater for drinking and cooking. During the rainy season, locals grow bananas, water taro, cassava, *kumala* and a variety of yams in their gardens located on higher grounds. They then dug nearby channels to minimise the damage of floodwaters to their crops. The community also assisted those affected by moving their household items to higher ground, rebuilt damaged houses and replanted gardens. Gyampoh et. al, (2007) noted that farmers in the Offin River Basin in Ghana were adapting to changing climate by planting different crops in areas that previously did not support their cultivation. An example was the shift from cocoa cultivation to drought-resistant crops such as cassava. Fabiyi and Oloukoi (2013) noted that the high social capital in some selected coastal rural communities in Nigeria who had put in place coping mechanisms through mutual support, reducing the effects of losses to flood through cooperative society, religious organizations and age grade groups. The assistance given to flood victims include loan, outright grant, temporary accommodation, food items in the events when flood ravages the farmland of flood victims.

However, there is a gap in knowledge about how the communities along the river Oti are able to cushion change, maintain or increase assets and use opportunities to achieve better livelihood outcomes such as poverty reduction.

2.4.3. Learning/experimentation and adaptation.

Learning is an important precondition for building resilience and may enable actors to respond accurately to social-ecological feedback (Armitage et al., 2008). From the UNU-IAS Policy Report (2013), communities strengthened resilience by experimenting, innovating, and learning within and between different knowledge systems, cultures, and age groups, though many communities were losing their knowledge of local resources, biodiversity and the historical events that have shaped the landscape which could be lessened when elders, parents and the younger generations in a community document and share it. The role of young people in valuing traditional knowledge and assimilating it with the new knowledge acquired in urban centres and schools was crucial, but often underestimated (Bergamini et. al, 2013).

Under adaptation, Fabiyi and Oloukoi (2013) found out that the coastal rural communities in Nigeria have adapted their building materials and building style to withstand the regular devastating flood disaster in the communities. It was noted that the communities took a cue from natural features in the areas to construct their buildings. The river birds and mangroves provided insight to the people in the communities for building on piles and raft foundation (Fabiyi and Oloukoi, 2013)

The impacts of indigenous knowledge in climate change studies (adaptation techniques) have been well documented by Ifejike- Sperenza et. al (2010) who demonstrated the richness of indigenous knowledge and the diversity of indigenous knowledge-based indicators for monitoring climate variability and change in East Africa. Ifejike-Sperenza et al (2010) asserted that custodians of the indigenous knowledge were gradually dying out and it is imperative to document all which can be used in climate monitoring and assessment.

The paucity of data in this area of research (though currently there is more emphasis on resilience building calls) for the need to know what the people are doing on their own and whether those practices are good enough to be adaptation strategies. This research seeks to separate indigenous knowledge resilience strategies from strategies that extension officers or humanitarian agencies bring by looking at how long that knowledge has been in existence. This research seeks to fill the gaps in opportunities in resilience building for the proposed study areas. It seeks to qualitatively find the role that indigenous knowledge plays regarding the three key components of resilience, namely, how indigenous knowledge helps the community to **anticipate, buffer/bounce back, reorganize, learn and adapt**. The choice of the proposed study areas is based on the effect of flooding by the same river and this comparative analysis can help to know the good practices in each region and inputs from one community can be replicated or passed to other communities and countries.

2.5 CONCEPTUAL FRAMEWORKS FOR RESILIENCE

The Department for International Development, DFID resilience framework is one of the frameworks used in measuring resilience as shown in figure 2.4 below. There are four elements in this resilience framework namely the context, disturbance, capacity to respond and finally the reaction to disturbance. Together these elements form a resilience framework used to examine the level of resilience that exists. The exposure, sensitivity and capacity subcomponents all fall under the capacity to respond. Disturbances are either shocks (floods, high winds, landslides, droughts or earthquakes) or stress. Sensitivity is the degree to which a system will be affected by, or respond to, a given shock or stress. Determining levels of resilience is an important part of understanding the concept. However, the challenge to this framework is that it is limited to only adaptive capacity while there are currently three different types of capacities under resilience.

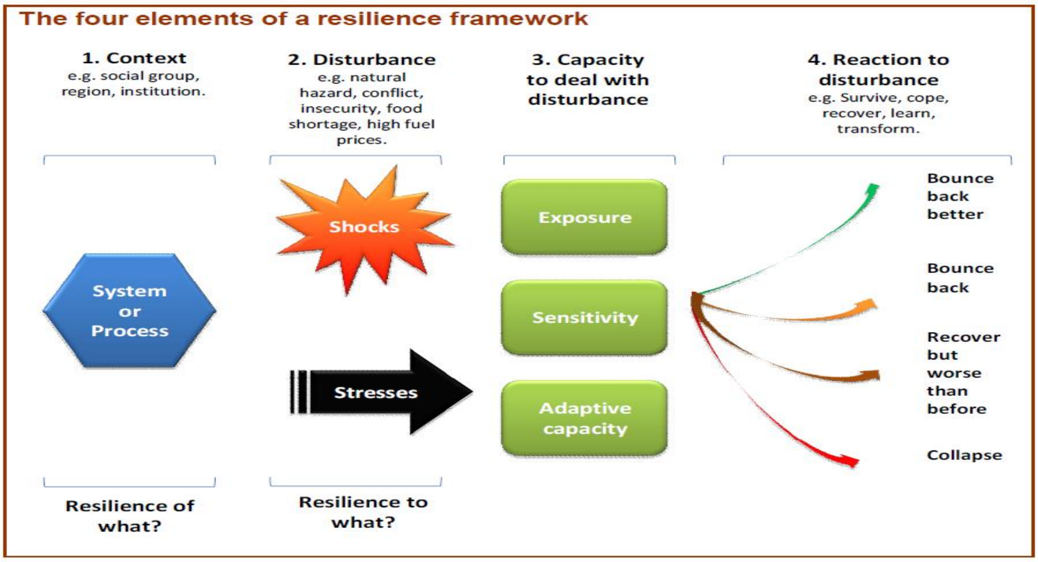

Figure 2.4: Conceptual framework on Disaster Resilience

Source: DFID Disaster Resilience Framework (2011)

The second framework was developed by Ifejeka- Sperenza (2012) to measure farmers' livelihood resilience. There are 3 general features of resilience clearly stated; **buffer capacity**, **self-organization** and **capacity for learning** as indicated in figure 2.5 below. It helps the researcher to measure these capacity straight away. Indicators for the 3 features were also developed in the context of farmers resilience. However, the context of the system of process is not included as well as the type of shock or stresses. Furthermore, the degree of exposure and sensitivity of the SES to the shock or stress are not used in this framework.

Figure 2.5: Conceptual framework showing main features of resilience updated from Ifejeke-Sperenza.

Source: Ifejeke- Sperenza et. al (2012).

Another analytical framework as shown in figure 2.6 below is from the expert consultation on resilience measurement for food security which is the proposed measures for estimating food security resilience consisting of four set of indicators for a) baseline well-being and basic conditions, b) disturbances, c) response, and d) end-line well-being. It also does not give the context, the shock or stress. However, the three capacities under resilience have been highlighted well (Frankenberger and Nelson, 2013).

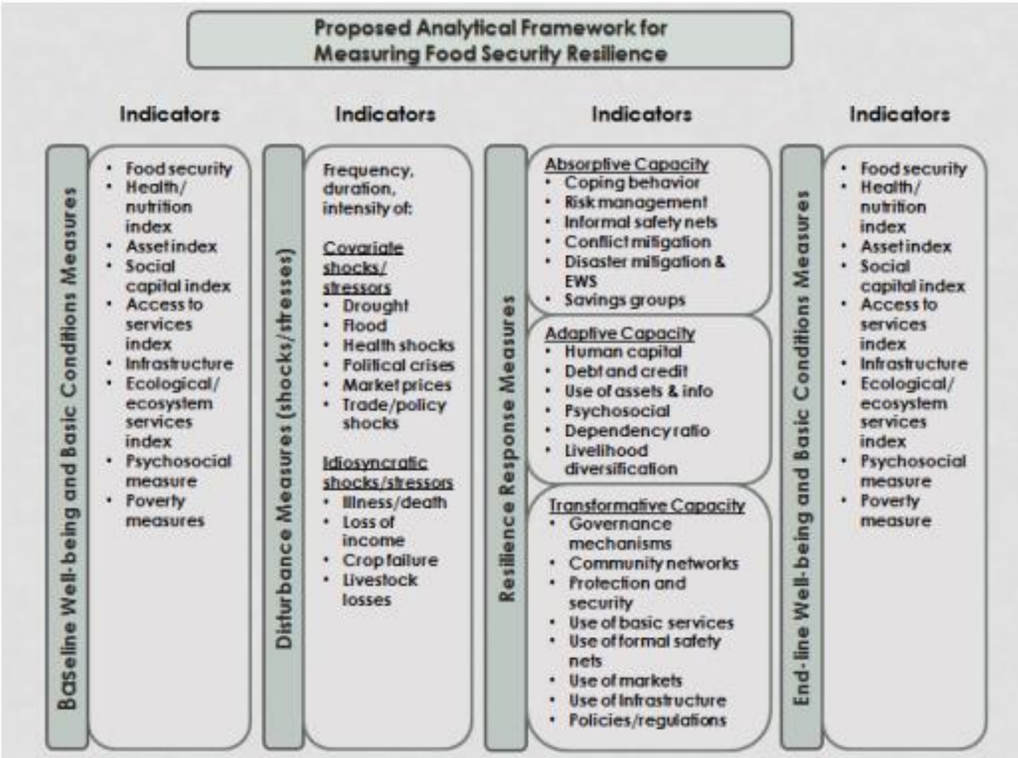

Figure 2.6: Analytical framework for measuring food resilience.

Source: Frankenberger and Nelson (2013).

2.6 INDICATORS SELECTION

The indicators were developed bearing into mind the DFID conceptual framework. The main focus of this research is on the capacity subcomponents of the framework. The indicators for resilience incorporates the capacity to anticipate, capacity to cope, capacity to adapt and capacity to recover from the flood. The indicators are selected based the existing literature and personal judgement shown in table 2.1 below.

Table 2.1: Set of indicators developed from figures 2.1 and 3.1.

Component	Sub component	Indicator name	Justification	Scale	Source	References
Exposure		Agriculture dependent population	High ADP means a higher percentage of people are exposed to a climate sensitive sector.	Local	HHI	Asare-Kyei et al (2015).
Exposure		Flood frequency	The higher the number of flood events, the more exposed the population.	Local	HHI	Balica (2007).
Exposure		Flood duration	The higher the flood duration, the more exposed they are to crop failure and diseases.	Local	HHI	Balica (2007).
Sensitivity	Ecological Sensitivity	Crop type	The higher the diversity of crops, the lower the crop failure and loss due to floods.	Local	HHI FGD	Asare-Kyei et al (2015).
	Sociological sensitivity	Gender (women)	A higher % of women increases the sensitivity of the system,	Local	HHI	Muller et al. (2011).
Absorptive	Capacity to anticipate	Number of useful local indicators	The higher the number of the indicator, the more they can predict the flood.	Local	FGD	Researcher of study (2015).
		Alternate food and sources of income apart from agriculture	Inhabitants with additional food and income sources cope better with disasters.	Local	HHI FGD	Hahn et al (2009) Asare-Kyei et al (2015)

capacity		Early maturing seeds	Farmers with early maturing seeds can plant and harvest early before flood.	Local	HHI FGD	Researcher of study (2015)
	Capacity to buffer	Access to emergency funds and relief items	Funds and reliefs from emergency committees are important to cope and recover after flood.	Local	HHI, FGD	Bollin, and Hidajat (2006)
		Presence of emergency management committee	Household's ability to cope with disasters is determined by the effectiveness of the local disaster management committees.	Local	FGD	Bollin, and Hidajat (2006)
		Early warning and action taken from local knowledge	The existence of early warning system from indigenous knowledge increases resilience.	Local	FGD	Balica (2012)
		Migration rate	Potential to reduce casualties and exposure to the effect to the flood	Local	HHI, FGD	Researcher of study (2015)
	Capacity to recover	Recovery time to flood (rebuild houses).	The longer it takes people to rebuild, the more time they spend in resettlements	Local	HHI	Hooli (2015)
	Capacity to adapt	Long term residents	The higher the %, the more adapted they may be to the hazard.	Local	HHI, FGD	Fekete et. al(2010)
		% of livestock accumulation	Essential for revenue access during crises.	Local	HHI, FGD	Asare-Kyei (2015)

Adaptive capacity	Capacity to Self-organize	community participation/social capital	Community members can be mobilized in times of crisis to help each other and increase resilience.	Local	FGD ,observation	Mecher (2005) Asare-Kyei et al (2015)
		Community access to canoes	Access to canoes in times of flood is essential so that people can easily move to safe places	Local	FGD	Researcher of study (2015)
	Capacity to learn	Safe places in other villages	People can move to other places when the village are flooded.	Local	FGD	Researcher of study (2015)
		Indigenous knowledge Transfer	The greater the degree of transfer, the higher the opportunity to build resilience.	Local	FGD	Ifejeka- Sperenza et al, (2012)
		Documentation of indigenous Knowledge.	Traditional knowledge documents can preserve knowledge between generations.	Local	HHI, FGD	Bergamini et. al (2013)

3. CHAPTER THREE: MATERIALS AND METHODS

3.1.STUDY AREAS

The Chereponi district shares boundaries with the following districts; Gushiegu district to the West; Bunkpurugu-Yunyoo district to the North, and Saboba district to the south and the Republic of Togo to the East bordered by the river Oti with a total land area of approximately 1,080 sq. km. the study areas for the research in the Chereponi district (Ghana) are Bukasu fishing camp, Nandungbani fishing camp and Kpani fishing camp in Map 1a below; and Mango Fomboro and Fiegou located in the Oti district (Togo) in Map 1b.

3.1.1. Climate of the Chereponi District

It is located between latitudes 10 ° 10 ^{1}S and 10°N eastwards and longitude 10° 10^{1} N and 10° 20^{1} S northwards and located in the savannah ecological zone. The climate is characterized by wet and dry seasons of equal lengths of six months. The annual rainfall ranges about 1000mm more or less, falling between May and October. A long dry period follows the end of the rains from November to April. The temperature, which is generally high throughout the year, ranges between 21° C and 41° C. [2] The vegetation in the district is the guinea savannah type which is mostly grass interspersed with drought resistant trees. The common tree species are the *Parkia biglobosa* locally called "dawadawa" and the shea trees. The vegetation is greenish only in the rainy season and very dry in the harmattan period. Agriculture is the mainstay of the people. About 40 percent of the land area is used for agricultural purposes. However, a greater portion is left uncultivated and farming is mostly done on subsistence basis with small farm holdings which average about two acres. Farmers cultivate large areas of maize, yam and rice for commercial purposes. The district is known for its production of soya beans.[3]

3.1.2. Climate of Oti district (Togo)

The climate is characterized by a dry season from mid-October to mid-May with the trade winds (November to February) and a rainy season from mid-May to mid-October. It rains about 800 to 1200 mm per year in the district of Oti. Much of the rain falls during the months of July and August causing floods in the district (Dzogbedo, 2012). The average temperature is 26 ° C in the rainy season and 30 ° C in dry periods.

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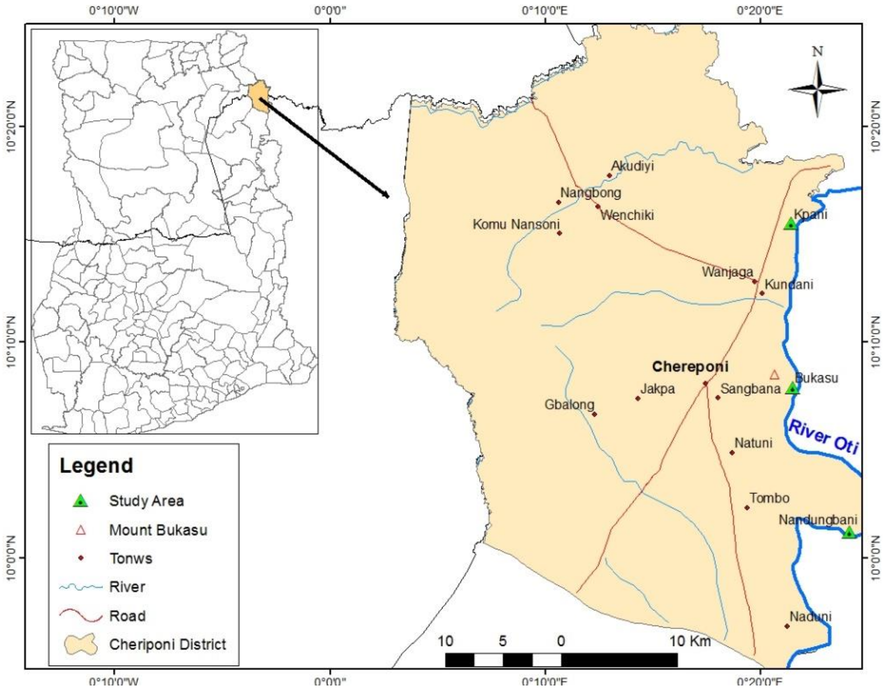
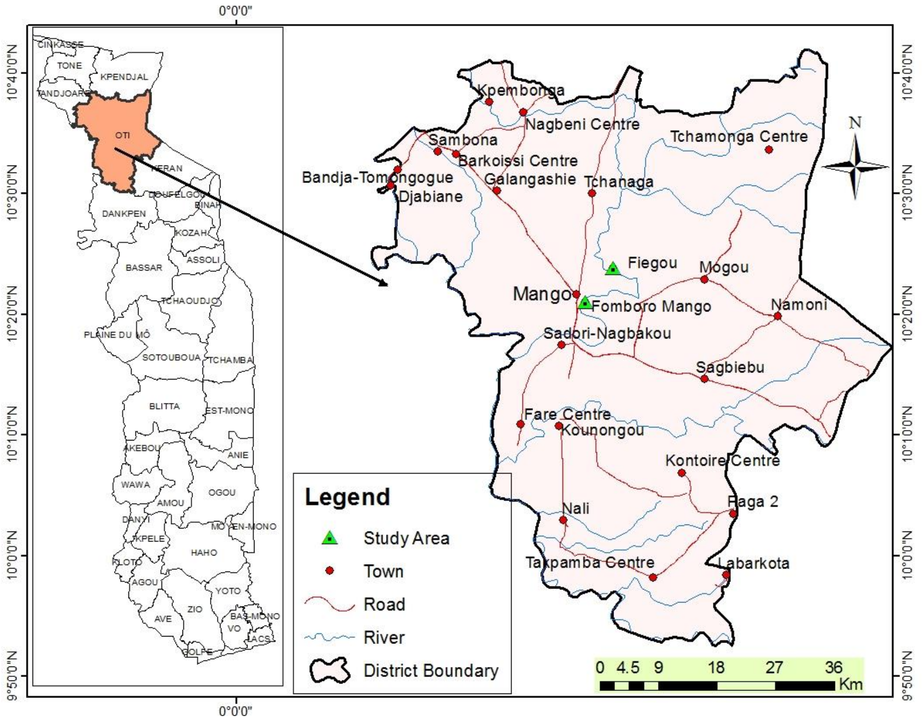
[2] Website of Chereponi District. http://chereponi.ghanadistricts.gov.gh/districtinfo.php
[3] Website of Chereponi District. http://chereponi.ghanadistricts.gov.gh/districtinfo.php

In harmattan period, the temperature range is higher than the annual average 18 ° C against 13 ° C. It's the hottest district in the region (Dzogbedo, 2012).

The vegetation is basically Sudanian savannah woodland, consisting of short deciduous trees widely spaced and ground flora, prone to be burnt by fire or scorched by the sun during the long dry season (Dzogbedo, 2012).



Map 1a: Map of the study area in Chereponi district (Northern Ghana)



Map 1b: Map of the study areas in the Oti district, Northern Togo

3.1.3. Water bodies in the Oti district that affect river Oti

The river Oti flows through the Oti district from where it takes its name. As one of the big rivers in Togo, the Oti takes its source from the Atakora in the Republic of Bénin in the north at Natitingou which is 500 m by altitude under the name Kpendjari. It cuts across the plains in Mango and forms the border between Togo and Ghana and empties itself in the Volta in the south of Kétékratchi. Its principal tributaries are Ouké, Sansargou, Namiélé and Koukombou. In Ghana, one of its eastern tributaries is the Kara River. The basin receives an average water depth of 1,250 m^2 per year and is subject to a tropical regime with a rainy season, flood peak lying in August-September (Dzogbedo, 2012).

3.2. CONCEPTUAL FRAMEWORK

The selected conceptual framework for this study is the DFID resilience framework. The "context" is study areas which are the farming and fishing communities along the river Oti in the two countries, and the type "disturbance" is flood event by the same river. In order to capture the various degrees of resilience starting from the absorptive coping capacity and the adaptive capacity. transformative capacity was not included because one needs enough time to first of all know the first state of the system at first (how it was before the hazard) before one can measure the change that it has undergone. This research doesn't provide enough time to adequately study the transformative capacity. However, the capacity to deal has been modified to correctly capture the absorptive coping capacity and the adaptive capacity in illustrated in figure 3.1 below was not in the original framework. Also, one pathway was drawn and that is using the indigenous knowledge pathway.

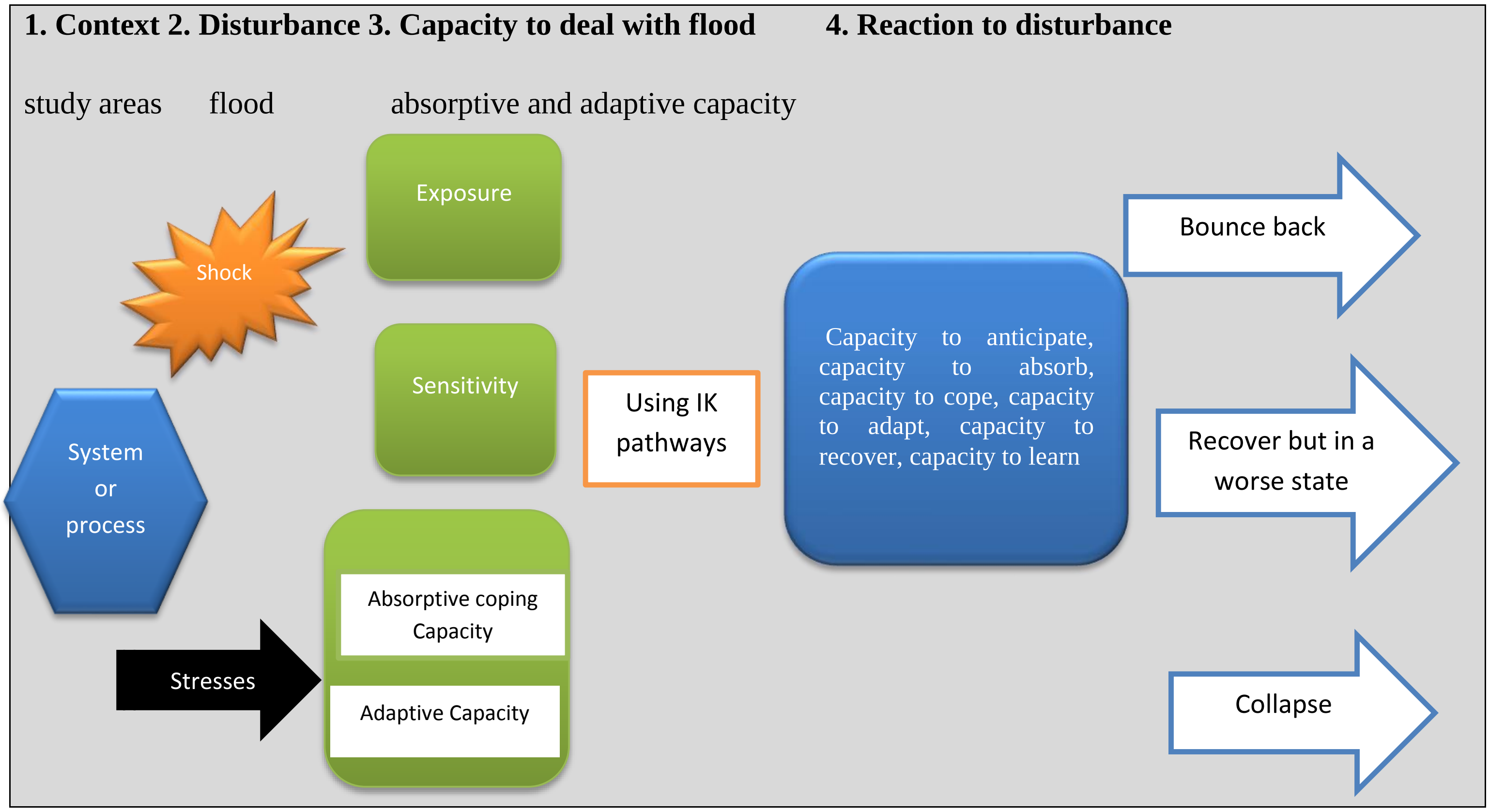


Figure 3.1: Conceptual framework for study.

Source: Adapted from DFID Disaster Resilience Framework (2011) with inputs of capacities from Béné et al., al (2013) and IPCC definition of resilience.

15 indicators were chosen. According to the resilience framework selected, 8 of these indicators were absorptive capacities and 7 were adaptive capacities (see Table 3.1 below). However, it was the capacities on absorptive and adaptive capacities that were used in the project.

Table 3.1 Selected indicators and their functional relationship with resilience

Component	Abbreviation	Sub component	Indicator name	Relation
Absorptive capacity	AC 1	Capacity to anticipate	Number of useful biophysical indicators	+
	AC 2	Capacity to buffer	Local early maturing seeds	+
	AC 3		Alternate food and income sources	+
	AC 4		access to emergency funds and relief items	

	AC 5		Presence of emergency management committee	+
	AC 6	Capacity to recover	Early warning and action	+
	AC 7		Recovery time after flood	+
	AC 8		Migration rate	+
Adaptive capacity	AD 1	Capacity to adapt	Long term residents	+
	AD 2		% of livestock accumulation	+
	AD 3	Capacity to Self-organize	Community participation/social capital	+
	AD 4		Access to canoes	+
	AD 5	Capacity to learn	Safe places in other villages	+
	AD 6		Ability to transfer knowledge	+
	AD 7		Practices of documentation of local Knowledge	+

Table 3.2 gives a logical framework of the sources of data to achieve the set objectives of this research.

Table 3.2: Logical framework to achieve study objectives

Objective of research	**Data sources**
1. Identify biophysical indicators that communities use to anticipate or predict the floods.	Focus group with old men Focus group with women Togo Red Cross book on local climate indicators
2. Find out how the communities cope, recover, adapt and learn using indigenous knowledge.	Questionnaire Focus group with old men in the villages Focus group with women
3. Identify the effectiveness and limits of indigenous knowledge in resilience building.	Questionnaire Focus group with old men in the villages Focus group with women

3.3. STUDY POPULATION AND SAMPLING

This research employed a purposeful selective sampling and area sampling techniques. The Chereponi district and Oti district were deliberately selected because of reported cases of flooding by the river Oti in these areas in Ghana and Togo, respectively. Area sampling was used in identifying flood-prone communities from where data were gathered with the help of volunteers from the Togo Red Cross for Togo. According to NADMO in the Chereponi district, 9 villages located by this river experienced flooding by the river Oti. Bukasu fishing camp, Nandungbani fishing camp and Kpani fishing camp were purposefully chosen because of their proximity to the river Oti and the floods that they had experience from the river. Fishermen who migrated from the Addidome in the Volta region in Ghana primarily occupy the areas along the river Oti in the Chereponi district. Farming and petty commerce are secondary activities in these areas.

Sampling procedure in study areas

The population of the study areas and the sample is shown in table 3.3 below. The three key qualitative data collection approaches for this study included household interviews, focus group discussions (FGDs) (for the older men and women) and field observations as shown in photo 1. The focus group with the older men was because they were seen as the custodians of indigenous knowledge in the villages while the older women were also agents of transferring indigenous knowledge to the younger generation. The research material were collected in June and September 2015. Six focus group meetings and 50 household interviews were conducted in three villages in the Chererponi district of Ghana. 90 household interviews and six focus group meetings comprising of two youth focus group meetings were conducted in the Oti district of Togo. The interviewees were at least between 30 to 40 years old. The household survey was done door to door using both random sampling procedures and open- and close-ended questions. The focus group meetings followed a similar semi-structured agenda in different locations.

Photo 1: focus group with women (left). Interview with older men (right)

Table 3.3 Population structure of the study area

Area of study	**Places affected**	**Population**	**Sample of people**
Chereponi district, Ghana	Bukasu fishing camp	177	20
	Nandungbani	333	15
	Kpani	238	15
Oti district, Togo	Mango Fomboro	1,900	52
	Fiegou	2,272	38

Source: Chereponi district health directorate, field survey, 2015

Pretesting of questionnaire: the questionnaire from the sample was pretested in Mango Fomboro for ground truthing and fine tuning.

3.2.1. Spatial analysis and mapping

Available maps of the Chereponi district and the Oti district were digitised, using ArcGIS 10.0. Features on the digitised map (boundary, roads, villages and location of rivers) were vectorised and combined with GPS co-ordinates to the final image.

To identify the areas lying in low elevation, Shuttle Radar Topographic Mission (SRTM) data for the study areas were colour-ramped to get the digital elevation models along with the boundary maps of the areas and the GPS coordinates.

Geographic Information System (GIS –ArcGIS 10.0) was used to identify spatial dimensions of the study areas and their nearness to the River. Maps were drawn to show some aspects of topography and elevation and the areas that were in low elevation areas. The final image was overlaid with the hill shade effect that gave a 3 D perspective of the image.

Microsoft excel and were used for the pie charts and bar charts.

3.4. DATA ANALYSIS

3.4.1. Statistical analysis

The questionnaires (see Appendix 4) which contained information on farmers' socio-economic data, flood exposure, sensitivity and capacities data for coping, adaptation and transformation were analysed. Frequency distribution, percentages and descriptive statistics were obtained through SPSS Version16. Trend analysis was done for the available rainfall data using the Mann-Kendall tests to show the significance level of the trend and the nature of it.

3.4.2. Normalization and weighting of indicators

The methodology used in UNDP's Human Development Index (HDI) (UNDP, 2006) was followed and normalized to obtain figures which are free from the units so that they all lie between 0 and 1. It is important to identify the functional relationship between the indicators and resilience. Two types of functional relationship are possible: resilience increases with increase (decrease) in the value of the indicator. The assumption is that the higher the value of the indicator, the more the resilience is. The equation 1 is for when the resilience increase with increase in the indicator value, while the equation 2 is vice versa (Iyengar and Sudarshan. 1982).

The equation one (below) was used for indicators such as the presence of community participation /social capital and the availability of local early maturing seeds etc. X is the normalized value of the indicator while Min (Xij) is the minimum value recorded for the 5 villages while Max (Xij) is the maximum value of the indicators among the villages where i =community and j =the indicator and Xij_i is the value of the indicator

$$Xij = \frac{Xij_i - Min\{Xij\}}{Max_i\ \{Xij\} - Min\{Xij\}}$$

Equation 1: Normalization formula for positive functional relationship

The equation two (below) was used for computing indicator for other levels of relevant sources of knowledge apart from indigenous knowledge.

$$Yij = \frac{Max\{Xij_i\} - Xij}{Xij - Min\{Xij\}}$$

Equation 2: Normalization formula for negative functional relationship

The normalized values were summed up. Weighting of the indicators was done in order to rank indicators by assigning weights to them. Ranking indicators helps to remove distortions that may be created by collinearity and data sources unreliability (Damm, 2010). However, equal weights were given to the indicators.

Following Cutter et. al (2010) on developing the resilience scores, the values were computed as scores by finding their standard deviations from the mean values and ranked before mapping to highlight those villages that are ranking exceptionally well or poor in terms of their disaster resilience using their indigenous knowledge.

Table 3.4: Grading resilience score

Value of standardized value	**Level of resilience**
Above average mean of standard deviation	High
Average mean of standard deviation	Moderate
Below mean average of standard deviation	Low

4. CHAPTER FOUR: PRESENTATION AND DISCUSSION OF RESULTS

4.1. SOCIO DEMOGRAPHIC INFORMATION, LIVELIHOOD ACTIVITIES AND FLOOD DESCRIPTION

The indicators on exposure and sensitivity were used to describe the socio-ecological system. The table 4.1 below summarizes the socio demographic information and livelihood activities which forms the context of the study. The flood description (occurrence, frequency, duration) and the agriculture dependent population characterise the exposure and while the soil type and crop diversity talks about the sensitivity of the system.

Table 4.1 Socio demographic information, livelihood activities and flood description

Name	Fomboro	Fiegou	Bukasu	Nandungbani	Kpani
Last flood occurrence	2012	2012	2010	2012	2012
Flood frequency (years)	3	3	5	3	3
Flood duration (days)	30	30	45	30	30
Primary source of income	Agriculture (farming)	Agriculture (farming)	Agriculture (fishing)	Agriculture (fishing)	Agriculture (fishing)
Agriculture dependent population (%)	92	95	60	67	53
Proximity to river Oti (km)	1-2	1-2	1-2	1-2	1-2
Soil type	Sandy	Sandy	Clay	Clay	Clay
Crop diversity	Maize, rice, yam, soya cassava, groundnuts.	Maize, rice, yam, soya cassava, groundnuts.	Maize, beans.	Maize, beans.	Maize, beans, rice.
Gender (% of women)	39	61	60	27	47

Source: Field survey

All the cops are flood sensitive with maize being the most common staple crop. Although they plant rice which is more water tolerant, the duration of the flood causes them to lose the crop. Flood tolerant crops such as oilpalm, plantain, banana and cocoa cope better with flood and reduce farmers' losses during floods than most food crops. However, due the climate of the study areas in the guinea savannah regions, these crops are not available.

The Man- Kendall two tailed test for the rainfall for Mango in the Oti district gave the computed p-value is 0.866 which is greater than the significance level alpha of 0.05, hence the null cannot be rejected. The slope error was -0.627. There is a decreasing trend but it was not significant

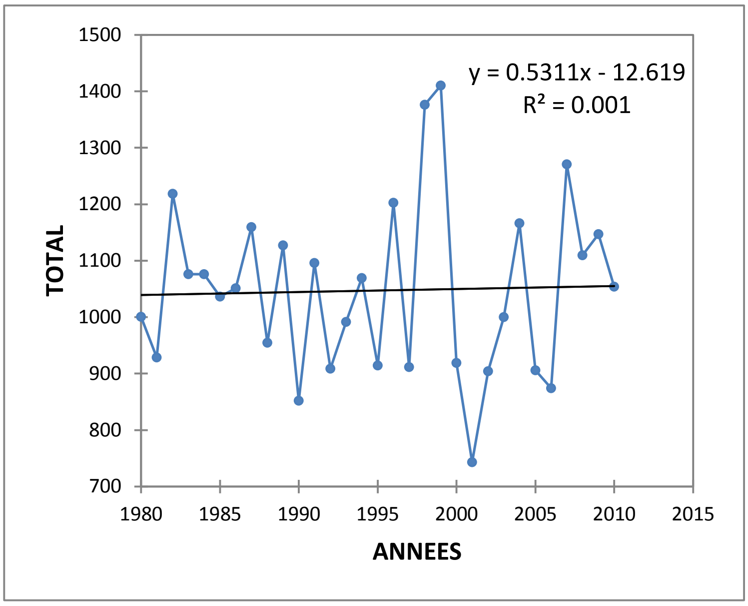


Figure 4.1 Rainfall trend for the Mango (1980-2010), Northern Togo

Source: Meteorological Agency, Togo

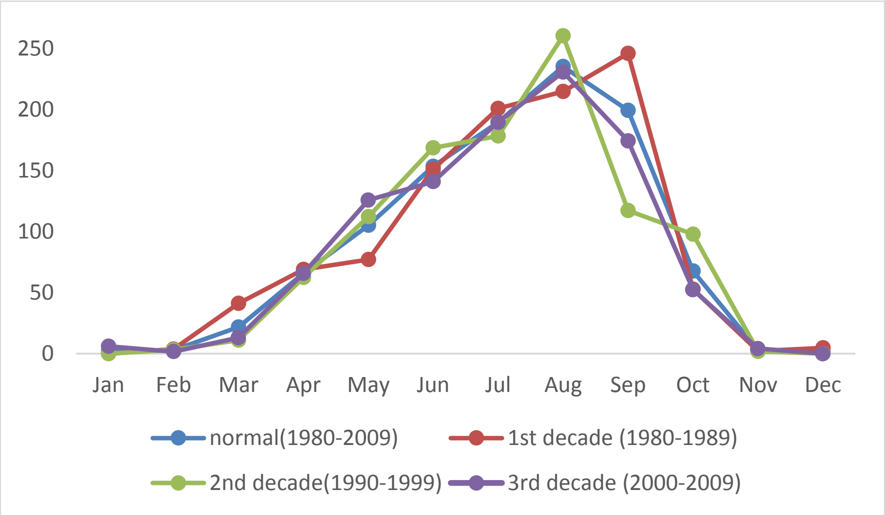


Figure 4.2: Comparing the mean of the normal against the last 3 decades

However from figure 4.2, the normal mean for the last 30 years (1980-2009) is compare with the last three decades and there are variations from normal mean for the first decade (1980-1989). The second decade (1990-1999) do not follow the normal mean. However, for the third decade (2000-2009), it is almost similar to the normal mean. Climate variability have been cited as part of climate change hence this variability is significant for the district.

According to respondents from the study areas Chereponi district, it is not the rainfall in the district that affects them. However, the flood occurs when it rains heavily in Togo, hence rainfall for Dapaong is used since one of the tributaries namely Namiele is affected by rainfall from Dapaong. The Man- Kendall two tailed test for the rainfall in Dapaong has a computed p value is 0.02 which is lower than the significance level alpha of 0.05, hence there is an increasing trend in the series for Dapaong. Hence the rainfall is increasing in Dapaong as shown in figure 4.3 below.

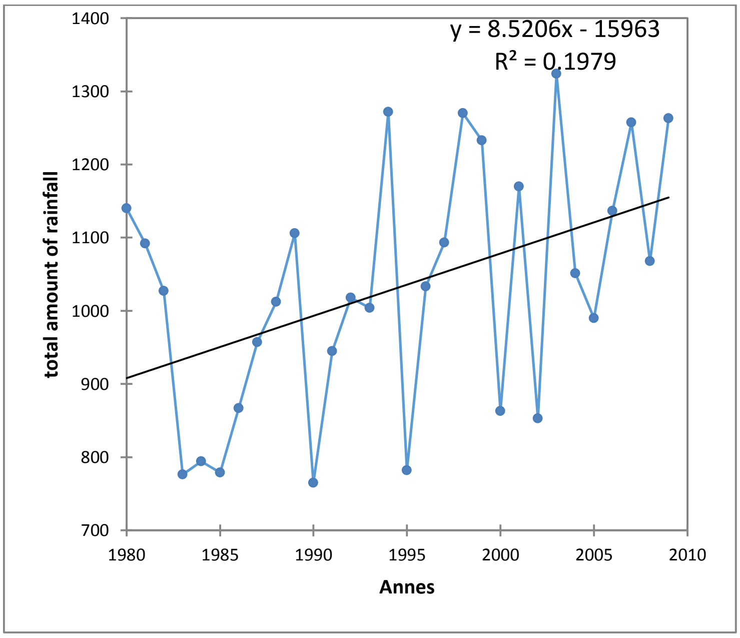
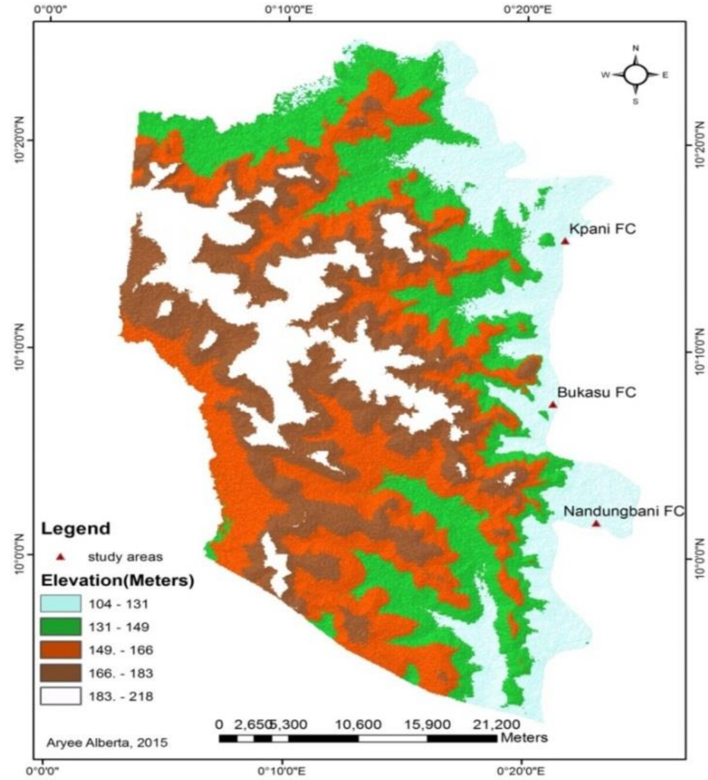


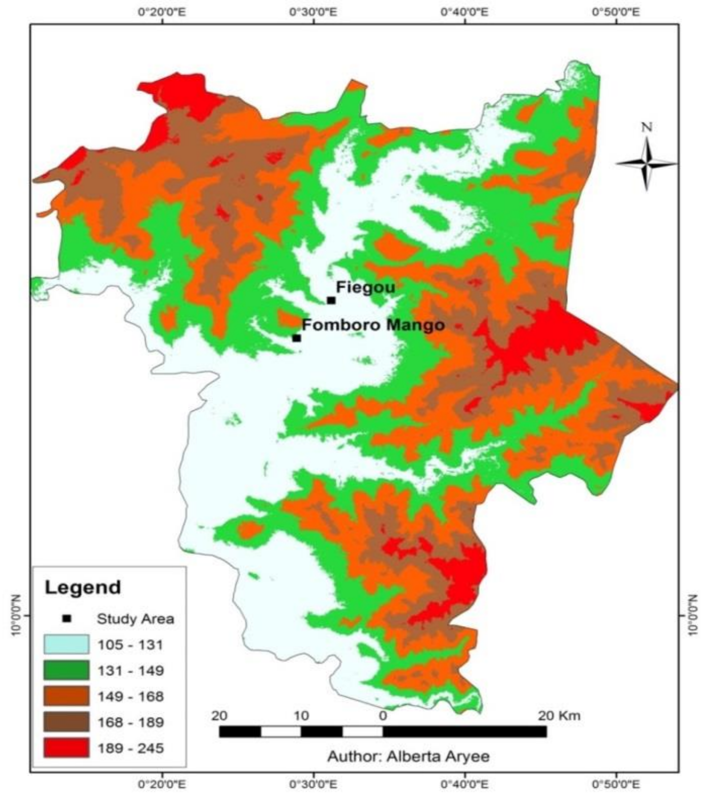
Figure 4.3: Rainfall trend for Dapaong (1980-2010),

Source: Togo Meterological Agency

All the three study areas in Chereponi district, Northern Ghana are located in low elevation. Map 2a captures the variation of elevations and hill shade effect which shows how the villages are predisposed to flooding by the river because of their location. Similarly, from Map 2b below, the two study areas for Oti district, Northern Togo are also located within low elevation.



Map 2a: Map of study areas in Northern Ghana showing elevation and hillshade effect on exposure



Map 2b: Map of study areas in Northern Togo showing elevation and hillshade effect on exposur

4.2. CAPACITY TO ANTICIPATE/ PREDICT USING INDIGENOUS KNOWLEDGE

The two countries use different natural resources to predict the occurrence of the floods. In the case of Chereponi district, 56% use flowers, debris from farms and wood logs on the water, while 26% use flowers, debris from farms and wood logs on the water and the cry of a black and white bird called “avadokploe” (a black and white bird with a pointed beak) as indicators. 12% use abundance of ants in the village as an indicator. With regards to the flower and wood logs, the respondents claim they come from Togo (see figure 4.4 below)

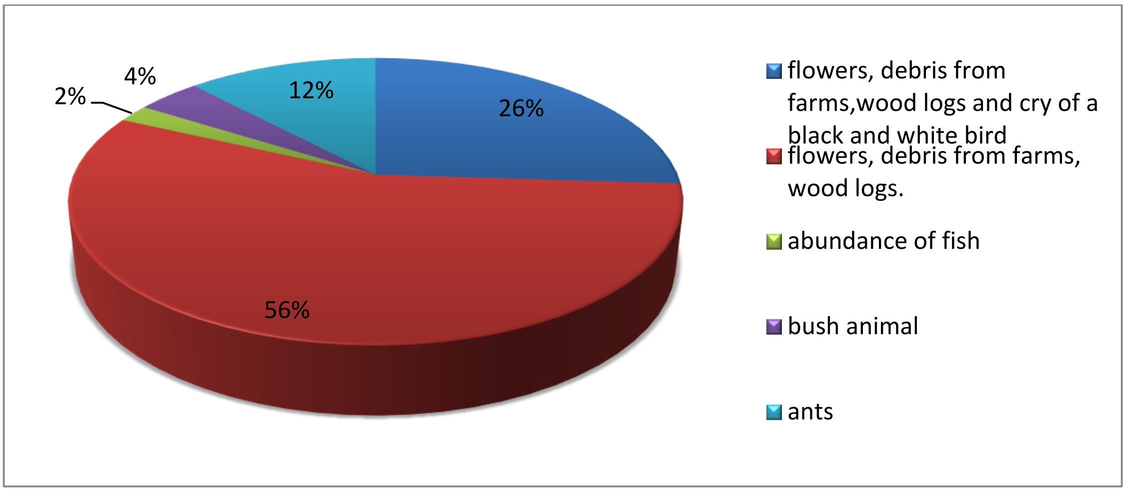


Figure 4.4 : Biophysical indicators for flood predicting in Chereponi district, Northern Ghana

The biophysical indicators (local climate indicators) were ranked according to their level of usefulness to the villages as enumerated in table 4.2 below.

Table 4.2: Indicators most useful to the people (Chereponi district, Northern Ghana)

	Bukasu Fishing Camp	**Nandungbani Fishing Camp**	**Kpani Fishing Camp**
Indicator 1	Use month of September	. Use month of September	Use months of August-September
Specific behaviour of indicator for flood anticipation	It is the flood prone month	It is the flood prone month	It is the flood prone month
Indicator 2	Faster river flow	Ants and snakes	Black and white birds.
Specific behaviour of indicator for flood anticipation	The faster the river flow indicates that flooding has started from the other	The presence of snakes in the village signals the increase.	The migration of the bird upstream (opposite to the flow of the river) in the month

	tributaries of Oti in Togo		of April signals the abundance of rain for the year and a potential flooding.
Indicator 3	Wood and flowers which float on the river.	Wood and flowers which float on the river.	Wood and flowers which float on the river.
Specific behaviour of indicator for flood anticipation	The greater the quantity of the wood and flowers means that flooding may have started upstream.	The greater the quantity of the wood and flowers means that flooding may have started upstream.	The greater the quantity of the wood and flowers means that flooding may have started upstream.

In the Oti district, 30% use ants that come into the village as an indicator, 21.1 % use the behaviour of snails. They said that the snails climb trees and cry. Also, 12.7% said that the cry of a black and white bird called “Nsu anomaa”, which literally means “water bird”, is an indicator for them. 6.9% use the appearance of serpents (snakes) and rats in the village as indicators, while 5.9% use the croak of frogs as indicators. 3% use the coming out of hippopotamus which is normally found in reserves as indicators and 3% others also use about the appearance of monkeys in the villages as illustrated in figure 4.5 below.

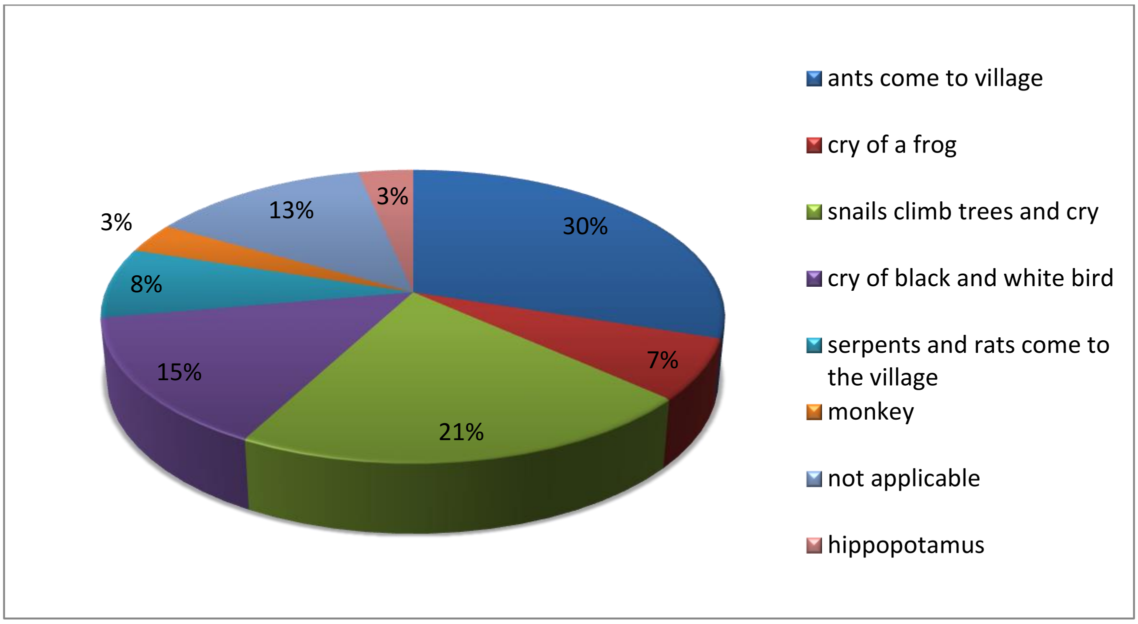


Figure 4.5: Indicators for predicting flooding in the Oti district, Northern Togo

The indicators were classified according to the degree of usefulness for the people in the Table 4.3 below

Table 4.3 Indicators most useful to the people (Oti district, Northern Togo)

Togo	**Indicator 1**	**Indicator 2**	**Indicator 3**
Mango fomboro	Snails.	Ants.	Cry of black and white bird.
Specific behaviour of indicator	They leave their usual habitats, normally close to the river banks and climb trees and search for dry areas.	They leave their usual habitats, normally close to the river banks and move to the villages and dry areas.	The loud chirping of bird signals flooding.
Fiegou	Ants.	Croak of frogs.	Cry of black and white bird.
Specific behaviour of indicator	They leave their usual habitats, normally close to the river banks and move to the villages and dry areas.	They croak louder when there will be a flooding event.	The loud chirping (noise) of bird signals flooding.

4.2.1. Current ability to predict floods using the biophysical indicator

82% in Chereponi district spoke about being able to predict the floods. However, 18% said that even if they see all the indicators that they have spoken about and it is not the flood month (August-September), they do not think that the flood would occur. In Oti district, 72% of the respondent said they are still able to predict the occurrence of the flood, while 28% said they are not able to predict using their local indicators due to the changes in the climate. The indicators are not enough to adequately predict the occurrence of the flood.

4.3. ABSORPTIVE COPING CAPACITY

4.3.1. Farmers with additional source of income

In Oti district, only 48 % of the respondents were involved in activities apart from agriculture as shown in figure 4.6 below. In Chereponi district, only 14 % were involved in activities apart from agriculture as shown in figure 4.7 below.

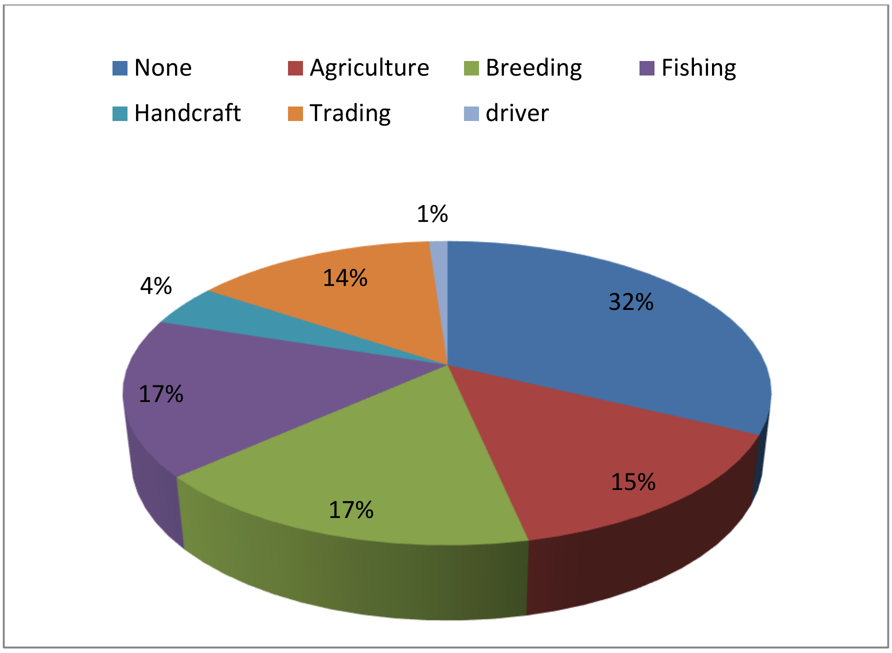


Figure 4.6 Secondary source of income in Oti district Northern Togo

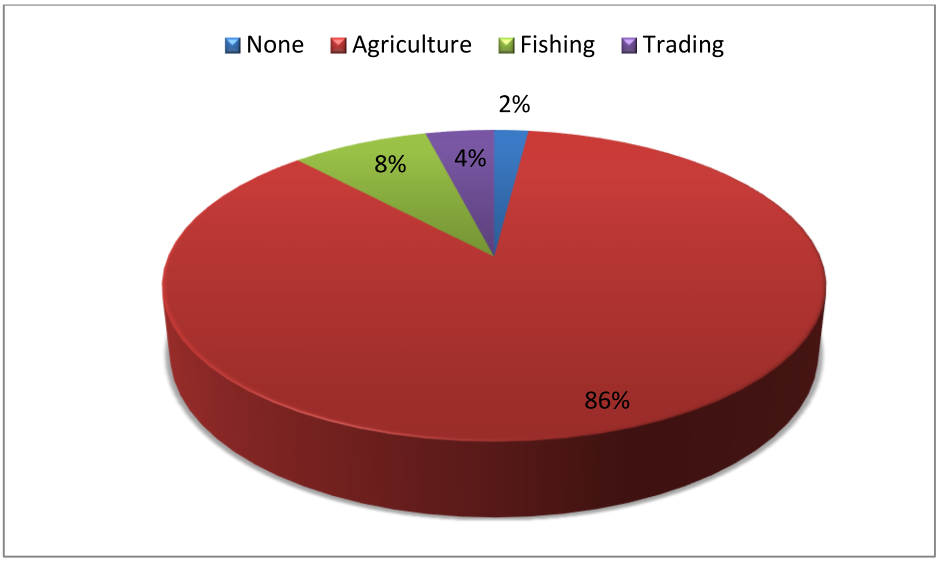


Figure 4.7 Secondary source of income in Chereponi district, Northern Ghana

4.3.2. Capacity to recover: Strategies in a flood-year that people lose part of their crops.

The common strategy used in both countries is replanting (80% in Chereponi district and 38.2% in Oti district) after losing their crops in the flood year. They mostly plant beans and groundnuts. However, in Chereponi district, 16% have no strategy while in Oti district, 10.8% sell firewood, 7.8% breed livestock, 7.8% trade, 5.9% change the crops that they normally plant, 5.9% depend on others, 4.9% fish and 4.9% had no strategy as shown in figure 4.8 below.

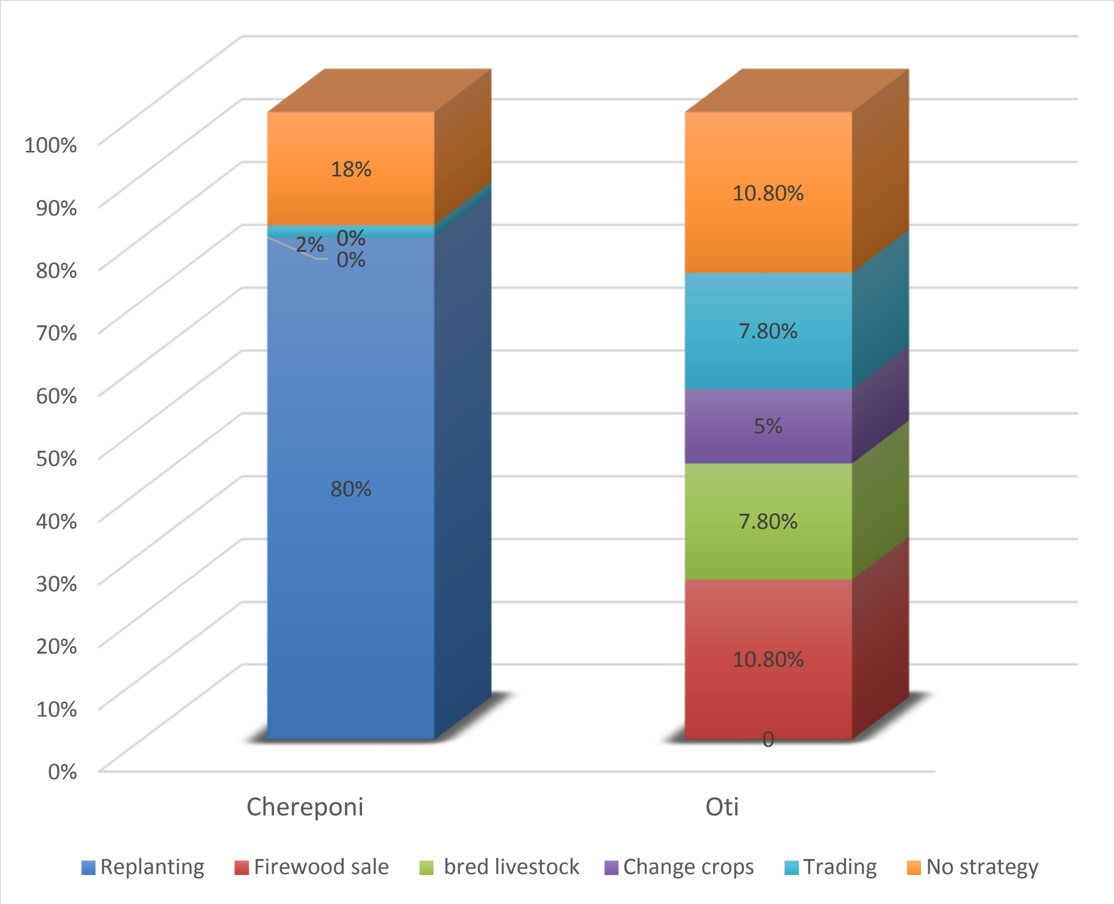


Figure 4.8: Strategies in a flood prone year

4.3.3. Capacity to recover: Strategies in a flood-year when all crops are lost

For Chereponi district, 40% buy from the market, 20% fish, 20% depend on others and 14% have no strategy when they lose all crops in a flood-year. In Oti district, this is not applicable for 51%. They have two farms, the first one is located far from the river and the second one is by the river banks. 13 % engage in petty trading, 10% continue in fishing activities and 8% of them sell firewood.

4.3.4. Capacity to take early action from indigenous knowledge received

The common early action for the two countries is "early harvesting". 25.56% of respondents practice early harvesting in Oti district, while 28% of respondents harvest early in Chereponi district. However, if the crops are not ripe, they leave it to be destroyed by the flood. In the case they have to harvest the crops that were not ready, the grains are small and they are consume at home (See photo 1 below). It is not be sold because the quality is not good.

In the Oti district, 8.89% of respondents are also planting early so that they can harvest it before the flood, while 7.78 % of respondents have shifted to more sustainable crops as illustrated in figure 4.9 below.

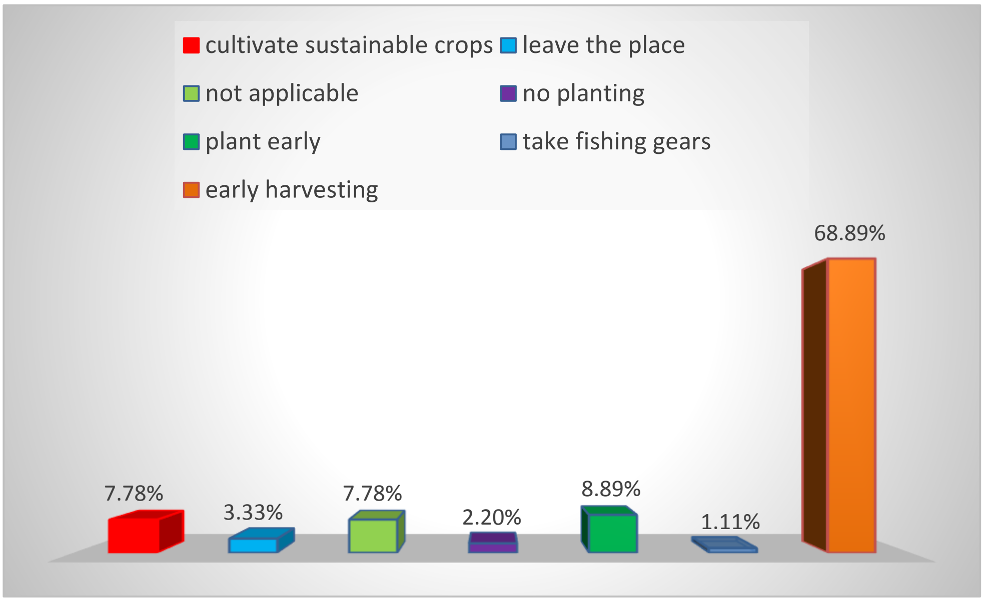


Figure 4.9: Early action taken from indigenous knowledge, Oti district

Photo 2: Smaller grains of maize from early harvesting taken during field survey (Mango Fomboro, the Oti district)

In the case of Chereponi district, 40% of respondents gathered their survival items and moved to the next village. However, 16% did not take any actions, 8% moved to the next village while 8% also gathered their survival items and placed them on the shed as shown in see figure 4.10

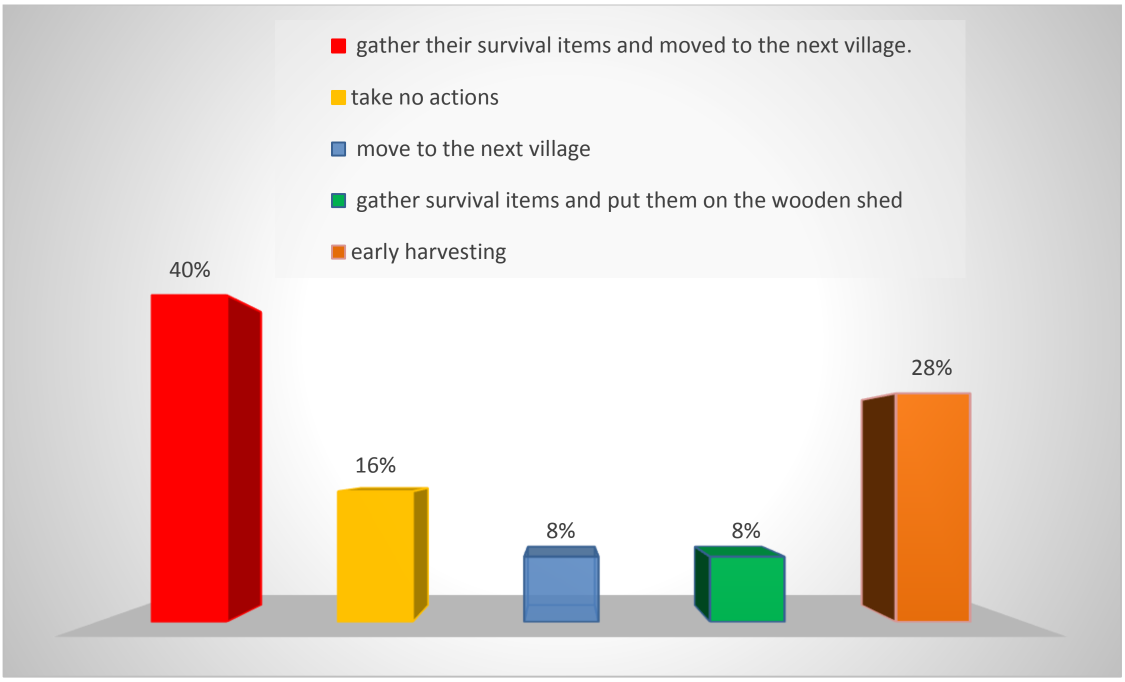


Figure 4.10 Early action taken from indigenous knowledge, Chereponi district

4.3.5. Presence of emergency management committee

50% of respondents attests to the presence of emergency committee in Chereponi while 50% also said there is no emergency planning committee. From the focus group discussion in Nandungbani, they formed their own committee in 2012 after the flood. In the Oti district, 73.3% of respondents said that there is no emergency committee, while 26.7% of respondents confirm the presence of an emergence committee.

4.3.6. Flood forecast information from other sources

The women who daily activities such as fetching water from the river and washing of clothes by the river Oti are the people who warn the inhabitants in the study areas in both districts that the river level is rising. The Chereponi district do not have the balise by the river nor Red Cross volunteers that warn them about the river level. Apart from the local knowledge that the inhabitants from the three villages in Chereponi district, there is no specific flood forecasting system. Along the river, there is no river or water level gauge during ground truthing. However for Mango Fomboro in Togo, there are some limnmeters placed along the river banks. In Mango Fomboro, there is a balise still under construction but the colours has not been painted yet. However there is a sign post close to the main road to show the colours for early warning. These are other sources of flood forecasting that can potentially reduce the dependence on indigenous knowledge.

4.3.7. Access to emergency funds and relief

In Oti district, 77.8% of respondents do not have access to funds and relief in times of flood, while 22.2% have access to it. In Chereponi district, 14% said that they have access to it while 86% do not have access to it.

4.3.8. Local varieties of crops better adapted in response to changing weather condition

82% of respondents in Chereponi district do not have local varieties that are better adapted in response to changing weather conditions. They do not have early maturing maize or groundnuts. This is because they are predominately fishermen. The remaining 18 % of respondents are engaged in trading activities. 74.4% of respondents in Oti district have local varieties that are better adapted in response to changing weather conditions however 24.4% of respondents do not have it.

The table 4.4 below and figure 4.9 below show how the two district performed with regards to the indicators for absorptive capacity.

Table 4.4: Indicators for absorptive capacities for each district

Indicators for absorptive capacity	**Chereponi district**	**Oti district**
Local early maturing seed(maize, groundnuts)	Not available	74.4% have it
Lack of access to emergency funds /relief	86%	77.8%
Early action from IK (Early harvesting)	28%	25.56%
Early action from IK (move to other villages)	40%	Not applicable
Secondary source of income apart from agriculture	14%	48%
Flood forecast information from other sources	Not available	Togo Red Cross (balise), meteorological agency, radio
Access to canoes	Yes	Yes
Migration	78%	3.3%

From figure 4.11 below, the total absorptive capacities for the two districts were compared against each other.

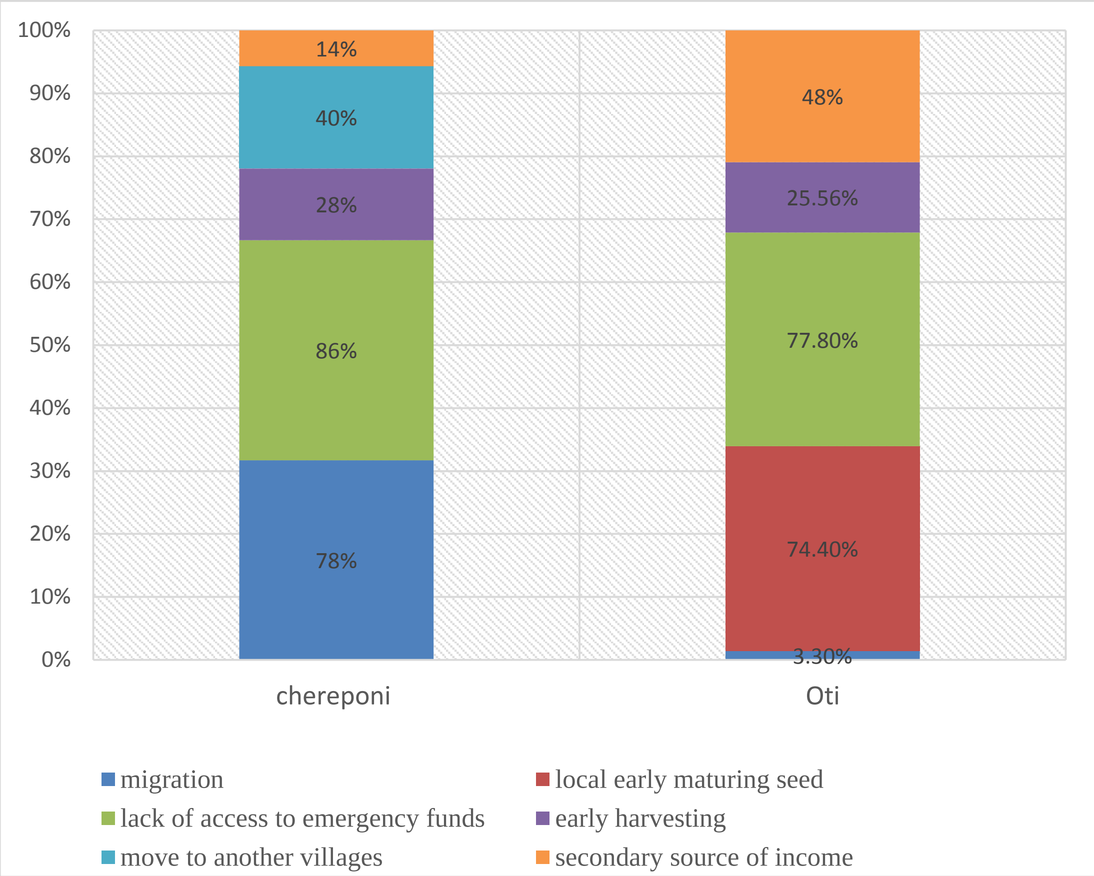


Figure 4.11: Total absorptive capacities for the two districts

4.4. ADAPTIVE CAPACITY

4.4.1. Capacity to self-organize

Under adaptative capacity, the capacity to self-organize is very important as it looks at the community's own capacity to respond or recover from the disaster independent from external assistance or aid. In Chereponi district, the villages are far from the district capital with poor road networks and since they are fishermen, they move to other villages to settle with their canoes without waiting for eternal help/aid. The three villages in Chereponi district have the wooden shed however in Bukasu fishing camp, 12% of respondents (mostly women) pack their things onto the shed before they move to another village. The men come for them later. This is confirmed by the head of the Bukasu fishing camp. When the houses collapse after the flood, the wood remains to supports the shed as shown in photo 3a below. After the water recede, the people help each other to build their houses demonstrating high social capital. For the communities in Oti district, each person is on left on his/her own during time of loss. 13% of them change their activities to fishing during the flood time and

25.56% do nothing. 12% respondents in Chereponi and 14% in Oti continue trading during the flood.

Photo 3a: Wooden shed with zana mat as roof, Bukasu fishing camp (Ghana)

With regards to access to canoes, all the study areas have community canoes that are used by members of the community. Since the major occupation of the study areas in Chereponi district is fishing, they have wooden canoes which they use in their occupation.

Fishing activities increase when it floods especially in Chereponi district. According to the fishermen, when the river floods, it brings fish also. The fishermen change their nets from two inches to three inches to catch bigger fishes though the approved fish net size is 31/2 inches as shown in photo 3b. The women are not left out in the fishing business. They use baskets to harvest fish during the flood time as shown in see photo 3c below. Some of the fish caught in the photo 3c below was identified by fishery expert, Prof Nunoo (University of Ghana) is *Chrysicthys walker* which is not common among the *Chrysichthys* species.

The coping strategies from fishermen can have negative consequences on the already dwindling inland fisheries in Ghana because the relatively smaller net sizes and the baskets used by women also harvest fingerlings.

Photo 3b: 2 inches nets used in dry season (left) 3 inches nets used in rainy season (right)

Photo 3c: *Chrysicthys walker* (left) and basket used by women to fish

4.4.2. Capacity to transfer knowledge

Indigenous knowledge on flood forecasting is transmitted orally in Ghana from one generation to the next. The knowledge is common since it is shared among the younger generation. The villages have smaller population size, close knitted and have a high social capital. The children are allowed to sit in the focus group. From the field survey, the young boys can swim and paddle canoes. 50% of respondents in Oti district said that the elders and parents taught them on flood forecasting with indigenous knowledge while 5.6% of respondents (from Mango Fomboro) stated that elders and parents do not teach them on flood forecasting with indigenous knowledge. However 82% of respondents stated the knowledge is only shared in the family, while 16.7% of respondents stated that it is specialized knowledge that only the elders in the society know it.

In Chereponi district, the major livestock are cattle, sheep and goats. In Bukasu and Kpani fishing camps, the fishermen have employed the services of Fulani herdsmen who live with them to take care of their cattle. However, 22% of respondents in Chereponi district do not have any livestock. In the Oti district, 20% respondents have sheep only, 15% have goats and fowls only 60 % have sheep, goats and fowls and 20% do not have any livestock.

4.4.3. Capacity to plan for the next rainy season

In Chereponi district, 42% of respondents had plans for the next rainy season based on the local knowledge that they have received while 58% do not have any plans. In Oti, 96.7% of respondents have plans for the next rainy seasons. These plans included planting early maize and groundnuts, yam and harvesting before the flood month. After the flood, they plan to plant beans at the banks of the river.

4.4.4. Long term residents and migration rate

In Chereponi district, 78% of the respondents are born in the village, while 22% move there from other villages. In the Oti district, 80% of the respondents are born in the village, while 20% move there from other villages.

In Oti district, 96.7% do not migrate seasonally while 78% migrate seasonally in Chereponi district. This is because they are fishermen and sometimes they go fishing in other parts of Ghana and neighbouring countries.

4.4.5. Capacity to learn

Resilience has an underlying capacity to learn. 68% in Chereponi district have not learned anything new using local knowledge that has helped them during times of floods as shown by figure 4.12 below. From the focus group with the men in Nandungabni fishing camp (Chereponi district) they have built houses across the river Oti on the Togo border where they move to during floods. They also change the way they built after the last flood in 2012 by now using palm fronds to build instead of the mud.

Photo 4: New building in Nandungbani (left). Yellow maize that matures in 2 1/2 months (right)

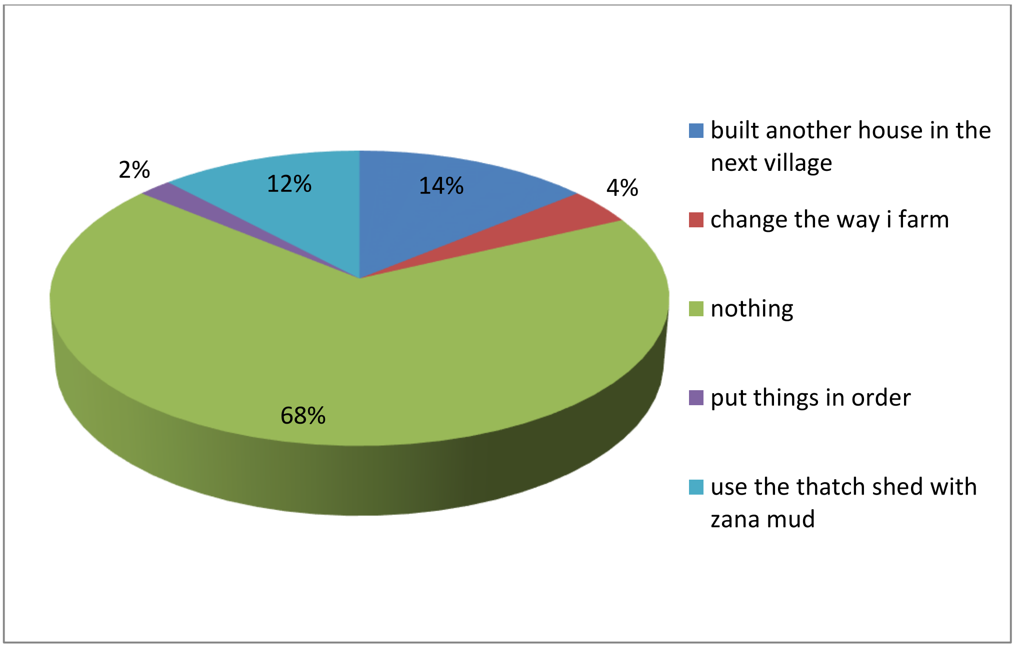


Figure 4.12: New things learned in Chereponi district, Northern Ghana

34% of the respondents have learned nothing new but 34% also have learned to plant early maturing seeds from the Oti district. From figure 4.13 below, 8 % said local indicators such as ants and snails is something new that they have learned.

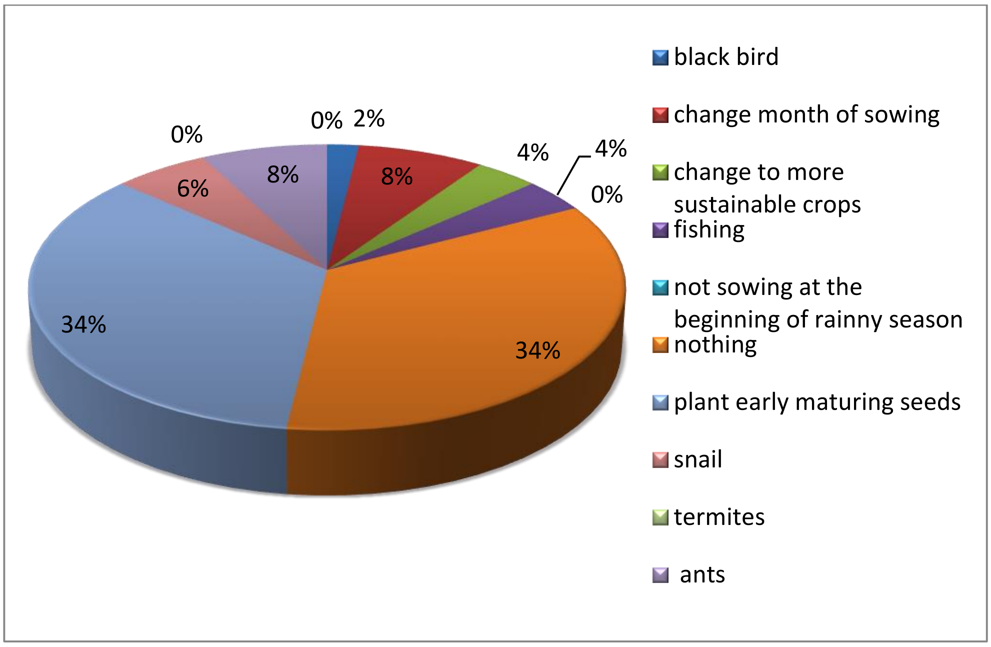


Figure 4.13 : New things learned in Oti district, Northern Togo

4.5. EFFECTIVENESS OF INDIGENOUS KNOWLEDGE AS COMPARED TO OTHER SOURCES OF INFORMATION

From the figure 4.14 below, 80% of respondents in Chereponi district think that the local knowledge is more relevant in comparison to other available information about potential floods, while 14% preferred the other sources of information on potential flooding. However, 6% did not make any choice.

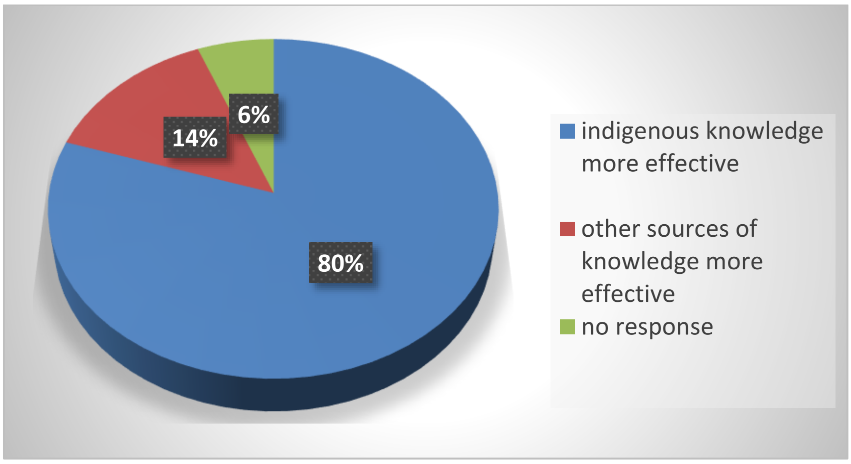


Figure 4.14: Effectiveness of local knowledge to other sources of knowledge (Chereponi)

In Oti district, 65.6% of respondents are of the view that the local knowledge is more relevant in comparison to other available information about potential floods and 32.2% opt for the other sources of information on flooding as more relevant. However, 2.2% do not make a choice.

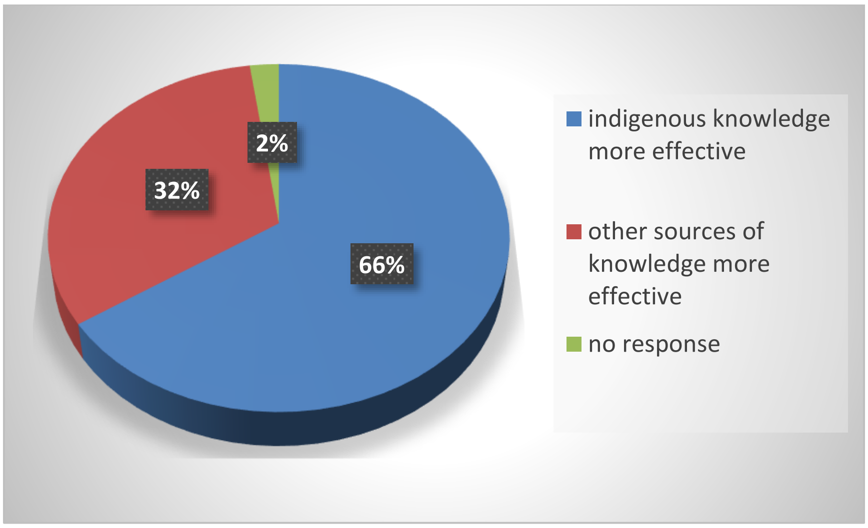


Figure 4.15: Effectiveness of local knowledge to other sources of knowledge (Oti District, Northern Togo)

4.6.LIMITATIONS OF INDIGENOUS KNOWLEDGE

From the research, indigenous knowledge has some limitations enumerated below

Indigenous knowledge and reduction of loss

From figure 4.16 below, 45 % of the respondents said that these biophysical indicators does not help them to reduce their loss in Oti district. 13.33% change the crops, 11.11% have change their farms. In Chereponi district, 80% of respondents said it do not help them to reduce their loss as illustrated in figure 4.17 below.

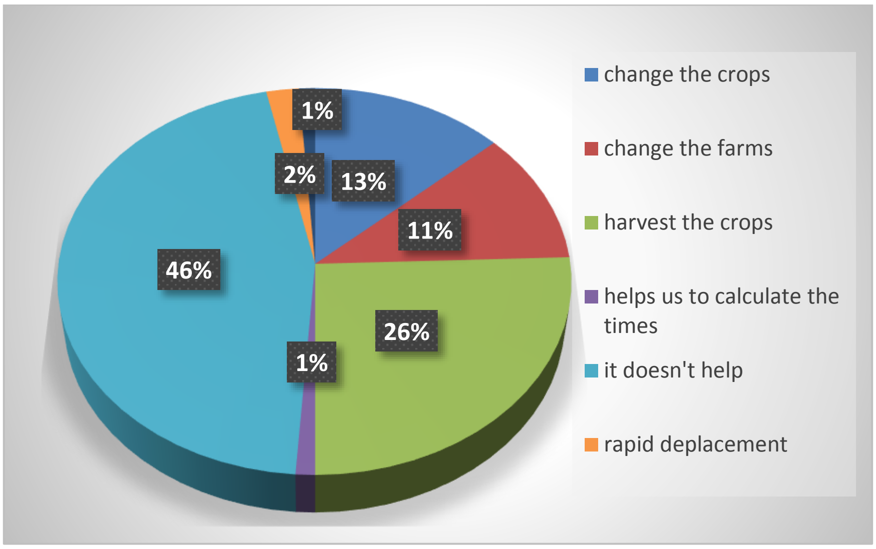


Figure 4.16: Loss reduction from indigenous knowledge received in Oti, district, Northern Togo

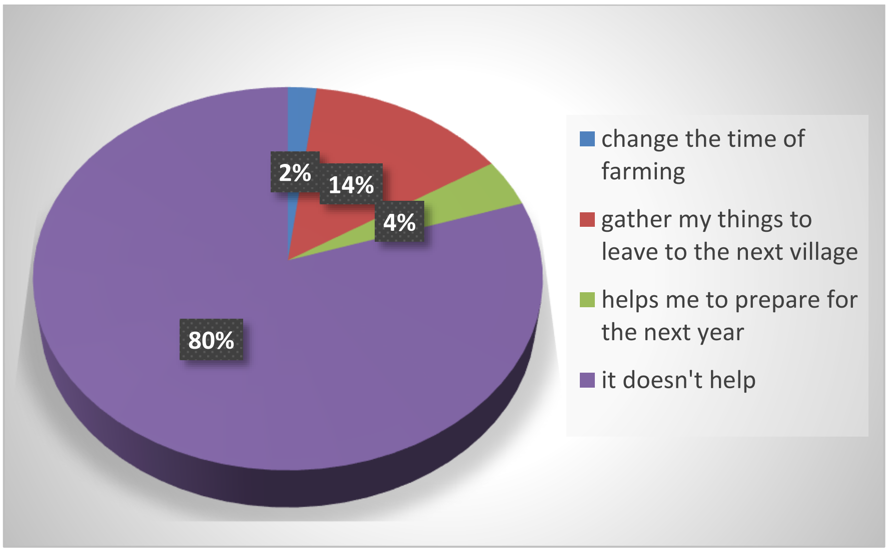


Figure 4.17: Loss reduction from indigenous knowledge received in Chereponi district, Northern Ghana

In addition to the above mentioned limitation, changes in the climate have affected how they used to predict flood events using their IK and thirdly the biophysical indicators arrive late.

4.7.NORMALIZATION OF INDICATORS

The indicators on community/social capital and transfer of knowledge were based on authour's judgement from field survey. Figure 4.18 below shows the sum of all the normalized absorptive capacities with Mango Fomboro having the highest followed by Fiegou which has moderate resilience as compared to the mean of the absorptive capacity of 2.9. However, all the study areas in Chereponi district have low absorptive capacities.

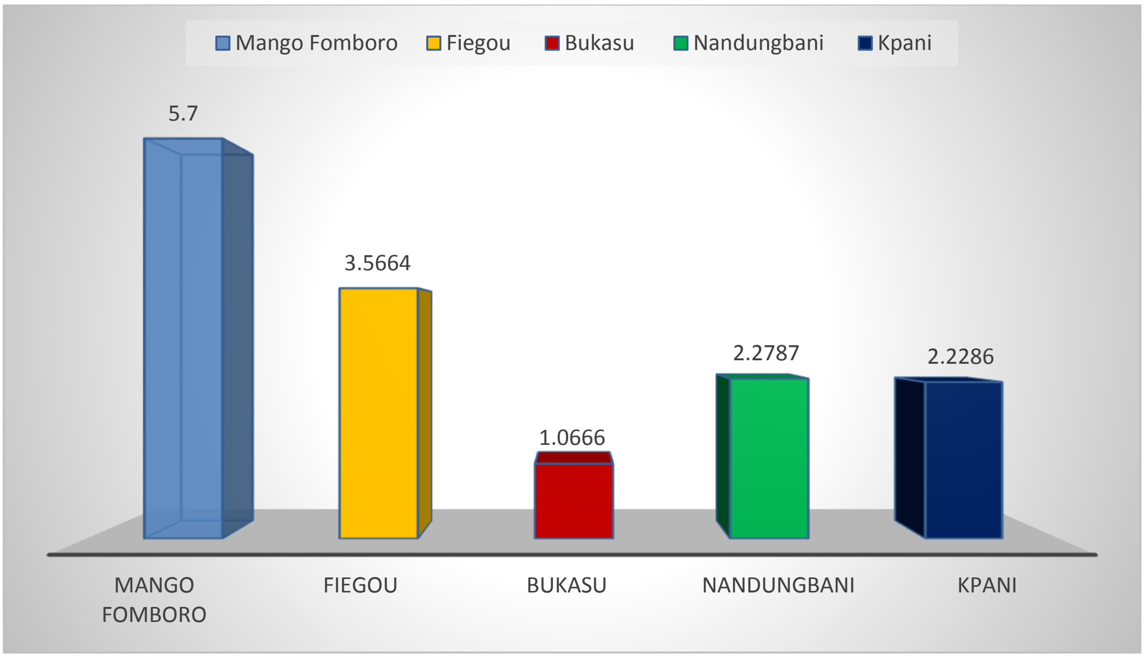
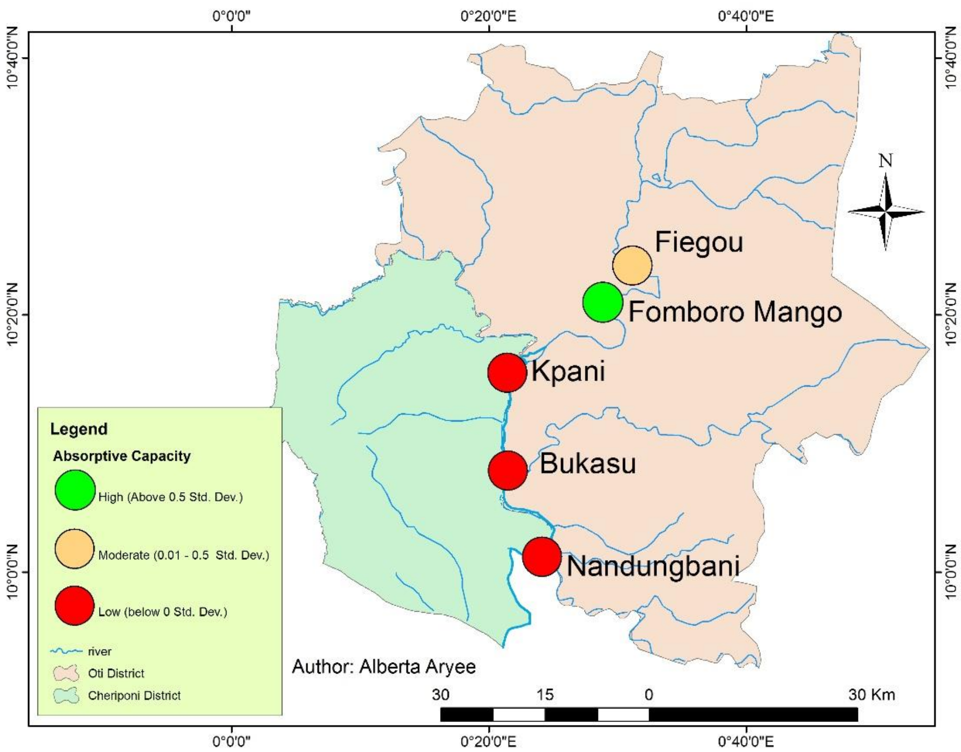


Figure 4.18 : Sum of all absorptive capacities

The computed values for the indicators were multiplied with the weight (Wi) of 1 to get the score per village in table 4.5 below. The overall absorptive capacity index for the villages was calculated in order to correctly rank the resilience of the people. The results were then mapped to clearly show the resilience rank as against the mean value of the standardized values of -0.290. Mango fomboro has the highest resilience score, followed by Fiegou which has the moderate resilience score. The three study areas in Ghana have low resilience score as shown in Map 3a below.

Table 4.5: Standardized deviation of the mean (Absorptive capacities)

Absorptive capacities	Mango	Fiegou	Bukasu	Nandungbani	Kpani
AC 1	1.99	1.833	-1.7436	-1.6853	-1.2
AC1*Wi	1.99	1.833	-1.7436	-1.6853	-1.2
AC 2	1.9596	1.2	-1.1662	-1.3267	-1.4697
AC2*Wi	1.9596	1.2	-1.1662	-1.3267	-1.4697
AC 3	1.4283	0.2	-0.98	-0.4	-0.98
AC 3*Wi	1.4283	0.2	-0.98	-0.4	-0.98
AC 4	0.2	-0.6	-0.6	0.4899	0.6633
AC 4*Wi	0.2	-0.6	-0.6	0.4899	0.6633
AC 5	0	0	0	0	0
AC 5*Wi	0	0	0	0	0
AC 6	2.0494	1.5492	-1.4832	-1.4832	-1.4832
AC 6*Wi	2.0494	1.5492	-1.4832	-1.4832	-1.4832
AC 7	-0.4472	-0.4472	0.44721	0	0.7071
AC 7*Wi	-0.4472	-0.4472	0.44721	0	0.7071
AC 8	-1.0392	-1.2961	1.0583	0.56569	1.1489
AC 8*Wi	-1.0392	-1.2961	1.0583	0.56569	1.1489
Sum of indicators	**0.767613**	**0.304863**	**-0.55844**	**-0.47995**	**-0.3267**



Map 3a: Resilience ranking for the study areas (absorptive capacity)

From the figure 4.18 below, compared to the sum of all the normalized adaptive capacities to the mean value of 2.863, Mango Fomboro has the highest followed by Fiegou which is moderate. However, all the study areas in Chereponi district (Kpani, Nandungbani and Bukasu) have low adaptive capacities.

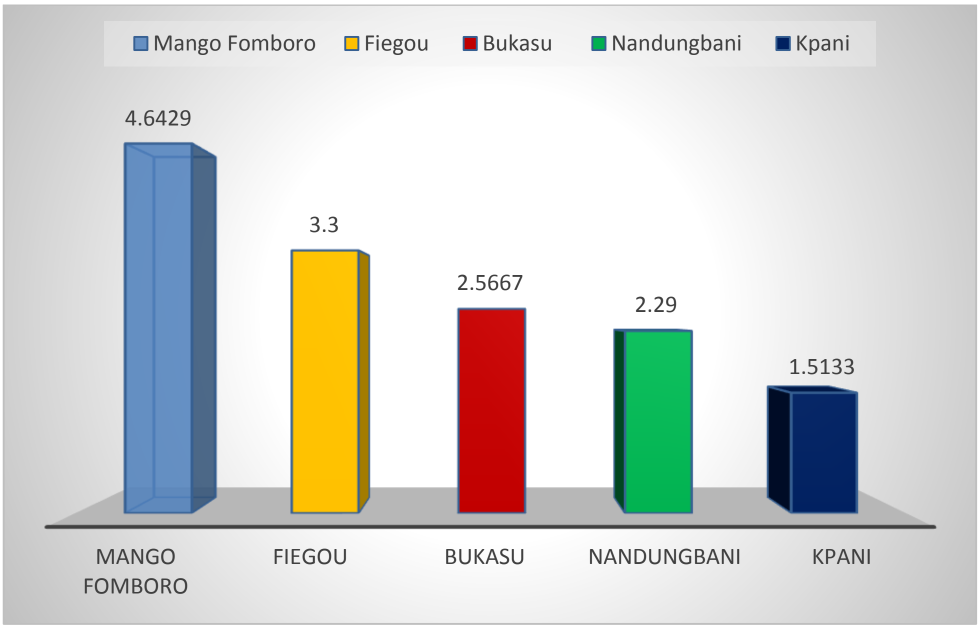


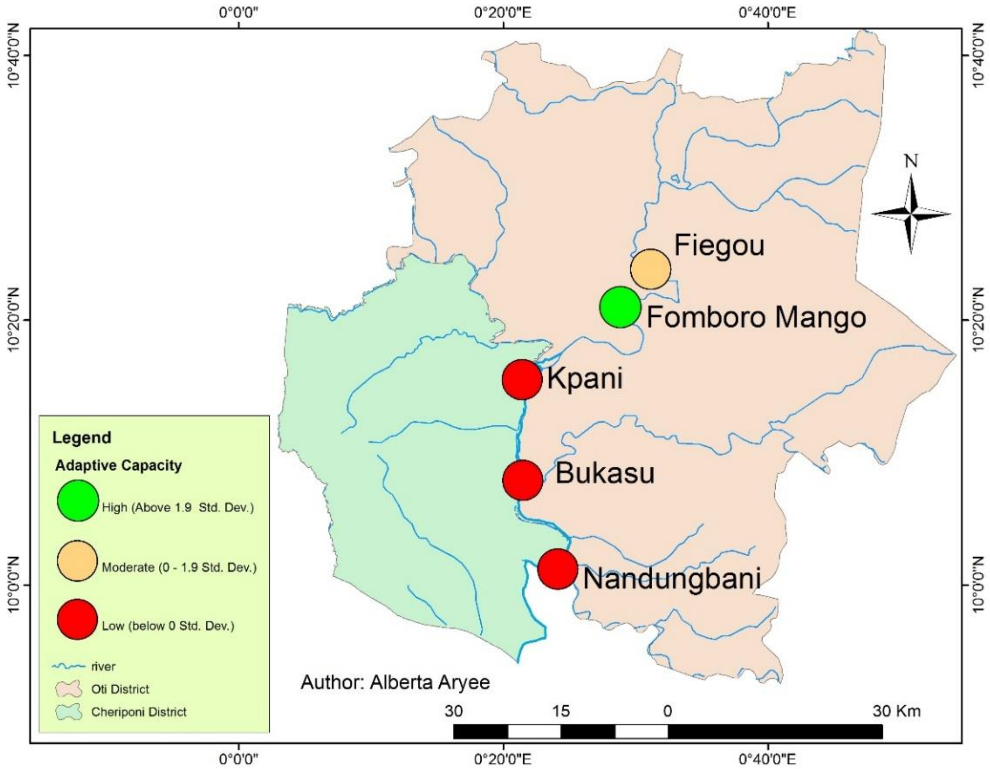
Figure 4.18: Sum of adaptive capacities

The overall adaptive capacity index for the villages was calculated in order to correctly rank the resilience of the people. The resilience index (RI) was multiplied by the weight (Wi) of 1 to get the score per village as indicated in table 4.6 below.

Table 4.6: Standardized deviation from mean for Adaptive capacity

Village	C'ty participation	local knowledge transfer	Documentation	Livestock	long term resident	Canoe access	safe places	Sum
Mango	-0.3464	-0.3464	0.4	1.6	1.989	0	-1.1832	**2.113**
Fiegou	-0.3464	-0.3646	-0.2	1.720465	1.249	0	-0.1832	**1.875265**
Bukasu	0.43353	0.43353	-0.2	-1.4283	-1.2806	0	1.6423	**-0.39954**
Nandungbani	0.43353	0.43353	-0.2	-0.8106	-1.4283	0	1.2649	**-0.30694**
Kpani	0.43353	0.43353	-0.2	-1.2806	-1.3565	0	-1.1832	**-3.15324**

From the Map 3b below, as compared to the mean of the standardized deviation of 0.129, Mango fomboro has the highest resilience score, followed by Fiegou which has the moderate resilience score. Kpani, Bukasu and Nandungbani all in the Chereponi district has low resilience score as compared to the mean of the standard deviation of 0.129.



Map 3b: Resilience ranking for Adaptive capacities

Robustness of the Resilience Index

Table 4.7 below compares the results of the resilience index of the communities, using the standardisation normalisation method, with the functional relationship normalization method. The results shows similar patterns of resilience using the two methods. In both cases, Kpani, Bukasu and Nandungbani have low resilience score, Fiegou has moderate resilience score and Mango has high resilience score. Hence, the resilience model is very robust.

Table 4.7 : Robustness test for resilience score

Study areas	**Absorptive capacity**		**Adaptive capacity**	
	Functional relationship	Standardization	Functional relationship	Standardization
Mango	5.7	0.7676	4.643	2.113
Fiegou	3.5664	0.3049	3.3	1.87526
Bukasu	1.0666	-0.5584	2.5667	-0.39954
Nandungbani	2.2787	-0.480	2.29	-0.30694
Kpani	2.2286	-0.3267	1.5133	-3.15324

4.8.DISCUSSION

The biophysical indicators most useful to predict the occurrence of flood for the study areas in Northern Ghana are the month of September, ants and snakes, black and white birds, the floating of wood and flowers on the river while the Oti district used snails, ants, croak of frogs as well as the cry of a black and white bird. This result confirms the Togo Red Cross publication (2014) on local climate indicators though it highlights only snails for Mango fomboro. Fiegou was not covered by the work of the Togo Red Cross however this research also found out that Fiegou also had three biophysical indicators used for flood prediction. The work done by Gyampoh and Asante (2011) in the Volta region (Ghana) where the people from study areas in the Chereponi district came from, birds were used to detect the occurrence of the rainy season. Tschakert and Dietrich (2010) and the project by ACEP and Canadian Hunger Foundation (2014) also confirmed the overabundance of ants in northern Ghana as an indicator for heavy rains. Recent literature assert the positive role of local and traditional knowledge in building resilience and adaptive capacity, and shaping responses to climatic variability and change in Africa (Ifejika Speranza et al., 2010 and IPCC, 2012b)

For absorptive coping capacity, the common early action from their indigenous knowledge in the two districts was early harvesting. However, when the crops aren't ripe, the grains are small and consumed at home because of its poor quality**.** Replanting, one of the major strategies after crop loss was low in Oti district as compared to the Chereponi district. From the focus group with the old men from Mango Fomboro in Oti district, at first the people were not replanting after the flood. When they experienced crop loss, they changed their work, sold their livestock or beg to survive. However, they realized that after the floods, the soils were fertile and so they planted beans and groundnuts. Others also did some gardening. This is an off season planting. This supports that assertion by Issaka et. al (2004) that the sites along the Oti River could be put to profitable crop production. Kissi (unpublished 2014) work on the Mono River Basin found similar results. Fishing activities does increase and there are some negatives practices that may harm the already pressurized sector as explained with photo 3b and c.

For the capacity to transfer knowledge, proactiveness in transferring knowledge to younger generation is based on social capacity. Indigenous knowledge was common knowledge in Chereponi district while it is shared among the elders in the Oti district. The older women in Mango Fomboro focus group lamented that though they taught the youth on the traditional knowledge, the youth criticized them, accused them of being liars and did not have respect for the indigenous knowledge. Mango Fomboro is a town with different tribes and languages. From the focus group with the youth of that village, they said that the aged are arrogant, egoistic and do not want to teach them about the knowledge that they have making it difficult for the youth to approach them. With regards to transfer of IK to the younger generation, the findings from this project work also confirms what Karadzandima (2002) also found out that the youth criticize the indigenous knowledge from their elders making it difficult for this knowledge to be passed unto them

The study areas in Chereponi district are not building on higher foundations which is contrary to the results by McNamara and Prasad (2013) where communities in Fiji and in Vanuatu have adapted to flooding by building their houses on stilts about 20cm above ground level.

In Oti district, sale of firewood, livestock breeding, trading, change of crops, dependence on others and fishing are other strategies in a flood year with some crop loss. However, in the two countries there is a minor percentage that do not have any strategy. In a flood-year when all crops are lost, the people buy from the market, some practice fishing or depend on others and some have no strategy at all. In Oti district, 50% of respondents have two farms so they do not lose everything, other engage in petty trading, fishing activities and sale of firewood. In Chereponi district, local varieties that are better adapted in response to changing weather conditions is not available and this was why they suffered crop loss. This is because they are predominately fishermen while 74.4% have the local varieties in Oti district. Under adaptation, the results from Chereponi district to be specific Nandungbani adapted their building materials to withstand the regular devastating flood disaster. Fabiyi and Oloukoi (2013) confirmed this similar results in coastal rural communities in Nigeria.

Both countries have similar plans for the next rainy season such as planting maize and groundnuts, yam and harvesting them before the flood month and replanting beans after the flood.

Under the capacity to learn, 68% in Chereponi district and 34% in Oti district have not learned anything new using local knowledge that has helped them during times of floods however others have built in other villages that they can easily relocate to. However 34% have also learned to plant early maturing seeds while 8% have changed the month of sowing in Oti district. In the Chereponi district, 12 % have built houses as safe places in other villages. They now use palm fronds instead of the mud to build to reduce the loss of houses. IPCC (2012b) stated that learning approaches for adaptation may involve combining local and traditional knowledge with scientific knowledge.

The resilience level was measured based on indicators. The study areas in Chereponi recorded low resilience level for absorptive capacity in the ability to cope and recover from the floods. The same trend was observed for the adaptive capacity. The best practices in the Oti district can be transferred such as the local early maturing seeds. Also documentation of IK and seasonal calendars can also be introduced.

The effectiveness of the local knowledge according to the study areas in the Chereponi district is more relevant than for the Oti district. From personal observations, the study areas in the Chereponi district are far from the district capital and do not have access to electricity. However they obtain information on flooding from radio stations in Togo. However, all the three study areas in the district have low resilience scores using the indicators. However, for the Oti district there were other sources of other information such as the radio stations, the meteorological agency in Mango and the Togo Red cross in the areas.

With regards to the limitations of the IK, the women's coordinator for Kpani fishing camp said that the indicators come late and it do not help them. If from the beginning of the year, they know whether the river would overflow they can adequately plan for it. That is the reason why they suffer crops losses.

LIMITATIONS OF STUDY

Indigenous knowledge is place and culture specific, the results cannot be generalized for other regions in the same country with the same cultural and socio-economic background. This study is limited in not including all the three capacities of resilience. Time constraints also did not allow the researcher to develop specific indicators at the local level and at the national level, hence there may be some very useful indicators that may have not been included in this research.

5. CHAPTER 5: CONCLUSION AND POLICY RECOMMENDATION

5.1. CONCLUSION

Indigenous knowledge is seen as a potential source of building community resilience towards disasters. This research looked at how these people who experience potentially similar river flooding along the river Oti in Northern Ghana and Northern Togo can anticipate, cope and recover from the flood. It also looked at how they handle flood events using indigenous knowledge. Data collection approaches included household interviews, focus group discussions and field observations. Secondary data were sourced from SRTM imagery and the map of study areas. The data were analysed with SPSS 16. Microsoft Excel 2013 was used for graphs and ArcGIS10.0 for maps. Normalized indicators for coping capacities and adaptive capacities were used to draw maps based on indigenous knowledge. The biophysical indicators most useful to predict the occurrence of flood for the study areas in Northern Ghana are the month of September, ants and snakes, black and white birds, the floating of wood and flowers on the river while the Oti district used snails, ants, croak of frogs as well as the cry of a black and white bird.

The standard deviation of the mean value of the indicators for both the absorptive capacity and adaptive capacity showed that Mango fomboro had the highest resilience score (level), followed by Fiegou which had the moderate resilience score. The three study areas in Chereponi district (Northern Ghana) had low resilience score, hence a low resilience level.

The local knowledge was more relevant in the Chereponi district than in Oti district though the three study areas had low resilience scores however the indigenous knowledge is limited in crop loss reduction, arrives late and affected by climate change.

Under climate variability and climate change, the inclusion of the good strategies from IK in resilience building is essential.

5.2.POLICY RECOMMENDATIONS

At the end of this research, some policy recommendations to governments, institutions and researchers were necessary to increase the resilience of some of the communities enumerated below

- For Fiegou and Mango fomboro in the Oti district, additional sources of income, mostly off farm activities to give them alternative livelihoods in the short term by development agencies and the government.
- New building codes (higher foundation using local materials) should be enforced in Bukasu fishing camp and Nandungbani fishing camp Kpani fishing camp in the Chereponi district by the government.
- Also local early maturing seeds should be transferred from the Oti district to Bukasu fishing camp, Nandungbani fishing camp and Kpani fishing camp in the Chereponi district so that they can reduce their crop loss. Documentation of the indigenous knowledge should be published into calendars so that these knowledge do not fade away for these communities in the Chereponi district

5.3 WAY FORWARD

There is the need for more research on reducing the limits of indigenous knowledge and assess the potential indigenous knowledge has on transformative capacity. Benin was left out of the research so the district from the source of the river can be added in addition to rainfall data from the source of the river in Benin. More villages can also be added from the districts. Also indicators for all the capacities can be developed at the local level and also with the experts. The perceptions of the people in the district to climate change can also be looked at.

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APPENDIXES

Appendix 1: normalized values (absorptive capacity)

abbreviation	Oti district, Togo		Chereponi district, Ghana		
	Mango Fomboro	Fiegou	Bukasu	Nandungbani	Kpani
AC 1	1	0.9143	0	0.0286	0.2286
AC 2	1	0.6	0.1333	0.0667	0
AC 3	1	0.3333	0	0.2667	0
AC 4	0.5	0	0	0.75	1
AC 5	0	0	0	0	0
AC 6	1	0.7188	0	0	0
AC 7	1	1	0	0.5	0
AC 8	0.2	0	0.9333	0.6667	1
Sum	**5.7**	**3.5664**	**1.0666**	**2.2787**	**2.2286**

Appendix 2: normalized values for adaptive capacity

Indicator	Oti district Togo		Chereponi district Ghana		
Adaptive capacities	Mango	Fiegou	Bukasu	Nandungbani	Kpani
AD 1 (LKT)	1	0.6	0.0667	0	0.0333
AD 2 (CP/SS)	0.6	0.6	1	1	1
AD 3 (LT)	0.6	0.6	1	1	1
AD 4 (DOC)	1	1	-1	-1	-1
AD 5 (LSTK)	0.9429	1	0	0.04	0.08
AD 6 (SP)	0	0	1	0.75	0
AD7(CAN)	0.5	0.5	0.5	0.5	0.5
Sum	**4.6429**	**3.3**	**2.5667**	**2.29**	**1.5133**

Appendix 3: Rainfall data for Mango (Average normal, first, second, 3rd decade)

Months	normal(1980-2009)	1st decade (1980-1989)	2nd decade(1990-1999)	3rd decade (2000-2009)
Jan	2.013333333	0	0	6
Feb	2.88	3.7	3.2	1.7
Mar	21.77666667	41.2	11.1	13
Apr	65.73	69	62.5	65.7
May	105.0433333	77	112.3	125.8
Jun	153.45	151.1	168.5	140.8
Jul	189.5666667	200.9	178.3	189.5
Aug	235.18	214.6	260.3	230.7
Sep	199.1333333	245.8	117.3	174.3
Oct	67.69333333	52.8	97.9	52.4
Nov	2.683333333	2.2	1.8	4.1
Dec	1.58	4.7	0	0

APPENDIX 4: QUESTIONNAIRE

Researchers Name: ARYEE Akwele Alberta

Researcher's Affiliation: West African Science Service Center on Climate Change and Adapted Land Use, University of Lomé, Togo.

Study Objective: This study is aimed at assessing the communities can build resilience using indigenous knowledge towards flooding. It is part of the requirement for the award of MSc. in Climate Change and Human Security. The information is for the purpose of MSc Research of the Researcher only. You are assured of the confidential treatment of the valuable information supplied.

PRELIMINARY

Name of Village …………………. District Number/Name……………………….

Date of Interview……………………………….

PART 1: SOCIO-ECONOMIC CHARACTERISTICS

1.1 Age: 18-30 ☐ 31- 40 ☐ 41-50 ☐ 51-65 ☐ Above 65 ☐

1.2 Gender: Male ☐ Female ☐

1.3 Marital Status: (a) Single parent ☐ (b) Married ☐ (c) Widowed ☐

(d) Divorced ☐ (e) Separated ☐ (f) Never Married ☐

1.4 Highest Education Status (a) no formal education ☐ (b) Primary ☐ (c) Secondary ☐

(d) Tertiary ☐

1.5 How long have you lived in this area?

Was born here ☐ , moved from _________ in the year _______________

PART 2: FLOOD EXPOSURE

2.1 Have you experienced flood before? Yes ☐ No ☐

2.2 Which year/years did you experience flood/field water lodging?

2.2.1 At what time in the year? (Either month or agricultural activity)

2.3 Which of the following types of flood did you experience on your farm? (a) Overflow of River Oti (b) heavy rainfall c. groundwater flood, e.g. in basfonds)

2.4 How often do you experience flood in your farm/village? (a) Annually (b) Once in 2 years (c) once in 3 years (d) once in 4 years (e) once in 5 years (f) once in 10 years
(h) once in 15 years (i) once in 20 years

2.5 How many days did it take the flood water to disappear from your field? ……………

2.6 How close to a river/stream is your field

a. <1km b. 1-2km c. >2km

2.7 Are your household's farmlands often affected by floods? Yes b. No

2.8 What were the impacts on your house?

2.9 How long did it take to rebuild your house?

PART 3: SENSITIVITY

3.1 Ecological Sensitivity

Percentage of lands with flood sensitive crops

30 % 40 % 50 % more than 50 %

What are these crops? …

3.3. Economic Sensitivity

What is your primary source of income?

Agriculture petty trading civil servant fishing handcraft

Others (specify) ....

What are the secondary sources of income for the household?

None Agriculture breeding fishing handcraft Trading
other specify.....................................

Do you/family members seasonally migrate? Yes No

How many livestock do you have? (Cattle…... sheep……., goats……. , pigs…….., chicken…… , ducks , guinea fowls……., others……)

PART 4: RESILIENCE USING THE INDIGENOUS KNOWLEDGE

4.1 Capacity to predict

What do you use to know that a flood is about to come?

Plants Animals insects birds

Name ……………………………………………………………………….

Specific indicator: Flowering of plants Growth Others

What is the type of behaviour of livestock to help you predict the occurrence of flood?

……………………………………………………………………………………………….

How do you interpret the stars and moon to know the river will flood?

When the moon is full and clear, flooding occurs ☐

Others ……………………………………………………………………….

How do insects and animals (ants, termites, lizard, frogs, birds, and millipedes) behave?

……………………………………………………………………………………………….

When (time of the year) do they appear?

Before the rainy season ☐ rainy season ☐ other time ……………………

Where do these insects and animals occur?

On the river ☐ close to the river ☐ in the village ☐

What are some of the changes in the weather used to predict the occurrence of a flood?

Direction and type of rain and wind (heavy rains ☐ strong winds ☐

Others …………………………………………………………

Form and colour of the clouds (dark clouds, ☐ big clouds, ☐ dark big clouds ☐

Others …………………………………………………………………………………….

Thunder and lightning

………………………………………………………………………..

The water flow ---fast water flow ☐ water flow normal ☐

Colour of the water flooding in channels……………………………………………………

Do you have a network of friends/relatives in other village upstream who let you know that a flood will come? Yes ☐ No ☐

Do you have any volunteers in your village, who inform about a potential flooding? (e.g. from Red Cross) Yes ☐ No ☐

4.2 Capacity to anticipate

Do you take any action from the indigenous knowledge you have before the flood?

Yes ☐ No ☐

If no, provide reason
……………………………………………………………………………………………

If yes what are the actions

What has the previous flood experience taught you?

…………………………………………………………………………………………..

4.3 Capacity to cope

Do your household undertake practices to protect the household from the floods?

Placing valuables higher in the house ☐ Gathering emergency survival items ☐

Making a plan for what to do when the flood becomes threatening ☐

Emergency relocation when the flood occurs ☐

What are some of the Spiritual preparations that you make before the floods?

Prayer ☐ Consult spiritual leaders ☐

Others ……………………………………………………………………………………

What are some of the mental preparations that you make before the floods?

……………………………………………………………………………………………………

4.4 Capacity to adapt

Do you have plans for the next rainy season based on the local knowledge that you received?

Yes ☐ No ☐

Did you change your cropping pattern to cultivate less flood sensitive crops? Yes ☐ No ☐

Did you change the location of your fields/homes? Yes ☐ No ☐

4.5 Capacity to recover

Do you have local varieties of crops that are better adapted in respond to changing weather conditions? Yes ☐ No ☐

Do you have additional income and sources of flood during floods? Yes ☐ No ☐

What are **your strategies** in a flood-year when you lose

a) Part of your crops/ fish………………………………………………………

B) All of your crops/ fish……………………………………………………..

c) Your house collapsed……………………………………………………………..

Has indigenous knowledge help you to reduce the losses you experienced on your fields, or collapse of houses Yes ☐ No ☐

if yes, please explain how indigenous knowledge help you

4.6 Capacity to learn and transfer indigenous knowledge to younger generation

4.6.1 Do the elders and parents teach you on flood forecasting with indigenous knowledge?

Yes ☐ No ☐

4.6.2 Is flood forecasting using indigenous knowledge?

Common knowledge ☐ Shared (only in the family) knowledge ☐

Specialised knowledge ☐

4.6.3 How was the transfer made?

Orally transmission ☐ Written down in your local language ☐

Using symbols and signs ☐

4.6.4 How relevant do you think is local knowledge in comparison to other available information about potential floods?

The traditional knowledge is more relevant than other types of knowledge (from radio, from meteorological station from other stations) Yes ☐ No ☐

The traditional knowledge less relevant than other types of knowledge (from radio, from meteorological station from other stations) Yes ☐ No ☐

4.7 Capacity to self-organize using indigenous knowledge

Are there organizations in the community that help the people during and after floods?

Yes ☐ No ☐

What are the roles of these organizations?

……………………………………………………………………………………………………

What are some of the things that you do to organize yourselves before, during and after the floods……………………………………………………………………………………

Before

During

After

4.8 Capacity to innovate using IK

What are the new things that you have learned using your local knowledge that has helped you during times of floods?

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4.9 Effectiveness of Indigenous Knowledge

Were you able to predict correctly flooding event using your Indigenous local knowledge?

Yes ☐ No ☐

Are you able to predict flooding event using your Indigenous local knowledge presently?

Yes ☐ No ☐

If No please give reasons

……………………………………………………………………………………………………….

4.10 Communities' resilience towards different weather extremes based solely on indigenous knowledge?

Do the traditional authorities and participants have in the focus group meetings to share their knowledge of indigenous knowledge during floods? Yes ☐ No ☐

What is the degree of certainty about the knowledge that they share on flood prediction, coping and recovery?

20% -50% ☐ 51%-70% ☐ 70%-80% ☐ 80%-90% ☐ 90%-100% ☐

How long was this group created? 1-5 years ago ☐ 6-10 years ago ☐ 11-15 years ago ☐ 15-20 years ago ☐ More than 20 years ago