Climate Change Risk Communication and Asset Adaptation of Indigenous Farmers in the Delta State of Nigeria

By

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Thesis

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DECLARATION 1-PLAGIARISM

I declare that this Thesis is my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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(Signature of candidate) 31th day of October, 2017

DECLARATION 2-PUBLICATIONS

I, Eromose E. Ebhuoma, hereby declare that I personally undertook all the data collection, analysis and writing of the manuscripts as mentioned below. I would like to express my sincere gratitude to my supervisor for providing me with useful feedbacks on earlier drafts of each manuscript. Sections of this work have been published, while others have been submitted for publication as indicated below:

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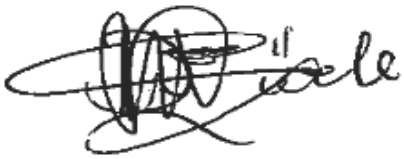
(Signature of Candidate)

As the candidate's supervisor, I certify that the above statement is current and have approved this thesis for submission.



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Prof. Danny Simatele

ABSTRACT

The purpose of this study was to examine how subsistence farmers in the Delta State of Nigeria employed their asset portfolios i.e. human, financial, social, natural and physical capitals to build their adaptive capacity and resilience to climate variability and change. The study was also interested in understanding the extent to which climate change risk communication facilitated the protection and adaptation of subsistence farmer's assets in the face of extreme weather warnings.

Primary data were obtained using the Participatory Climate Change Adaptation Appraisal (PCCAA), which comprises both the asset vulnerability analytical and the asset-based adaptation operational frameworks. The systems thinking approach, together with the asset vulnerability analytical framework were also used as an operational vulnerability framework to highlight the myriad factors undermining the rural poor from maximising their asset portfolios during food production. Focus group discussions and semi-structured interviews facilitated the use of the PCCAA tools.

Meteorological data reinforced subsistence farmer's perception (62%) that there has been an increase in temperature within the last decade, which have adversely affected on groundnut production. The farmers (92%) also listed heavy rainfall event and flooding as a climatic variable that impede their ability to produce cassava throughout the year. This is because their farmlands, which are generally low-lying, are always inundated for approximately four months every year. Nonetheless, the farmers still engaged in cassava production annually by adopting a strategy indigenously referred to as *elelame* (follow-water-go).

It is important to mention that in spite of the rapidly changing climate, the subsistence farmers did not rely on Seasonal Climate Forecast (SCF) in order to determine the appropriate time to grow their food. Instead, they relied on their Indigenous Knowledge

Systems (IKS) not limited to cloud observations, croaking of frogs and peculiar sounds made by the swamp chickens. However, the farmers acknowledged that their IKS have not been as reliable as it has always been in the past decades. Nonetheless, the farmers underlined being misled by an inaccurate scientific forecast in 2013 and, a lack of trust in the source of the forecast are some of the reasons they continue to rely primarily on IKS.

With climate change expected to continue occurring at unprecedented levels in Nigeria, it is crucial to build subsistence farmers trust in SCF while simultaneously not undermining the value of their IKS. This is because there is growing consensus that if subsistence farmers continue to rely on IKS alone, the key assets that play a huge role in food production will likely be eroded. This will adversely hamper households' ability to continue obtaining the livelihood they aggressively pursue. Thus, a useful starting point will be to generate a "unified" forecast whereby SCF compensates for the limitations of farmer's IKS. However, for the unified forecast to make meaningful contributions to the ways in which farmers produce their food and protect their assets in anticipation of an extreme weather forecast, it must be communicated through the various mediums that the farmers rely upon to receive vital pieces of information.

Keywords: *Indigenous knowledge systems, seasonal climate forecast, climate change risk communication, Delta State, Nigeria.*

DEDICATION

This thesis is dedicated to my parents for the huge sacrifices made during my upbringing and that of my siblings. *Orbilu*

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Ebowe, Barr. Erhire Oke, Mr. Solomon Ogedegbe, Mrs. Martha Seimode, Mr. John Ayiko, the Agricultural Extension Department of the Delta State, staff of the Nigerian Meteorological Agency (NIMET) and others who, unfortunately, I do not have their last names. Your time and effort were instrumental to the overall success of this study. I simply cannot thank you enough. Also, those who provided secondary data are not left out. In this regard, sincere appreciation goes to Mrs Wendy Philips, Mr Osadolor Ebhuoma and Dr Serge Kubanza.

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LIST OF ABBREVIATIONS

AC	Action Congress
BBG	Broadcasting Board of Governors
BMD	Bangladesh Meteorological Department
BNRCC	Building Nigeria's Response to Climate Change
CAMPFIRE	Communal Areas Management Program for Indigenous Resources
CBO	Community Based Organisation
CCRC	Climate Change Risk Communication
CCVR	Climate Change Vulnerability Resilience
CPC	Climate Prediction Center
CVCA	Community-wide Vulnerability and Capacity Assessment
FGD	Focus Group Discussion
GDP	Gross Domestic Product
IDP	Internally Displaced Person
IDSL	Integrated Data Services Limited
IFAD	International Fund for Agricultural Development
IISD	International Institute for Sustainable Development
IITA	International Institute for Tropical Agriculture
IKS	Indigenous Knowledge Systems
IPCC	Intergovernmental Panel on Climate Change
ISLGA	Isoko South Local Government Area
IRI	International Research Institute
LGA	Local Government Area
NAPAS	National Adaptation Programs of Action
NBS	National Bureau of Statistics
NDDC	Niger Delta Development Commission
NDES	Niger Delta Environmental Survey

NEMA	National Emergency Management Agency
NGOs	Non-Governmental Organisations
NIMET	Nigerian Meteorological Agency
NNPC	Nigerian National Petroleum Corporation
NOAA	National Oceanic and Atmospheric Administration
NPE	Network Political Ecology
PCCAA	Participatory Climate Change Adaptation Appraisal
PDP	People's Democratic Party
PIA	Participatory Impact Assessment
PRA	Participatory Rural Appraisal
RRA	Rapid Rural Appraisal
RWJF	Robert Wood Johnson Foundation
SDG	Sustainable Development Goal
SSA	sub-Saharan Africa
SCFs	Seasonal Climate Forecast
SDGs	Sustainable Development Goals
SRP	Seasonal Rainfall Prediction
TV	Television
USD	United States Dollars
UNDP	United Nations Development Program
VM	Vulnerability Mapping

CHAPTER ONE

FRAMES OF REFERENCE

1.1. Background of the study

Globally, there is widespread consensus to suggest that climate variability and change are no longer an abstract matter of science, but a lived reality (Adger et al., 2003; Moser, 2014). Globally, while climate variability and change have adversely impacted on different sectors of the economy, no sector has been affected like agriculture (Adger et al., 2003; Bandara and Cai, 2014; Calzadilla et al., 2013; Evans et al., 2014; Intergovernmental Panel on Climate Change (IPCC), 2014a). This is because, a vast range of agricultural activities that subsistence farmers engage in, particularly in the context of developing countries, are dependent on rainfall (Challinor et al., 2007; Thomas and Twyman, 2005). Thus, the slightest variation in climatic conditions can have significant impacts on agricultural productivity (IPCC, 2014b; Nelson et al., 2014).

In the context of sub-Saharan Africa (SSA), Barrios et al. (2008) are of the view that agricultural productivity in SSA has been highly sensitive to climate change within the last four decades of the 20th century. This has resulted in a significant decrease in agricultural productivity (Barrios et al., 2008). Furthermore, it has been documented by the IPCC (2014a) that climate variability and change have adversely affected the livelihoods of subsistence farmers in SSA. This is because approximately 97% of arable farmland in SSA, as argued by Calzadilla et al. (2013), is extensively dependent on rain-fed agriculture. It has also been argued that extreme spatial and temporal variability of precipitation could be the most significant factor affecting agricultural productivity in SSA (Laux et al., 2010).

It is, however, important to note that there are indications to suggest that future impacts of climate variability and change may present heightened challenge for agricultural productivity in SSA (Calzadilla et al., 2013). This view is buttressed by the IPCC (2014a) who pinpointed SSA as one of the regions in the world that will be highly susceptible to the impacts of climate variability and change by the end of the 21st century. In a related vein, Thornton et al. (2008) argued that rain-fed agricultural crop productivity in SSA will experience a decrease of about 10-20% by the year 2050. Further, the IPCC has projected that SSA will experience a temperature increase of 3˚C by the end of the 21st century (Schlenker and Lobell, 2010; Sultan et al., 2013). From this point of view, future climate change will likely have gross negative impacts on the yield potential of major crops by 2050, which in turn will adversely affect the livelihood of subsistence farmers. This is expected to worsen the food crisis in a region already classified as food insecure (Cooper et al., 2008; IPCC, 2014b; Schmidhuber and Tubiello, 2007).

In light of the foregoing, therefore, the need for subsistence farmers to adapt to climate variability and change cannot be overemphasised, especially if they are to continue effectively in food production in order to obtain their livelihoods. On the one hand, Adger et al. (2003) are of the view that adapting to climate induced weather changes is not a new phenomenon for subsistence farmers in developing countries. In fact, subsistence farmers in SSA have been observed to rely heavily on their Indigenous Knowledge Systems (IKS) not limited to the close monitoring of specific animal behaviours, paying delicate attention to wind direction and sky observations in order to determine the appropriate time, types and quantity of food to produce in a planting season (Eakin, 1999; Nyong et al., 2007). On the other hand, with climate variability and change increasingly becoming ubiquitous and intense, Moser (2011) argues that only those who can effectively adapt their assets will be able to continue obtaining their livelihoods. This is based on two premises; first, the bundle

of assets or asset portfolios owned by, or easily accessible to subsistence farmers will be able to tell us those that will be able to continue effectively in food production in the aftermath of an extreme weather event (Moser, 2011; Prowse and Scott, 2008). Second, there are growing concerns that the IKS of subsistence farmers will become increasingly unreliable to anticipate future weather conditions accurately (Roncoli et al., 2002). This is due to the increasing and unprecedented rate at which climate variability and change have been, and is expected to continue occurring in the future (IPCC, 2014b).

Nonetheless, it has been asserted that having adequate asset portfolios or easy access to assets alone might not suffice in making the poor completely resilient to the adverse impacts of climate variability and change (Tanner and Mitchell, 2008). Explicitly and implicitly, government policies, institutions, structures and Non-Governmental Organisations (NGOs) have to provide an enabling environment and deliver services that will facilitate more meaningful asset adaptation for the rural poor (Moser, 2011; Tanner and Mitchell, 2008). An ideal example whereby they will have to rely on governmental and non-governmental agencies is not only in the provision of Seasonal Climate Forecast (SCF) but in communicating the risks effectively through the right channels (Harvey et al., 2012; Moser, 2010). This is because the most accurate SCF, as argued by Moser and Dilling (2011), is inconsequential if it is not communicated through the right channels and in a manner that the message can be easily understood by those vulnerable to the anticipated extreme weather condition. In this regard, Climate Change Risk Communication (CCRC) is perceived to be a vehicle through which the poor can protect their livelihood assets by adopting planned adaptation strategies in the aftermath of a forecasted extreme weather event (Roudier et al., 2014; Ziervogel et al., 2005).

1.2. Thematic consideration

Nigeria, a country where approximately 70% of its population depends on agriculture for its livelihood, is endowed with a variety of natural resources (Apata et al., 2010). This ranges from rainforest and mangroves in the southern region to the savannahs in the northern region, which forms the basis for an effective agricultural system (Apata et al., 2010). Within the last two decades, however, empirical observations have brought to the fore the Delta State as one of the States in the country where the highest amount of rainfall have been recorded (Adeniji et al., 1997; Ayinde et al., 2011; Enaruvbe and Yesuf, 2012; Vanguard, 2012). On average, this ranges from about 2500mm to 2300mm (Niger Delta Environmental Survey (NDES), 2000). The heavy rainfall events and coupled with the Delta State geographical location makes it extremely susceptible to flooding.

The frequent heavy rainfall events are compromising the ability for 90% of subsistence farmers in the Delta State to engage more meaningfully in food production practices (International Fund for Agricultural Development (IFAD), 2014; Obioha, 2008). It is, however, important to note that in spite of the unprecedented rate in which flooding events have been occurring, subsistence farmers are not passive victims of these extreme weather events. By relying on their IKS, the farmers have been able to identify various methods and techniques to adapt their bundle of assets in order to continue obtaining their livelihoods (Tawodzera, 2012). This is extremely important because the more assets farmers have, the less vulnerable they will be to climate variability and change, and therefore, better equipped to bounce back into food production in the aftermath of an extreme weather condition (Moser, 2011).

Writing from a SSA perspective, however, Ajani et al. (2013) and supported by Fabiyi and Oloukoi (2013), are of the view that the frequent episodes of extreme weather conditions will

overwhelm the ability for IKS to anticipate future weather events accurately. This is expected to have severe consequences for household food security in regions within SSA that continue to rely predominantly on IKS. Consequently, it is imperative for subsistence farmers to adopt effective and efficient strategies aimed at enabling them protect and adapt their assets. This will ensure that they can continue to obtain their livelihood in the face of a rapidly changing climate (see Choi et al., 2015; Klopper et al., 2006).

It is within this context that CCRC is perceived to be a vehicle that can facilitate asset protection and adaptation to climate change, and in so doing increase agricultural productivity and yield (Wilks and Wolfe, 1998). In a similar vein, Challinor et al. (2007) argue that access to credible and reliable information is an indispensable element that can enable subsistence farmers to protect and adapt their assets effectively to the adverse effects of climate variability and change. This is because, if the various institutions mandated to disseminate SCF to subsistence farmers conduct their duties effectively, it can help preserve the assets of subsistence farmers against the extremities of weather by identifying problems, raising awareness, fostering dialogue and influencing behavioural change (Moser, 2010).

In view of the aforementioned observations, this study was interested in understanding how subsistence farmers in the Delta State protected, modified and adapted their assets against the impacts of extreme weather conditions. The study was also interested in highlighting the extent to which subsistence farmers depend on IKS when making farming decisions. Further, this study also sought to understand the importance of CCRC in enabling the farmer's to protect, adapt and transform their assets against the impacts of climate variability and change in order to continue effectively in food production and obtain a sustainable livelihood.

1.2.1. Research questions

In view of the above observations, this study was guided by the following research questions:

I. In what ways have climate change and variability affected the livelihood systems and options available to subsistence farmers in the rural Delta State of Nigeria?

II. What are the various forms of IKS that subsistence farmers in the rural Delta State rely upon to determine the appropriate time, the type(s) of crop and quantity of food to produce in a planting season?

III. In what ways have CCRC contributed to the protection and adaptation of the fundamental assets that subsistence farmers in the Delta State rely on to obtain their livelihoods?

IV. What entry points for policy formulation aimed at enabling subsistence farmers in the rural Delta State build their adaptive capacity and resilience to climate variability and change can be ascertained from the findings of this study?

V. What are the implications of this study in a wider context, particularly for SSA?

1.2.2. Aims and objectives of the study

The aim of this study was to investigate the role of CCRC in protecting the livelihood assets of subsistence farmers in the Delta State of Nigeria. The study was particularly interested in understanding how CCRC aided subsistence farmers to protect and adapt their asset portfolios against climate induced extreme weather conditions in order to ensure they obtain sustainable livelihoods.

In view of the above aims, the following were the objectives of the study:

I. To create an inventory of asset portfolios that enable subsistence farmers in the rural Delta State of Nigeria to grow their food in the face of climate variability and change.

II. To identify the various IKS that subsistence farmers in the rural Delta State rely upon to anticipate future weather conditions.

III. To establish the role that effective CCRC has played in enabling subsistence farmers in the rural Delta State of Nigeria to protect and adapt their assets in the face of extreme weather conditions.

IV. To identify the most effective channels for communicating predicted climatic risks to subsistence farmers in the rural Delta State of Nigeria.

V. To construct a framework that integrates SCF with the IKS of subsistence farmers in the rural Delta State of Nigeria.

1.3. Some theoretical perspectives on asset-based adaptation to climate change, IKS and CCRC

Within the last three decades, the concept of livelihood gained increasing momentum within the discourse of rural development, arguably because of the patchy success achieved in eradicating rural poverty (Carney, 1999; Chambers, 1983). The Department for International Development (1999) defined livelihood as the assets, capabilities and activities required to obtain a living. They further asserted that livelihood is deemed sustainable only when individuals can effectively adapt their assets and become resilient to shocks, trend and seasonality both now and in the future without compromising the natural resource base.

From a climate variability and change perspective, a core element that determines how individuals and households can adapt and become resilient to the changes in climatic conditions have been attributed to their asset portfolios (International Institute for Sustainable Development (IISD), 2003; Moser and Satterthwaite, 2008). Bebbington (1999) argues that "assets are the resource endowments and capabilities that people have to sustain their livelihood and enhance their welfare". In other words, it gives individuals the "capability to

be and to act" (Bebbington, 1999). The indispensable assets or capital are natural, physical, social, financial and human capitals (Moser and Satterthwaite, 2008; Moser and Stein, 2011a). These assets or capitals (see Table 1), en masse, serve as the basis for understanding how people will respond to climate variability and change (IISD, 2003).

Table 1: Definition of the five fundamental assets or capitals

Asset or capital	Definition
Physical	This includes equipment, infrastructures such as road networks and other productive resources owned by individuals, households, communities or the country itself.
Financial	This refers to financial resources available and easily accessible to individuals, which includes loan, access to credits and savings in a bank or any other financial institutions.
Human	This refers to the level of education, skills, health status and nutrition of individuals. Labour is closely associated with human capital investments. Health statuses of individuals impact either positively or negatively on their ability to work, while skill and level of education is crucial because it influences individuals return from labour.
Social	This refers to the norms, rules, obligations, mutuality and trust embedded in social relations, social structures and societies' institutional disposition.
Natural	This refers to the atmosphere, land, minerals, forests, water and wetlands. For the rural poor, land is an essential asset.

Sources: Bebbington (1999); Thornton et al. (2008); Moser and Satterthwaite (2008); Moser (2011)

Moser and Satterthwaite (2008) argue that asset adaptation refers to the measures or steps adopted by individuals or households in preparation for, or in response to, actual or expected changes in weather conditions. The aim of undertaking these actions is to minimise adverse impacts or to take advantage of the opportunities presented by these changes (Frayne et al., 2012). This is because climatic risks have been observed to present some windows of opportunities (see, e.g., Scheraga and Grambsch, 1998). The above claim is based on two premises; first, it has been observed that the vast majority of assets owned by individuals and households, particularly the poor, are susceptible to multiple stresses, shocks, trends and/or

seasonality (see Frayne et al., 2012). Thus, there is the need for the poor to adopt various strategies in order to minimise the adverse effects of climate variability and change and associated risks on their livelihood assets. This is because the more assets people have or have easy access to, the better equipped they will be to continue in food production and vice versa in the aftermath of an extreme weather event (Prowse and Scott, 1998).

The second premise is the fact that the poor are not docile or passive victims to the impacts of climate variability and change. They are actively and consistently trying to seek various ways in which they will be able to protect and modify their assets against climate variability and change (Frayne et al., 2012). It is, however, important to note that there are three major ways in which individual's and households employ asset-based adaptation strategies to minimise the impacts of climate variability and change on their livelihoods. They are:

a) Asset-Based Adaptation to Build Long-Term Resilience: This is arguably the most effective means of preventing extreme weather events. But for the poor, it can be the most difficult to implement due to the limited resources at their disposal (Moser, 2011). Insuring farmlands, for example, could be a means whereby households can protect their food, which is crucial for the attainment of the livelihood they pursue, against the extremities of weather conditions. However, this act can have adverse implications for the financial capital of the rural poor because the premiums could be extremely high. Other asset-based adaptation strategies employed by households to build long term resilience include renting or purchasing a farmland in a region less prone to extreme weather events, which could have negative consequences on the poor's financial and social capitals (see Moser, 2011).

b) Pre-disaster strategies to minimise damage to productive assets: Prior to any anticipated extreme weather event, adopting strategic or planned actions can inherently minimise the loss of productive assets (Moser, 2011). This is crucial to communities that are

highly susceptible to extreme weather events, especially those that have limited resources to invest in long-term resilience strategies. To facilitate asset-based adaptation by protecting and limiting damage to livelihood assets, social capital, for example, can be crucial. To illustrate, there is a tendency for social capital to facilitate the dissemination of climate information in a timely fashion within communities projected to be affected by a predicted extreme weather condition (see Moser, 2011; Moser and Stein, 2011a). This could enable the poor adopt strategies such as early planting, planting crops on elevated ground (if the farmland where they usually cultivate on is highly susceptible to flooding) and early harvesting. Within this context, IKS have been observed to play a pivotal role in minimising the loss of the farm produce and other productive assets of the rural poor (Eakin, 1999; Nkomwa et al., 2014; Roncoli et al., 2002).

Roncoli et al. (2002), for example, argue that prior to the 1997 food shortages in Burkina Faso, the resource-constrained farmers, through the use of their IKS, were already aware of a looming crisis six months before the official forecast was disseminated. In a related vein, Fabiyi and Oloukoi (2013) argued that the appearance of the full moon in some rural coastal communities in Ondo and Delta States of Nigeria, was an indication that coastal flooding was imminent. As a result, the farmers started preparing to harvest their farm produce. These case studies suggest that, while local farmers lack a thorough understanding of the processes that lead to the change in climatic conditions they are experiencing, they possess a detailed understanding of their local environment as well as the indigenous flora and fauna (Eakin, 1999; Pareek and Trivedi, 2011). This is, arguably, because their livelihoods are overwhelmingly tied to the natural environment and therefore, they have come to rely on various local indicators to predict future weather events and prepare accordingly.

c) Asset-based adaptation after extreme weather events: In the aftermath of any disaster, individuals and households usually embark on rescue missions with a goal to recover those assets that have been partially affected by the disaster. Subsistence farmers, for example, will go out and attempt to harvest crops that did not rot away in the aftermath of a flood episode (see Frayne et al., 2012). In the aftermath of an extreme weather event, human and social capitals, for example, could play an immense role in enabling the poor bounce back into food production. This is because friends, relatives and some governmental and NGOs can provide financial assistance and/or offer to lend them parcels of land and seedlings, so that they can engage almost immediately in food production, thereby ensuring that they continue to obtain the livelihoods they aggressively pursue (Frayne et al., 2012).

It is, however, noteworthy to mention that there are growing concerns that future climate-related events will overwhelm the ability for IKS to predict weather events accurately due to the unprecedented rate at which extreme weather conditions are expected to occur globally (IPCC, 2014b; Kalanda-Joshua et al., 2011; Roncoli et al., 2002; Shepherd et al., 2013). Consequently, only by planned adaptation strategies will the rural poor be able to protect and adapt their assets, and in so doing, continue more effectively in food production (Fankhauser et al., 1999). It is within this context that proponents of SCF argue that it is a technology can facilitate effective asset adaptation and minimise the adverse impacts of climatic risks on the agricultural practices of the rural poor (Hansen et al., 2011; Phillips et al., 2001; Vogel, 2000).

There is emerging consensus that advances in SCF on its own will enable economic and social benefits to accrue (O'Brien, 1993). However, by merely providing more accurate SCF to subsistence farmers and other interested parties alone will not suffice. For subsistence farmers and other end-users to benefit from SCF, it is argued that the forecast must be disseminated in a timely fashion, communicated through the right mediums and in a language

that are familiar to the poor rural households (Padgham et al., 2013). Communicating in a local dialect where feasible, for example, will be more effective than a second language (Padgham et al., 2013). Other factors that are critical to the uptake of SCF by subsistence farmers include using a trusted messenger to convey the forecast, communicating the limits of the forecast and subsistence farmers must be willing to align their farming practices with the forecast (Fraisse et al., 2006; Hallegatte, 2012; Longstaff and Yang, 2008).

It has also been argued that anticipated extreme weather events should be conveyed to vulnerable groups by personalising or tailoring the message. Individuals need to be able to effectively understand how the predicted extreme weather will affect their livelihood. This will enable them to adopt proactive behaviours that will aid in mitigating the impacts of the anticipated extreme weather event (Lorenzoni and Pidgeon, 2006; Pelletier and Sharp, 2008). According to Spence and Pidgeon (2010), "personal relevance impacts on the ways in which information is processed". Meyerowitz and Chaiken (1987), by contrast, argue that proactive behaviours will only be adopted when the consequences of inaction has been successfully communicated. Nonetheless, studies have shown that being a past victim of an extreme weather condition plays a pivotal role in the adoption of proactive actions (Jackson, 1981; Siegrist and Gutscher, 2006).

In brief, it has been argued that individuals and households residing in spaces that are highly susceptible to climate change within developing countries often lack access to reliable information that could enable them build their resilience and adaptive capacity to climate variability and change (Roncoli et al., 2002). The need for SCF, and more importantly, effective communication strategies through competent communicators, cannot be overemphasised (Padgham et al., 2013). Ideally, the first step should be to identify the vulnerable groups and then listen to what is of utmost importance to them. The next step will be to explain to them how the anticipated extreme weather condition can erode those items

that of utmost importance to them, including the assets that enable them to obtain their livelihoods on a yearly basis. Thereafter, practical and realistic measures they can undertake in order to minimise the proposed impacts on their livelihood assets should be proposed (Somerville and Hassol, 2011). This is essential because SCF is only beneficial when there are potential responses that can be undertaken by individuals and households to protect and adapt their livelihood assets (Fraisse et al., 2006).

1.4. Significance of the study

There is scant evidence in the literature regarding the ways in which climate variability and change have negatively affected the livelihood of subsistence farmers in Nigeria, including the adaptive strategies the farmers employ to "outwit" the adverse impacts of climatic risk on their livelihood (Enaruvbe and Yesuf, 2012; Ifeanyi-obi et al., 2012; Oparinde and Hodge, 2011). However, within the context of the rural Delta State, there is no documented evidence on the various strategies that subsistence farmers employ in a bid to maximise their asset portfolios in order to continue in food production in the face of climate variability and change. Also, no study has been able to bring to the fore the strategies and techniques utilised by subsistence farmers to protect and adapt their household assets in anticipation of, or just before an extreme weather condition occurs. This study is crucial because findings from this and parallel studies conducted within the Nigerian context can provoke meaningful discussions on the most effective measures that development practitioners need to put in place in order to ensure that they create useful platforms that can facilitate the protection and accumulation of subsistence farmers' crucial assets. This is of crucial because assets, as emphasised by Bebbington (1999), "give people the capability to be and to act". Thus, the erosion of the assets of subsistence farmers can, in the long run, undermine their ability to

bounce back swiftly into food production in the aftermath of an extreme weather condition and obtain the livelihoods they pursue.

Also, in spite of the fact that the Nigerian Meteorological Agency (NIMET) usually forecast seasonal rainfall and temperature variations annually, no literature within the context of Nigeria has documented the role that CCRC has played in facilitating asset-based adaptation among subsistence farmers to extreme weather events. Further, apart from Fabiyi and Oloukoi (2013), no study has documented the various IKS that subsistence farmers in the rural Delta State utilise to anticipate future weather conditions and what factors, if any, have facilitated the loss or increased unreliability of their IKS. It is, therefore, imperative to bring to the fore the factors that have and is still contributing to the loss of the farmer's IKS, which most indigenous people hold in high esteem (see Janke, 2005). This is to ensure that effective and sustainable measures can be undertaken where possible to prevent or minimise the loss of IKS. The aforementioned formed the basis for this study. Thus, findings from this study can provide crucial insights for the review of policies such as National Adaptation Programs of Action (NAPAS).

1.5. Philosophical underpinning

According to Asif (2013), all social science research adopts either positivism, interpretivism or critical philosophical positions. However, for the aims and objectives of this study to be met, the interpretivist philosophical position was adopted. The interpretivist paradigm, which was generated as a critique of the positivist approach, was founded on the theoretical assumption that reality is usually constructed within a social context (Robert Wood Johnson Foundation (RWJF), 2008). In other words, our cultural background, social settings and interaction with others, tends to define or shape what we know (RWJF, 2008). Thus, reality exists as individual's experience it and assigns meaning to it (Neuman, 2014).

The adoption of the interpretivist paradigm was primarily due to the fact that it relies extensively on naturalistic methods (RWJF, 2008). To illustrate, the researcher had to rely extensively on the views of the rural poor in a bid to understand the impacts climate variability have had on their livelihood assets as well as the steps they usually take to protect and adapt their livelihood assets in the face of climate variability. Also, the researcher had to depend on the views of the participants to understand why they do not rely on SCF to protect and/or adapt their assets. This, in turn, enabled the researcher understand motives, meanings and other subjective experiences that shaped the decision making process and behaviour of the rural poor (Hudson and Ozanne, 1988; Neuman, 2014).

1.6. Research design

The study was purely qualitative. Qualitative methodologies, as Taylor et al. (2016) point out, are well suited to collect descriptive data. They further argued that it places huge emphasis on data that fully captures participant's views and perceptions regarding the subject(s) matter under investigation. In other words, qualitative methodologies create avenues for participants to freely air their thoughts and concern on the issue(s) under investigation, without being restricted to the best suitable pre-conceived answers that often characterises closed ended questions (quantitative) based studies. In addition, qualitative methodologies, as Crang (2002) asserts, enable researchers to see "economic activities as a set of lived practices, assumptions and codes of behaviour".

1.6.1. Snapshot of the Delta State

The study sites are located in the Delta State, which is situated in the Niger Delta region of Nigeria. Geographically, it is located between longitude 5˚ 00' and 6˚ 45' East and between latitude 5˚ 00' and 6˚30' North of the Greenwich Meridian. It is bounded to the north and

west by Edo State, to the north-west by Ondo State, to the east by Anambra, Imo and Rivers States, to the south-east by Bayelsa State and on the south-west by the Bright of Benin, which covers about 160 kilometres of the state's coastline. The State has a population of approximately 4, 098, 291 inhabitants, and a total surface area of 16, 842 Km^2 (National Bureau of Statistics (NBS), 2014a). The Delta State is divided into three senatorial districts; Delta North, Delta Central and Delta South. There are eight Local Government Areas (LGA) in each district with the exception of Delta North, which comprises nine LGA (Delta State, 2014). The Delta State is generally low-lying without remarkable hills. The southern parts of the State are transverse by numerous flat floored rivers that drain into the Atlantic Ocean. Furthermore, it is predominantly a low lying coastal area without prominent hills (Emaziye et al., 2012).

The Delta State is characterised by a lengthy rainy season (commonly referred to as the wet season), which usually commences from May to October, and a dry season, which begins in November and ends in February. Prior to this, the early rain usually commences from February and continues until the last week in May. A short spell of dry season termed "August break" usually interrupts the rainy season in the month of August or on rare occasions in late July. Temperatures are relatively high and constant throughout the year. Average monthly maximum and minimum temperatures range from 28˚C to 38˚C and 21˚C to 23˚C respectively (Niger Delta Development Commission (NDDC), 2005). The average annual rainfall, according to Emaziye et al. (2012), is approximately 3,000mm.

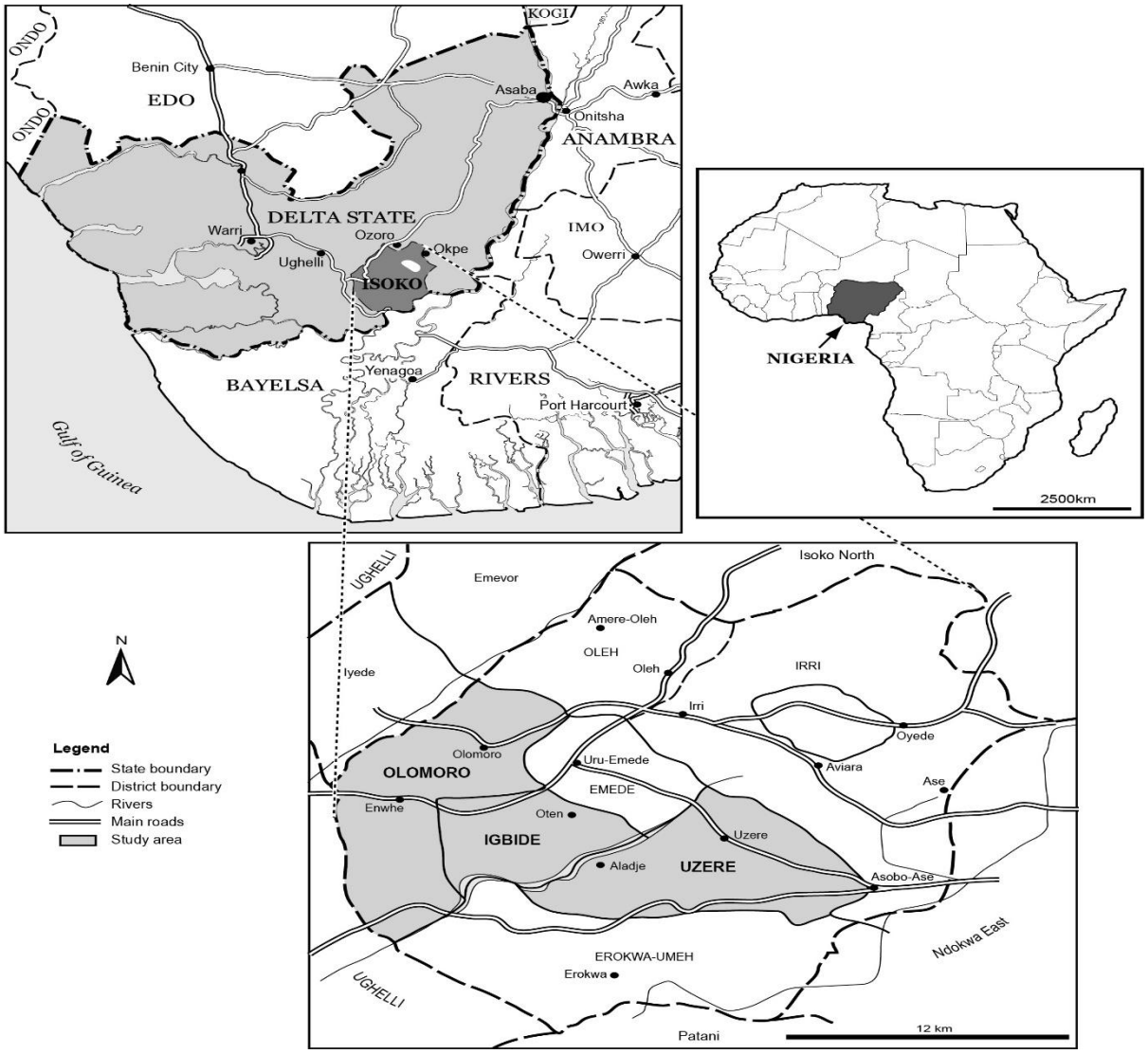

Figure 1: Map of the study areas in the Delta State of Nigeria. *Source:* Wendy Philips (2015), cartographic unit, the University of the Witwatersrand.

Although the State derives 79% of its revenue from oil exploration, agriculture is the highest employing sector, particularly in the rural communities. In fact, approximately 90% of subsistence farmers depend on agriculture for its livelihoods, with the majority living below the global poverty line of living on less than two US dollars a day (International Fund for Agricultural Development (IFAD), 2014; Ike and Uzokwe, 2015). Crop farming, as documented by Ojeh et al (2012), is the major type of farming activity the subsistence

farmers in the rural Delta State engage in. According to Jemiriye (1998), the majority of rural households, who depend on subsistence farming for its livelihood, are Christians.

According to Obioha (2008), the predominant extreme weather event that besets the Delta State on a yearly basis is heavy rainfall. This view is reinforced by Ozor et al. (2012) who argued that rainfall is the main climatic variable that confronts the Delta State on an annual basis. It should be noted that Delta North senatorial district is the region least susceptible to heavy rainfall events in the Delta State. It has an average annual rainfall of about 1500mm (NDDC, 2005). Delta South, on the other hand, is the region that has suffered severe consequences from erratic rainfall and flood disasters in recent times, most notably the 2012 flood disaster (see Omohode, 2012).

1.6.2. Sampling procedure and methodological approach

Since the entire Delta South senatorial district is highly susceptible to flood disasters, it would have been ideal to interview participants from each of the eight LGA. However, due to time, financial and logistical constraints, it was not feasible for the researcher to adopt such a procedure. Thus, participants were drawn from Igbide, Uzere and Olomoro communities, situated in Isoko South Local Government Area (ISLGA) in the Delta South senatorial district (see Figure 1). The choice of these communities was hinged on Omohode's (2012) observation in the aftermath of the 2012 flood disaster. He stated that the aforementioned communities were completely submerged with no visible trace of any building, thereby making the entire area look like an emergency ocean when viewed from afar.

The study employed purposive sampling techniques was used to identify eligible participants for the study. Purposive sampling technique is, as Tongco (2007) aptly puts forward, “a type of non-probability sampling that is most effective when one needs to study a certain cultural domain with knowledgeable experts within”. Eligible participants were identified with the

help of key informants who have been residing in each of the communities for over 40 years, and an agricultural extension officer in ISLGA. Specific criteria's used in identifying the participants included those that have been farming in each of the study areas for a minimum of 10 years, gender, those whose household assets and livelihoods were adversely affected by the 2012 flood disaster, and those that cultivate predominantly on low-lying farmlands.

This study comprised 35 Focus Group Discussions (FGDs) in total i.e. 11 FGDs in Uzere, 15 in Olomoro and nine in Igbide. Of the 35 focus groups, 24 were made up of female participants; five were made up of male participants; while six comprised both male and female participants. The fundamental reason for having more female FGDs is because feminisation has been observed to be the primary driver of subsistence farming, particularly in the context of rural developing countries (Binns et al., 2012; Mberu, 2005). Each of the FGD was made up of about three to twelve participants. The rationale for having about two-thirds of the FGDs made up of women is because they are the ones that are actively involved in food production. Two-thirds of the participants were between the ages of 40 and 85. In addition, 14 individual face to face semi-structured interviews were also conducted with participants in the study areas. The fieldwork was conducted between June 2015 and July 2016.

FGDs and semi-structured interviews facilitated the use of the Participatory Climate Change Asset Adaptation Appraisal (PCCAA) framework. The PCCAA framework comprises two closely related components: the asset vulnerability analytical and the asset adaptation frameworks (Moser, 2011). The PCCAA uses the principle of a bottom-up approach, whereby it is the participants themselves who identified the ways in which climate variability has directly or indirectly facilitated the erosion of their asset portfolios (see Moser, 2011). Furthermore, the use of the PCCAA approach enabled the researcher to understand the

institutions that facilitated the ability of subsistence farmers to bounce back quickly into food production in the aftermath of the 2012 flood disaster strictly from the participants' lenses (Moser, 2011).

In addition to the aforementioned, 15 questionnaires with open ended questions were administered to agricultural extension workers in ISLGA, identified using stratified purposeful sampling technique. Also, semi-structured interviews were conducted with two senior Nigerian Meteorological Agency (NIMET) officials in the forecasting department situated in the NIMET headquarters, Abuja and a NIMET official in the Delta State in charge of disseminating daily rainfall and temperature data's to media outlets in the State. The overarching aim was to understand their role in the dissemination of, and helping subsistence farmers in the Delta State to make sense of SCF. Other aims included unpacking the strategies used in disseminating extreme weather warnings, and the challenges the NIMET officials are usually confronted when disseminating SCF to subsistence farmers that depend on agriculture for their primary source of livelihood.

Finally, a semi-structured interview was conducted with a senior official of the Nigerian Red Cross Society in the Delta State. The official was actively involved in the search and rescue operation during and in the aftermath of the 2012 flood, as well as ensuring that those displaced were successfully registered and camped in Internally Displaced Person's (IDP) camps provided by the Delta State government. The data were analysed using the thematic content analysis technique. The aforementioned analytical technique enabled the researcher to quantitatively present observed patterns emanating from the FGDs and interviews, attribute meanings as well as underlying motives to the observed patterns (see Rejnö et al., 2012).

1.7. Structure of the thesis

This thesis comprises seven chapters including this introductory chapter. The thesis is made up of five scholarly papers including one published paper, one accepted paper and three others that are currently under review. The first paper (chapter two) provides empirical evidence of the impacts of climate variability on food production. This chapter uses the PCCAA framework to explore subsistence farmer's vulnerability to extreme weather conditions. It also highlights the various forms of asset adaptation strategies that the farmers employed during the 2012 flood disaster, and how the subsistence farmers drew on their asset portfolios to bounce back into food production. The second paper (chapter three) makes a case for the asset vulnerability analytical framework and systems thinking as methodological imperatives to effectively understand how vulnerable subsistence farmers in the Delta State are to climatic and non-climatic stresses and stressors from an asset based perspective. In addition, this chapter brings to the fore issues that could compromise the ability of households to continue in food production in the future if livelihoods are pursued under the current state of affairs without any behavioural adjustments or "radical" policy interventions. The third paper (chapter four) foregrounds the consequences of not relying on the various forms of indigenous techniques of communication, which the subsistence farmers rely upon to receive vital pieces of information. The fourth paper (chapter five) identifies the various IKS that the subsistence farmers in the Delta State use to anticipate future weather conditions. The paper also unpacks the factors that prevent the poor from utilising SCF when making farming decisions. The fifth paper (chapter six) conceptualises a framework that integrates SCF with indigenous systems of forecasting. The overarching aim is to enable SCF compensate for the deficit of IKS. Chapter seven presents key findings of the study and suggest viable policy recommendations to development actors that could aid in building the

resilience and adaptive capacity of the subsistence farmers to current and future extreme weather events.

CHAPTER TWO

Defying the odds: climate variability, asset adaptation and food security nexus in the Delta State of Nigeria[1]

Abstract

There is overwhelming evidence to suggest that the adverse impacts of climate variability and change are making it increasingly difficult for the poor rural populations, particularly those in sub-Saharan Africa (SSA) to continue engaging in meaningful agriculture and obtain secure livelihoods. This is, partly, because agricultural productivity in SSA is highly dependent on rainfall. Thus, the slightest variation in climatic conditions has the potential of subjecting a large proportion of the rural poor to increased poverty and misery as the ability to obtain their livelihoods can be compromised. Despite the effects of climate variability and change on rural livelihoods, the rural poor are not passive actors. They are actively and consistently involved in adapting and modifying their asset portfolios to reduce the impacts of climate variability, and consequently, build their adaptive capacity and resilience. Drawing on a recent field-based research conducted in the Delta State of Nigeria and using the Participatory Climate Change Adaptation Appraisal (PCCAA) framework, this paper discusses the various asset adaptation strategies employed by the rural poor in building their adaptive capacity and resilience to extreme weather conditions. These issues have been explored in the broader theoretical debates revolving around climate change adaptation and food security in countries of the developing South.

Keywords: *Climate variability, food security, assets, Nigeria.*

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2.1. Introduction

Globally, there is now overwhelming evidence to suggest that climate variability and change have been occurring at unprecedented levels (Intergovernmental Panel on Climate Change (IPCC), 2014a; Moser, 2014). Climate variability and change has been observed to negatively affect the environmental, social, economic and agricultural sectors in various parts of the world especially in less economically developed countries. This is because of high levels of poverty, limited technological advancement and adaptive capacity both at the national and grassroots levels (Chavas et al., 2009; Perez et al., 2015). It is, however, argued that no sector has been more adversely affected like agriculture (Bandara and Cai, 2014; IPCC, 2014). This is, in part, because a vast range of agricultural activities that people in developing countries engage in are predominantly dependent on rainfall (Challinor et al., 2007; Conway and Schipper, 2011; Thomas and Twyman, 2005). Thus, the slightest variation in rainfall patterns can have devastating implications for agricultural yields and productivity (Nelson et al., 2014). The IPCC (2014a) reverberated that the changes in climatic conditions are partly responsible for the increased difficulties preventing the poor in SSA from engaging in more meaningful food production practices. It has also been argued that the vulnerability of the poor people in many rural spaces in sub-Saharan Africa (SSA) to climate variability and change are exacerbated by limited technological advancement, low levels of education, rapid population growth, high rates of poverty, lack of social safety nets, and weak institutional setup and policy frameworks (Binns et al., 2012; IPCC, 2014a; Perez et al., 2015; Roudier et al., 2011).

Nigeria, like many other countries in SSA has had its share of the impacts of climate variability on agriculture, a sector that contributes approximately 20% to the nation's Gross Domestic Product (GDP) thereby making it the mainstay of the economy after crude oil (National Bureau of Statistics (NBS), 2014b; World Bank, 2016). Furthermore, it has been

estimated that 66% of the nation's labour force are actively involved in agriculture, making it the largest contributor to employment in the country (Food and Agriculture Organisation of the United Nations (FAO), 2016). Within the Nigerian context, agriculture plays a crucial role in the survival of many rural households, as it forms the basis for income generation as well as myriad sources of livelihoods that are available to the rural people. In the rural Delta State, for instance, about 90% of all households are rigorously involved in food production (International Fund for Agricultural Development (IFAD), 2014; Niger Delta Budget Monitoring Group (NDBMG), 2005). However, the changes in climatic conditions, which have been observed in the form of rising temperatures, erratic rainfall patterns, and seasonal flooding (Adejuwon, 2006; Enaruvbe and Yesuf, 2012; Ifeanyi-obi et al., 2012; Ozor et al., 2012), have become a serious cause for concern among the rural poor mainly because the expected crop production output can no longer be guaranteed. This was vividly illustrated by a farmer, in her late 60's, from Igbide in Isoko South Local Government Area (ISLGA) in the Delta State when she stated that:

> *In the past, this community used to receive enough rainfall between March and May of every year to cultivate and produce enough food. But nowadays, like this year (2015), for example, things were different. There was not enough rainfall and we were unable to produce enough food as we normally did in the past. See what is happening now. We are in July and it is raining constantly. But we cannot afford to plant now because our farmlands, which are low-lying, will be flooded anytime from now. So we have to harvest our farm produce before this happens* (*Pers. Comm,* 2015a).

Within the literature on climate change in Nigeria, there is a recognition that the impacts of climate variability and change are undermining the efforts of many poor rural households to engage more meaningfully in agricultural production (Adejuwon, 2006; Enaruvbe and Yesuf,

2012; Ifeanyi-obi et al., 2012; Ozor et al., 2012). It has been argued that climate variability and change have the tendency to compromise the ability and potential for rural agriculture to contribute enormously to economic growth and national development of the Delta State (Roudier et al., 2011; Spielman et al., 2010; World Bank, 2000). In view of the above arguments, various avenues have been identified and explored in an attempt to build the resilience and adaptive capacity of rural population in Nigeria and SSA as a whole, and in so doing, minimise the adverse impacts of climate variability and change on the lives of the poor. These avenues include educating and effective dissemination of information on climate variability and change, planting early maturing and drought tolerant crops, alternating planting dates, engaging in off-farm activities (Agrawal and Perrin, 2008; Ellis, 2000) and migration (Simatele and Simatele, 2015a). Others include development of strong social networks, the sale of assets, use of early warning and monitoring systems, irrigation of farmlands, establishments of safety nets in order to minimise the adverse effects of climate variability and change, insurance of crops, and construction of dykes (Ochieng et al., 2016; Perez et al., 2015), to mention but a few.

Nonetheless, some authors have argued that if policy developers utilise the asset-based adaptation framework developed by Moser and colleagues, it will be relatively easy to identify appropriate policy interventions and entry points necessary to build the resilience and adaptive capacity of the poor (Moser, 2011; Simatele and Simatele, 2015b). The framework is premised on the assumption that individuals, households and communities are not passive, but active actors who possess resources that they deploy to respond to emergencies such as extreme weather conditions (Asian Coalition for Housing Rights (ACHR), 2005; Moser, 2011). These resources, in the context of asset adaptation, are referred to as asset portfolios, bundle of assets, capital assets or endowments and entitlements. It comprises the human, financial, physical, natural and social assets. It is against this background that this paper seeks

to understand how the rural poor households in ISLGA draw on their asset portfolios to build their adaptive capacity and resilience to the impacts of climate variability and change in order to ensure household food security.

2.2. Assets and food security nexus in a changing climate: realities in the developing world

It has been argued that future impacts of climate variability and change will be particularly severe for about 80% of the rural people in the developing world whose primary source of livelihood (agriculture) are overwhelmingly dependent on rainfall (Calzadilla et al., 2013; Shepherd et al., 2013). Without putting effective adaptive measures in place, climatic impacts will likely impede the ability for the present and future generations to produce more food locally and sustainably (Godfray et al., 2010). This will exacerbate the food insecurity situation and challenges in the developing world and SSA in particular, a region already classified as food insecure (Schmidhuber and Tubiello, 2007). The impacts of climate variability and change will not only be felt in rural areas but also in urban areas since it is estimated that 60 – 80% of the food consumed in the urban spaces of the developing world are produced by the rural people (Mehra and Rojas, 2008). With the global population expected to reach 9 billion by 2050, the ability to produce more food could be further compromised due to stiff competition for viable farmlands (Godfray et al., 2010). This observation, therefore, entails the need to develop adaptive measures that will build the resilience of rural population in order for them to win the fight in becoming food secure and ensure sustainable development.

Seeking solutions to ensure food security in the context of developing countries that are already adversely affected by climate variability and change is not an easy task. Many of the developing countries are beseeched by a number of vulnerabilities and deprivation markers

among which include; high levels of poverty, unemployment, high mortality rates, low levels of education, increased levels of environmental degradation and a prevalent disease environment, which makes the formulation of any policy intervention measures a mammoth task. Simatele and Simatele (2015b), however, argued that policy makers and development professionals should develop systems and mechanisms for identifying the key assets[2] that plays a crucial role in ensuring the poor obtain a livelihood. This process would then enable them to develop appropriate intervention measures that would be aimed at prioritising and enhancing the most important assets that the poor households use to build their adaptive capacity and resilience against the impacts of climate variability and change (Moser, 2011; Moser and Satterthwaite, 2008). Several pieces of literature have illustrated how the poor actively engage their critical assets in order to continue in food production and ensure household food security in the face of an extreme weather condition.

In Jamalgonj Upajila, under the province of Sunamgonj in Bangladesh, for example, Al Mamun and Al Pavel (2014) pictorially captured how the poor drew on their human and natural assets[3] to continue in food production on their flooded farmland. The subsistence farmers practiced heap adaptation method whereby they firmly place a tukri[4] on the heaps of the water weed that usually pile on the apex of the waterlogged farmlands. Next, they constructed a platform using bamboo sticks adjacent to the heaps in order to allow creeping plants thrive. In a related case study, Motsumi et al. (2012) highlighted how the poor in Ngamiland district in Botswana who practiced flood recession farming (locally known as *molapo* farming) employed their human capital to produce food. In the face of frequent episodes of desiccation as a result of the receding flood water from the farmland, the people

[2] Assets (capitals) refer to "resource endowment and capabilities that people have to sustain their livelihoods and enhance their welfare" (Moser and Stein, 2011).

[3] Human capital refers to level of education, health status, nourishment, skills and attributes embodied in an individual that promotes the creation of personal, social and economic well-being. Natural capital refers to resources drawn from nature such as soil, grass, trees, etc. (Bebbington, 1999; Moser, 2011).

[4] Tukri refers to a bamboo basket where soil has been immersed in it as well as the seedling and cow dung.

in Ngamiland maximised the moisture left by the receding flood water by planting crops like maize, millet and sorghum that mature within a short timeframe. To maximise output, they ploughed the regions in their fields were the grasses were tall, an indication of good quality soil for optimal food production.

A remarkable feature of the two case studies, however, is that they illustrate carefully crafted adaptive measures by individuals with low levels of formal education. Low levels of education have been listed as a contributing factor to low levels of adaptive capacity of individuals and households to climate variability and change. A study carried out by Loevinsohn (2009), for example, concluded that a combination of low levels of education and climate variability were, in part, responsible for a crisis of social reproduction that culminated in low agricultural productivity vis-à-vis a famine that later ensued in Malawi. On the contrary, other scholars have argued and demonstrated how the poor draw on their portfolio of assets and IKS to minimise the impacts of climate variability and change on food production (Mavhura et al., 2013; Paul and Routray, 2010).

Although many of the poor rural households use a combination of assets to deal with both internal and external stressors, social capital have been identified as one of the most important assets that they employ to build their resilience and adaptive capacity against the adverse effects of extreme weathers (Adger, 2003; Oni and Fashogbon, 2012; Simatele and Simatele, 2015b). Social capital refers to those social networks and ties that people build by living together in a community and the interactions that ensue thereof. At its core are issues of trust, reciprocity, mutual understanding, shared norms and values, as well as network that facilitates cooperation and coordinated actions among individuals, households and communities (Adger, 2003; Joshi and Aoki, 2014; Paul et al., 2016). Social capital is perceived to be a stock through which a pool of benefit flows, which is why it is commonly referred to as an intangible asset. For the poor, social capital has been acknowledged to

facilitate the procurement of other capital assets such as financial and physical assets, which plays prominent roles in food production and also in minimising the adverse effects of climate variability (see, e.g., Abenakyo et al., 2007; Simatele, 2010).

Financial capital, for instance, has been acknowledged to foster economic productivity among rural households, thereby making substantial contributions to the asset portfolios of those with easy access to it, as opposed to those unable to access loans from formal financial institutions (Akoijam, 2012; Akudugu, 2011). The reality for majority of the rural poor in the developing world, however, is that there are rarely viable platforms through which they can have easy access to funds (Dulal et al., 2010). It is within this context that bonding social capital has been observed to act as a cushion that helps to alleviate the poor's financial woes. Simatele (2010), for example, observed that bonding social assets, through the cultivation of shared aspiration, trust and values, resulted in the development of stokvels[5] (indigenously referred to as *Chilimba*) in Kalingalinga and Linda compounds in Lusaka, Zambia.

Although stokvel members share the money on a rotational basis, there is a lot of flexibility that enable members to draw resources whenever the need arises, although prior negotiations is mandatory for this to happen. He also stated that bonding social capital played a key role in enabling flood victims to secure shelter, food and other essential amenities necessary to sustain themselves during and in the aftermath of a flood disaster (Simatele, 2010). Social capital also has the potential of linking members of a group or network to other networks beyond the boundaries of their ethnic, racial or religious beliefs (Adger, 2003; Joshi and Aoki, 2014; Paul et al., 2016). Thus, poor people can have an opportunity to be linked to key institutions or political groups that are beyond their local communities, which can play

[5] Stokvels serve as rotational credit or saving schemes. It involves members contributing fixed sums of money to a central fund on either a weekly, fortnightly or monthly basis. The cumulative amount is then disbursed to each group member on a rotational basis.

significant roles in building their adaptive capacity and resilience to climate variability and change.

It has also been recognised that the poor usually engage in several asset adaptation measures before, during and after an extreme weather event (Mavhura et al., 2013). Asset adaptation, from a climate change perspective, refers to the steps taken by individuals in preparing for, or in countering and minimising the projected or actual impacts of a severe or extreme weather condition (Moser and Satterthwaite, 2008; Frayne et al., 2012). In Muzarabani, an area in Zimbabwe where seasonal floods in January or February have been the norm for decades, for example, Mavhura et al. (2013) observed that the locals engaged in various sequential asset adaptation strategies in order to prevent or minimise the erosion of their assets against flood waters. These strategies include placing of sandbags around the house to act as flood water defences, the use of construction materials not easily susceptible to cracking during flooding, construction of floating houses, elevating the kitchen and storeroom platforms in order to adequately preserve food, water, and other assets during flooding. Other asset adaptation measures known to have been adopted by vulnerable people include taking shelter on higher ground, moving personal belongings, elevating mattress using bricks or stones, reducing caloric intake and relying more on cheap foods, to mention but a few (Dulal et al., 2010; Mavhura et al., 2013; Paul and Routray, 2010; Simatele and Simatele, 2015b).

These asset adaptation strategies are pivotal because the more assets people have the less vulnerable they are likely going to be to the impacts of climate change (Moser and Satterthwaite, 2008). Prowse and Scott (2008), for example, argue that by looking at the asset portfolios of individuals and households, one can determine those that will be able to adapt and recover swiftly from the impacts of extreme weather and become food secure. With global climate variability and change now expected to continue occurring at alarming levels, it is now a matter of urgency to seek and identify measures that will facilitate the building of

adaptive capabilities and resilience of people that are expected to be highly susceptible to climate induced weather events. One of such approaches is to build on the already existing knowledge that these individuals and households have and identify how they utilise their asset portfolios to cope with the impacts of climate variability and change. This is extremely important in the Nigerian context because, to my knowledge, no study has aptly demonstrated how the rural people, who produce most of the staples consumed in the country (see Attah, 2012), utilise their asset portfolios in adapting to climate variability and change.

2.3. Methodology

The paper is based on data that was collected in Olomoro, Igbide and Uzere communities located in ISLGA of the Delta State in Nigeria (see Figure 1). The choice of these communities was influenced by Omohode's (2012) observation in the aftermath of the 2012 flood disaster, the first of its kind in ISLGA. He observed that most of the coastal communities in the area were totally submerged without a visible trace of any building, thereby making the region look like emergency oceans when viewed from afar. These study sites will, therefore, not only serve as an important case study in understanding how subsistence farmers grow food in the face of climate variability, but also how they employ their asset portfolios to attain household food security in the aftermath of a flood disaster with devastating impacts.

It is documented that the mean annual rainfall from March–October in the Delta State ranges from 2500 to 3000mm (Adejuwon, 2011). The heavy rainfall events and coupled with the fact that the study areas are nestled within the boundaries of the lower Niger floodplain, with its tributaries traversing a large portion of the land mass (Ajeluorou, 2013), is responsible for the seasonal inundation of the low-lying farmlands in the study areas. According to the farmers, the low-lying farmlands are usually inundated from June to the last week in October every

year. In extreme conditions, the low-lying farmlands remain inundated until the third week in November.

Subsistence farming is the primary economic driver of these three communities, with the women mostly involved in the practice. The men usually engage in fishing, albeit some do assist their wives in food production. Cassava and groundnut are the predominant staples cultivated in all three communities on a yearly basis. Fieldwork data suggest cassava comprises approximately 65% of the total calories consumed in each community. Other staples planted in the study areas include yam, cocoyam, potato, pepper and plantain.

The Participatory Climate Change Adaptation Appraisal (PCCAA) framework, which employs the principles and practices of participatory research for data collection was employed in the study. The PCCAA framework comprises two components; the first is the asset vulnerability analytical framework, which identifies the links between different vulnerabilities and assets of the poor (Moser and Stein, 2011a). Although, vulnerability can be economic, legal, political, and social (Moser and Stein, 2011b), for the purpose of this paper, however, vulnerability was restricted to climate variability. The second component is the asset-based adaptation operational framework. It identifies the different asset adaptation strategies that enable social actors build their resilience to cope with, or reduce or recover from the adverse effects of extreme weathers (Moser, 2011). Further, the three closely interdependent phases of the asset-based adaptation framework; asset adaptation to build long-term resilience, asset protection during climate variability and asset rebuilding after a severe weather were also incorporated in the study (Moser, 2011). The aim was to get an avid description of the measures adopted by the farmers at each stage of the asset adaptation process.

In view of the above, Focus Group Discussions (FGD's) and semi-structured interviews facilitated the use of the PCCAA tools which include transect walk, brainstorming, causal flow diagram, community risk mapping, and historical timelines, among others. In total, the study comprised 35 FGD's and four individual face to face semi-structured interviews (two in Olomoro, one in Igbide and Uzere) conducted between June and October 2015. Of the 35 focus groups, 24 were made up of female participants; five were made up of male participants, while six comprised both male and female participants. Each FGD comprised three to 12 participants. The age of the participants ranged from 20 to 85. The purpose of separating most of the focus groups based on gender was twofold; first was to understand how the different genders were affected by climate change, the adaptive measures they embarked on and adopted to reduce the impact thereof. Second, it was to avoid related cultural issues where women might not be able to express themselves freely without the consent of their male counterparts, as they could be misinterpreted as being disrespectful if they do so. The data were analysed using the content thematic analysis technique.

The participants in each community were identified using purposive sampling based on age, gender, those who have been farming in the study areas for a minimum of 10 years, those whose household assets and livelihoods were severely affected by the 2012 flood disaster, as well as those that cultivate on low-lying farmlands. The identification process of the participants was facilitated by key informants that have been residing in each of the communities for over 40 years and an agricultural extension worker.

2.4. Results

2.4.1. Crops and assets vulnerability to climate variability and change

92% of the participants stated that heavy rainfall and flooding events were the most crucial weather phenomenon that adversely affected food production and other livelihood assets in

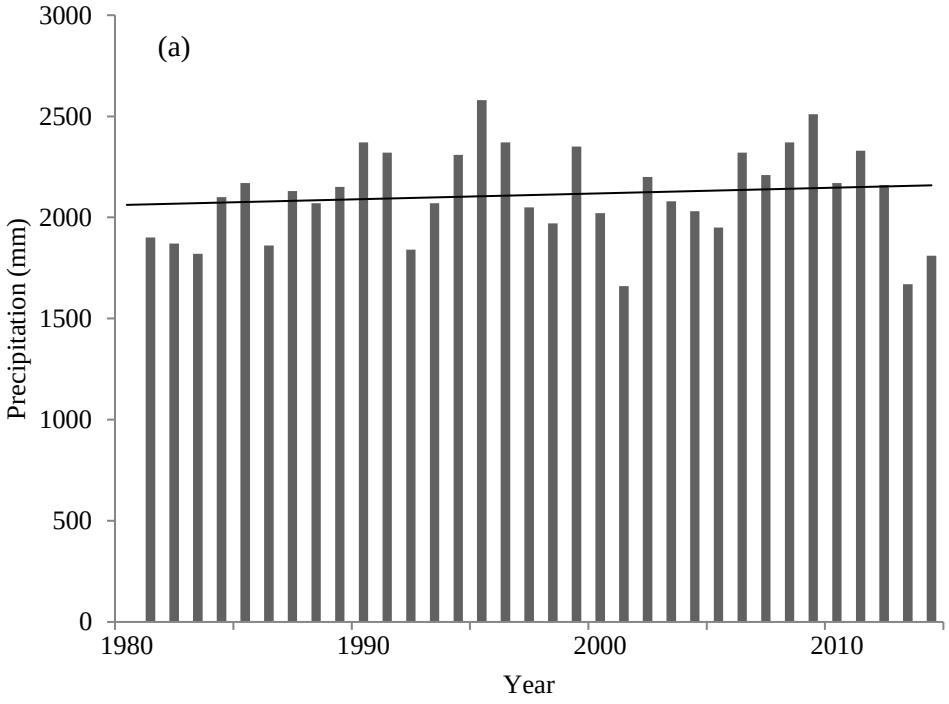
the study areas. The farmers in all the study sites overtly emphasised that seasonal flooding of their low-lying farmlands, which have always been part of the community's fabric, is one of the factors impeding the maximisation of their natural capital. For example, a farmer from Uzere, in his late 40's, lamented that:

> *One of the major challenges we face in Uzere is the seasonal planting that we do because our farmlands must be flooded as from July to October every year due to heavy rainfall. I wish we had high-lying areas to cultivate on; life would have been a lot easier for us because the high grounds are never affected by seasonal floods* (*Pers. Comm*, 2015b).

As documented by the IPCC (2014a), heavy precipitation events in Africa can create huge uncertainties for the livelihood of farmers due to the disruption of agricultural activities. As shown in Fig. 2a, the mean rainfall for Oleh in the Delta State, which is less than 20 km from the study areas, from 1981 to 2014 is 2111.94mm. Fig. 2b reveals that the mean rainfall value for the rainy season i.e. May to October from 1981 to 2014 is 3449.88mm. Thus, the high precipitation event and coupled with the low-lying farmlands makes it impossible for farming activities to be carried out between July and October, which is the heart of the rainy season. Consequently, they usually do not have more than enough food to sell and therefore, find it challenging to address some of their financial commitments comprehensively. It also has the tendency to result in malnutrition and undernourishment especially in the aftermath of a poor harvest due to the destruction of crops by floodwaters.

On the other hand, 62% of the participants underlined rising temperatures, particularly between February and April, as the second climatic variable impacting negatively on food production. While participants in their 40's and below argued that they started observing the warmer climate within the last decade, the elderly participants (50 years and above) argued

that the change in climate began from the early 1980's. Both parties, however, agreed that in the last five years, the temperatures in the preceding months have become agonisingly scorching. This has resulted in the inability for the majority of the farmers to work efficiently on their farmlands in the afternoons.



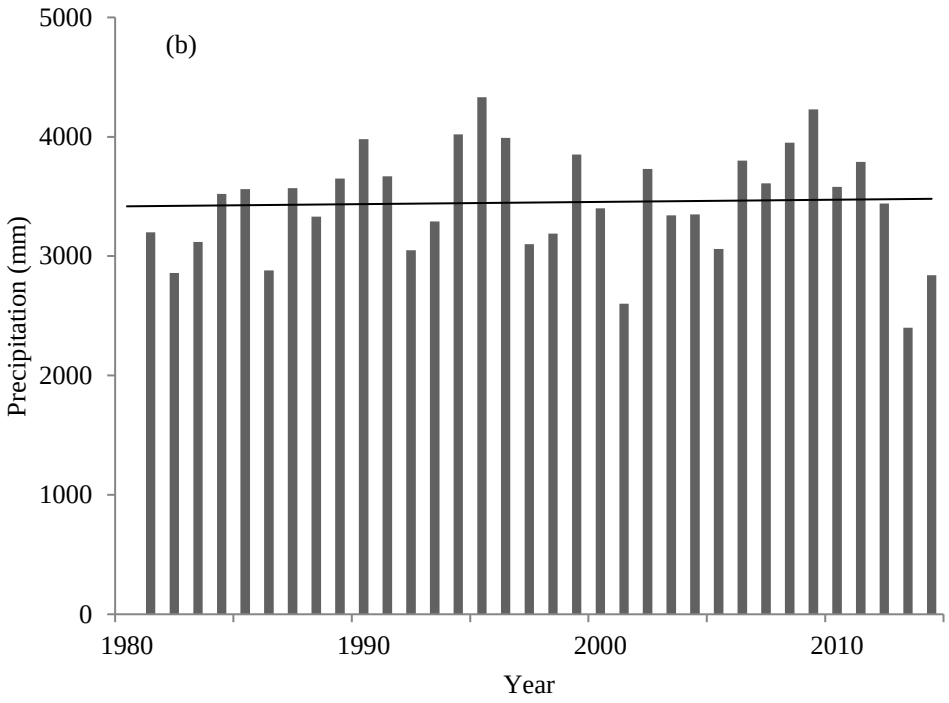


Figure 2: Rainfall data for Oleh (< 20km from study sites) from 1981 – 2014. Precipitation is the yearly mean (a) while (b) is the yearly mean for the rainy season (May – October) Source: Climate Hazards InfraRed Precipitation with Station (CHIRPS) data archive.

Further, the participants were of the view that the negative impacts of the warmer climate are mainly felt in groundnut production. A farmer residing in Igbide, in her 70's, for example, bemoaned that:

> *The sun these days between February and April is terrible. It is affecting most of our crops, especially groundnut...In the 1960's when you plant groundnut on a hectare of land in Igbide, you can harvest up to 10 to 12 bags (5kg bags). But today, when you plant on the same acre of land, hardly before you can harvest up to 5 bags. Most of the groundnuts harvested these days are just empty pods* (*Pers. Comm,* 2015c).

Scientific evidence corroborates the farmer's perception. Figure 3a shows that there has been an increase of 0.81˚C in mean temperature from 1960–2013. Figure 3b, which is the seasonal value (February to April) from 1960–2013, shows an increase of 0.86˚C rise in temperature.

With regards to factors contributing to the change in weather conditions, 81% of the participants echoed that the changes in weather conditions they are experiencing is as a result of supernatural forces. This understanding of the factors contributing to changes in climate was illustrated during a FGD by a female participant from Olomoro, in her 30's, who stated that:

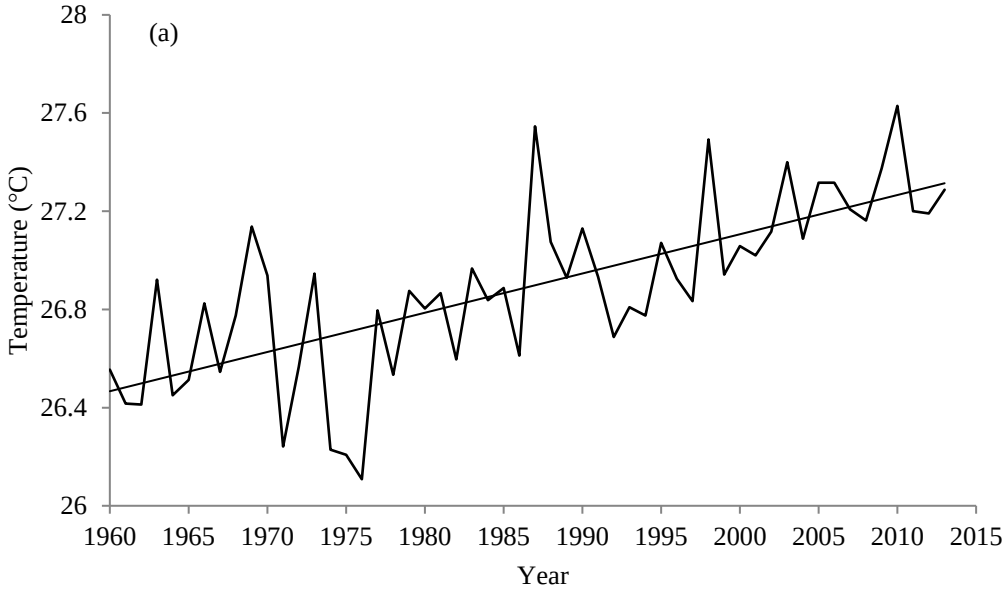
> *Our pastor said that the reason for the change in weather patterns that we are currently facing in this community is due to what our forefathers, who were idol worshippers, buried on the ground* (*Pers. Comm,* 2015d).

Despite this argument, some study participants, especially the youths, argued that the change in weather conditions can be attributed to the attitudes of the farmers. One youth in Uzere, for example, emphasised that the increase in temperature is due to the unprecedented rate at which deforestation exercises are being carried out by the farmers in order to obtain firewood. Two elderly participants, however, attributed the rising temperatures in recent years to constant gas flaring activities from the defunct Shell Oil Company exploration activities for over four decades[6]. In fact, an elderly male participant from Olomoro, in his 60's, commented:

> *Shell's oil exploration activities including gas flaring have been going on in this community for over 40 years. The flared gas causes the atmospheric temperature to rise, especially in those regions that are in proximity to the rig. Also, because of the exploration activities, the soil's natural nutrient has declined sharply, causing the quality of farm produce to reduce drastically* (*Pers. Comm,* 2015e).

[6] These communities, *en masse*, have 62 oil wells that Shell drilled oil from before selling all its oil wells in these communities to the Integrated Data Services Limited (IDSL), a subsidiary of Nigerian national petroleum corporation (NNPC), in 2014.

Over two-thirds (89%) of the farmers in all the study sites identified oil exploitation activities as the sole factor responsible for the decline in the quality of farm produce harvested, which has compromised the nutritional value of the food they now consume, especially *garri* (processed cassava). Just less than 10% of the participants underlined the inability to practice bush fallowing, due to land contestation stemming from massive population growth, as an additional key factor responsible for the reduction in the quality of farm produce harvested.



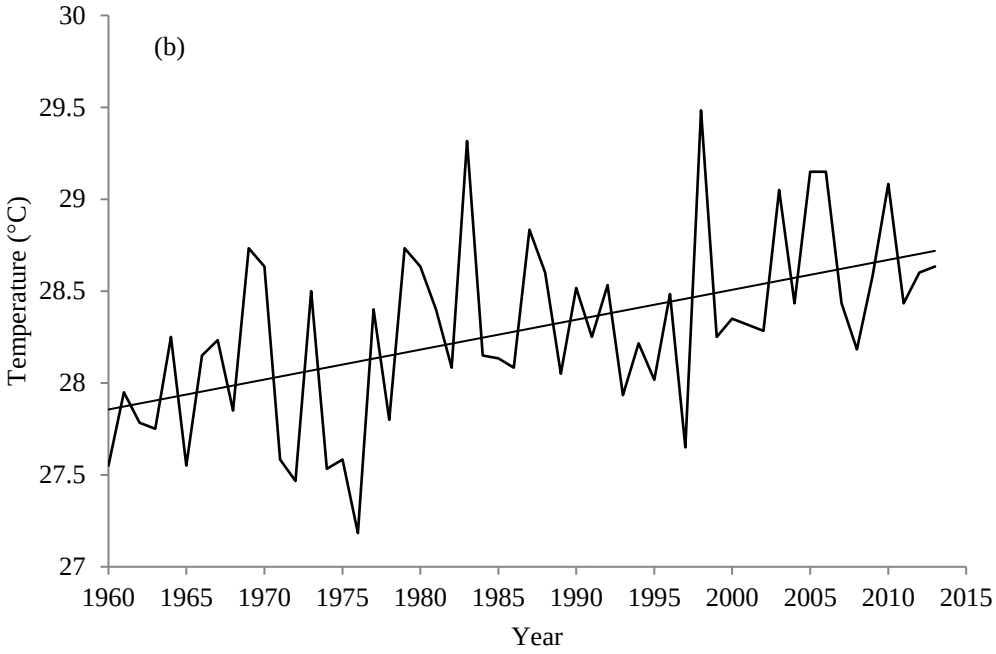


Figure 3: Temperature for the Delta State. Temperatures are the yearly mean (a), while (b) is the seasonal value (February to April) for the period 1960 – 2013. Source: Climate Research Unit (CRU), University of East Anglia, UK (2014).

It is imperative to point out that the impacts of climate variability on household food security were not parallel (see Table 2). Fieldwork data suggest that it is mostly the female-headed households and female-maintained families that are within the bracket of the most vulnerable. In a FGD in Olomoro, the women argued that it is mostly the women that bear the brunt of parenting and catering for the family in the community, with one participant lamenting that "she has not seen a man in this community cater or feed the wife. It is usually the other way round". The plight of some of the female-maintained families is made worse due to the physical and emotional abuse they suffer in the hands of their husbands. A farmer in Olomoro, in her late 30's, stated that:

> *When a woman struggles to provide food for the children but refuses to give the husband food for failing to meet up to his duties, she gets beaten up. The sad part of our ordeal is that when the matter is taken to the police station, with just #1,000:00*

($3.30), they are released on bail with no further prosecution. The women here need help. They are slowly dying (*Pers. Comm,* 2015d).

2.4.2. Asset portfolios in ensuring household food security

For the resource-constrained farmers to continue in food production, there must be a critical blend of several key assets (Simatele and Simatele, 2015b; Tawodzera, 2012). In this light, 41% identified natural, human and physical assets as the most crucial in facilitating food production. Financial, social and human capitals (29%) were listed as the second most essential assets, while social, human and financial assets (18%) were identified as the third most significant combination necessary to obtain household food security. Farmland (a component of natural capital) plays a prominent role in the livelihood of the rural poor in all three communities. A key attribute of the less vulnerable households to seasonal floods is the ability to secure farmlands on the highlands, thereby, ensuring that they become relatively food secure on an annual basis (see Table 2).

Table 2: Vulnerability of individuals and households asset portfolio to climate variability

Type of assets	Features of the most vulnerable	Features of the less vulnerable
Financial	Inability to access loans from both the State government and micro-finance banks. Loans are usually obtained from money lenders and other unregulated financial groups, which are always at exorbitant interest rates. Little or no remittances from relatives and, no viable alternative livelihood source.	Receive monthly pension, frequently obtain remittances from relatives, have other viable sources of livelihoods, hardly secure loans from money lenders and other unregulated financial groups.
Natural	Cultivating only on low-lying farmlands and on small acres of land. Do not have title deeds to farmland and cultivate yearly on farmlands.	Cultivate on low-lying and high-lying areas respectively, normally cultivate on large acres of land, allow farmlands to undergo bush fallow and, have title deeds to farmlands.
Social	Unable to join local groups to partake in weekly monetary contribution (*osusu*).	Ability to join a group based on trust in order to partake in weekly monetary contributions (*osusu*).
Human	Physical and emotional abuse of housewives by husbands, are not usually assisted by their husbands and relatives on the farm, illness, laziness.	Are usually assisted by their husbands, children and other relatives on the farm, the women in this category are rarely victims of any form of abuse.
Physical	Walk on foot to their respective farmlands. They usually carry the harvested cassava tubers on their heads or through the use of a wheelbarrow to the grinding unit. Also, firewood is equally carried on the head from the point of purchase or where the tree was felled to their various houses. This means they do spend an enormous amount of time on other chores, thereby limiting the amount of time they spend on the farmland.	They have bicycles and motorbikes which they use to transport harvested cassava tubers from the farm to the grinding unit. Bicycles and motorbikes also facilitate conveying of firewood from the point of purchase or where the tree was felled to their various houses. Thus, they are able to spend more time on their respective farmlands thereby ensuring optimal yield and productivity.

Source: Fieldwork-based materials, 2015.

Since several pieces of literature have underlined the importance of farmland on the livelihood of the resource-constrained farmers (Barbier, 2012; IFAD, 2009), I refrain from replicating the wheel and focus on other key findings of the study.

In the context of human capital, its importance in ensuring food security for the rural poor households has been acknowledged (Chambers, 1983). What is perhaps more fascinating is the manner in which the farmers systematically utilise their human capital against the annual seasonal floods in order to ensure that they are always able to continue in cassava[7] production. As earlier highlighted, a challenge for the most vulnerable is that the low-lying farmlands are usually flooded from mid-June to last week in October (1 – 2m above ground level) annually. Thus, regimented precision is crucial in ensuring that they effectively continue in cassava production.

Generally, between the first and second week in December, the seasonal floodwater starts retreating disproportionately from the farmlands. As soon as some portions of the soil become visible and moist, the farmers start cultivating. Subsequently, as the retreat of the floodwater continues in other portions of the farmlands, they employ the same process. Next, after the full commencement of the rainy season in the following year (usually in June), the floodwater starts inundating farmlands unevenly from mid-June, although some argued that it starts occurring in July in other farmlands (see also Appendix VIA). Just before the floodwater begins to inundate the farmlands, the farmers start harvesting the produce closest to the point where the farmlands are expected to be first inundated, to about 5 – 20 meters away from the anticipated starting point (depending on the slope of the farmland). The main reason for adopting this strategy is that in the eventuality of not being opportune to return to the farmland within the next 4 – 5 days, the floodwaters will not get to the point where they

[7] Cassava production is the only staple that is usually affected by the annual floods. The other crops take a maximum of four months to attain maturity. Thus, they are able to cultivate and harvest them well before the commencement of the seasonal flood.

temporarily stopped harvesting (see Figure 4). Shortage of household labour is another key factor that determines the extent to which they temporarily stop harvesting, as some farmers might have up to five different plots of farmland where they cultivated on.

Another reason for not harvesting all the cassava tubers at the same time is that the longer they remain in the soil, the bulkier they become, which means more food. Consequently, some can stay for up to six weeks in the soil after other tubers on the same farm plot have been harvested. This strategy, which is deemed the only viable option they have to continue in cassava production annually, is indigenously referred to as *elelame* (follow-water-go). After harvesting, they still employ their human capital by creating temporary platforms on their respective farmlands (usually before the entire farmland becomes inundated) in order to protect the stems of the harvested cassava tubers from decaying (see Figure 5 and Appendix VIB). This facilitates cassava production for the next planting season without eroding the financial asset of the farmers.

With regards to groundnut production, due to the adverse effects of rising temperatures and erratic early rainfall patterns, most of the farmers under 50 years of age employed their human capital in minimising what some referred to as "economic waste" by planting late i.e. around the second to the third week in March. For most of the elderly participants, however, the only factor that determined the commencement of groundnut production was the early rainfall. After probing their decision to factor in only the early rainfall, it was discovered that most of them did not engage in numerous off-farm activities, unlike their younger counterparts.

Figure 4: A farmer in Igbide explaining the *elelame* process. Stems of harvested cassava lying on the ground, while the cassava yet to be harvested are in the background. Photo by Gabriel Ebhuoma, (2015).

Figure 5: A temporary platform to preserve cassava stems constructed by a farmer on a waterlogged low-lying farmland in Igbide. Photo by John Ayiko (2015).

In the context of bonding social capital, 11% of the participants emphasised that it facilitated the accruement of natural capital for those without the immediate financial resources to do so. A farmer in Uzere community in her 40's, for example, commented:

> *It is during the planting season that people run out of money. For those who are trusted by the landlord, however, the farm plots are leased to them without having to pay the required charges upfront. It is after they have harvested and sold some of the produce that they pay the landlord* (*Pers. Comm*, 2015f).

Bonding social capital was further employed by some farmers in situations where they were unable to harvest all their cassavas before the seasonal inundation of the farmlands, due to shortage of family labour, to ensure that they obtain the livelihood they seek. Some farmers rely on the assistance of neighbours, relatives and friends to expedite the harvesting process in order to prevent some of the cassava tubers from decaying. It was also argued that bonding social capital facilitated the attainment of financial capital. This is crucial since the farmers, with the exception of one household, claimed they have "never been beneficiaries of any loan scheme made available by the government", even though it has been documented that the Delta State government have been allocating farm loans consistently to subsistence farmers for over a decade (United Nations Development Program (UNDP), 2014). While there are microfinance banks that have been mandated to assist the rural poor with soft loans in the Delta State, it is contingent upon issuing substantial collaterals equivalent to the loan sought for and, having a functional bank account with the respective micro-finance banks. A farmer in his 50's in Igbide, for example, echoed that:

> *IC Global (a micro-finance bank) does not just give money to anybody. You must have a functional bank account with them to be able to secure a farm loan. When you hardly have enough to fend for yourself and your family, how can you open an account where you now save money?* (*Pers. Comm*, 2015g).

Fieldwork data suggest that the farmers earn about #50, 000:00 ($164) to #80, 000 ($262) a year from food production. This is grossly inadequate in ensuring that they obtain meaningful livelihoods and engage in a more purposeful agricultural practice. Consequently, one of the ways in which they cushion the financial drought is by some members in each community forming a group based on trust where they make weekly monetary contributions to a trustworthy person who, after collecting the funds, deposits it in the bank. At the end of each month, the cumulative sum is given to a member of the scheme, based on prior arrangement.

This is referred to as *Osusu*. *Osusu*, as 35% of the farmers argue, is a viable option in ensuring that they can purchase seeds and other related items in order to continue in food production.

But in spite of the intelligent utilisation of their asset portfolios against extreme weather conditions, the majority have not been able to transcend the global poverty index of living on less than $ 1.90 a day (Livingston et al., 2011). The farmers highlighted the low income accrued from the sales of *garri* as a major factor. As earlier highlighted, they reverberated that the depleted soil nutrients where they cultivate on have led to a reduction in the quality of *garri* they now produce. As a result, their staple cannot compete effectively in the market with others produced in locations where oil exploration activities are not carried out. Thus, they are constrained to sell their produce at a much lower price. In addition, the astronomical interest rate attached to loans obtained from "financial poachers" (i.e. informal groups and money lenders) in their respective communities was also underlined as another factor preventing some farmers from evading the poverty maze.

Due to their financial commitments ranging from paying children's tuition, family upkeep and other social obligations, some farmers always run of funds before the next farming season. Thus, the only option they have is to secure farm loans from financial poachers due to the fact that their requirements are less stringent in comparison to the necessary documentations that are required before a bank loan can be secured. While the loan from the poachers addresses the immediate needs of the farmers, it is deemed counterproductive over the long haul. This is because if a farmer borrows #10,000:00 ($32.80) for six months, for example, the farmer is expected to pay back the sum with a 40% interest. But since the farmers cannot afford to be food insecure, it is certified to be the only option they have to ensure they continue growing their food. The poachers, on the other hand, are well informed

that the loans for some farmers have become a prerequisite and therefore, are not willing to compromise on their terms and conditions. A farmer in Igbide in his 50's commented:

> *Without loans, it is impossible for some to produce food. When these farmers have secured loans, cultivated, harvested and sold some of the produce to pay their debts, in most cases, they are left with little or nothing for the next planting season. So these farmers go back to the respective groups to borrow again. This has been the way some farmers have been surviving in this community* (*Pers. Comm,* 2015g).

It is important to mention that because the study areas are situated in a coastal region, the farmers usually take adequate measures to protect and adapt their fundamental assets in order to build long-term resilience to extreme weather conditions (see Table 3). Protecting and adapting key assets are perceived as compulsory acts that must be carried out if they are to be food secure. If their homes are severely affected by floods, for example, they will be compelled to evacuate their homes immediately. This will compromise the ability for farmers to engage in crop production effectively as renovating their houses will become the ultimate priority (see Simatele and Simatele, 2015b) as it was the case in the aftermath of the 2012 flood disaster.

Table 3: Asset adaptation strategies to build long term resilience to climate change in the study areas

Asset	Long term strategies to build resilience	Implications for household food security
Housing	Because the study sites are coastal communities and coupled with poor drainage facilities, house foundations are raised about 1 – 2 m off the ground. Used concrete blocks to build houses because it is more unlikely to collapse in the event of a series of heavy rainfall unlike houses built with mud.	By protecting their houses from the impacts of heavy rainfall events, they minimise the knock-on effect on their financial capital they are likely to incur (e.g. renovation exercises) if such measures are not taken, which can compromise their ability to continue in food production.
Foodstuffs	Processed cassava (*garri*) is placed in an airtight sack bag. The sack bag is then placed on an elevated wooden platform of about 0.5m above ground level. This ensures that there is food (*garri*) for at least a year. This gives the farmers enough time to plant, harvest and process the cassava tubers to continually ensure household food security annually. For those whose foundations are not well elevated above ground level, heavy rainfall events often lead to excessive moisture in the house. This, in turn, results to the emergence of damp and mould. Damp and mould cause food items stored on the floor to decay. Consequently, shelves are constructed on the walls where food is preserved. Fish is preserved by roasting it. This ensures that fish is available for consumption for about five months.	Adequate storage of food means less expenditure on food, which means more finances to address other pressing needs.
Health	Prepare and consume a local herbal drink (*agbo*) during the rainy seasons as a preventative measure against malaria. Keep house and soundings neat and tidy. Use mosquito nets to prevent mosquito bites when sleeping.	The health of households is crucial to ensure increased output, as farming is subsistence. Thus, if any of them take ill, it can snowball into household food insecurity.

Source: Fieldwork-based materials, 2015

2.5. The role of asset portfolios in minimising the devastating effects of the 2012 flood disaster

The 2012 flood disaster was described by the Nigerian Red Cross Society as the second biggest humanitarian activity it has ever dealt with since the country gained her independence in 1960 (*Pers. Comm*, 2015h). As documented by Njoku (2012), the flood was due to heavy rainfall from the last week in August to October, which unfortunately is inconsistent with scientific data (see Figure 2). Agbonkhese et al. (2014), however, argued that the flood was largely due to the opening of Lagdo dam in Cameroon. The flood affected 30 of the 36 States resulting in the destruction of approximately 600, 000 houses and displacement of over seven million people. By the end of October, over two million persons were registered in Internally Displaced Person's (IDP) camps nationwide (Agbonkhese et al., 2014). A flood of this magnitude usually results in fatality. In the Delta State, anecdotal evidence suggests that no fewer than five persons lost their lives. In a FGD in Uruabe quarters, Olomoro, it was argued that as a result of the floods some women were still unaware of the whereabouts of their husbands till date.

The floods were particularly severe for most of the residents in Igbide, Uzere as well as those residing in Uruabe quarters in Olomoro. People had to use canoe to move from one location to another in some areas within the same community. The majority had to seek shelter in IDP camps located in Oleh and Kwale in the Delta State. Others, by drawing on social capital, were able to seek shelter in the homes of unaffected neighbours, friends, and relatives in nearby communities. Some of the elderly went to live with their children, grandchildren and relatives residing in other parts of the State. Some men, for fear of looters, decided to act as security guards in the treacherous conditions just to safeguard their properties after safely evacuating their families from the community. Of course, other livelihood activities like welding, trading and carpentry, for example, were brought to a halt. In the IDP camps, they

were reported cases of disease outbreaks such as malaria, cholera, dysentery and typhoid due to overcrowding, inadequate hygiene and sanitation facilities. Using a cause and effect relationship, some participants in Olomoro outlined the impacts of the 2012 floods (see Figure 6).

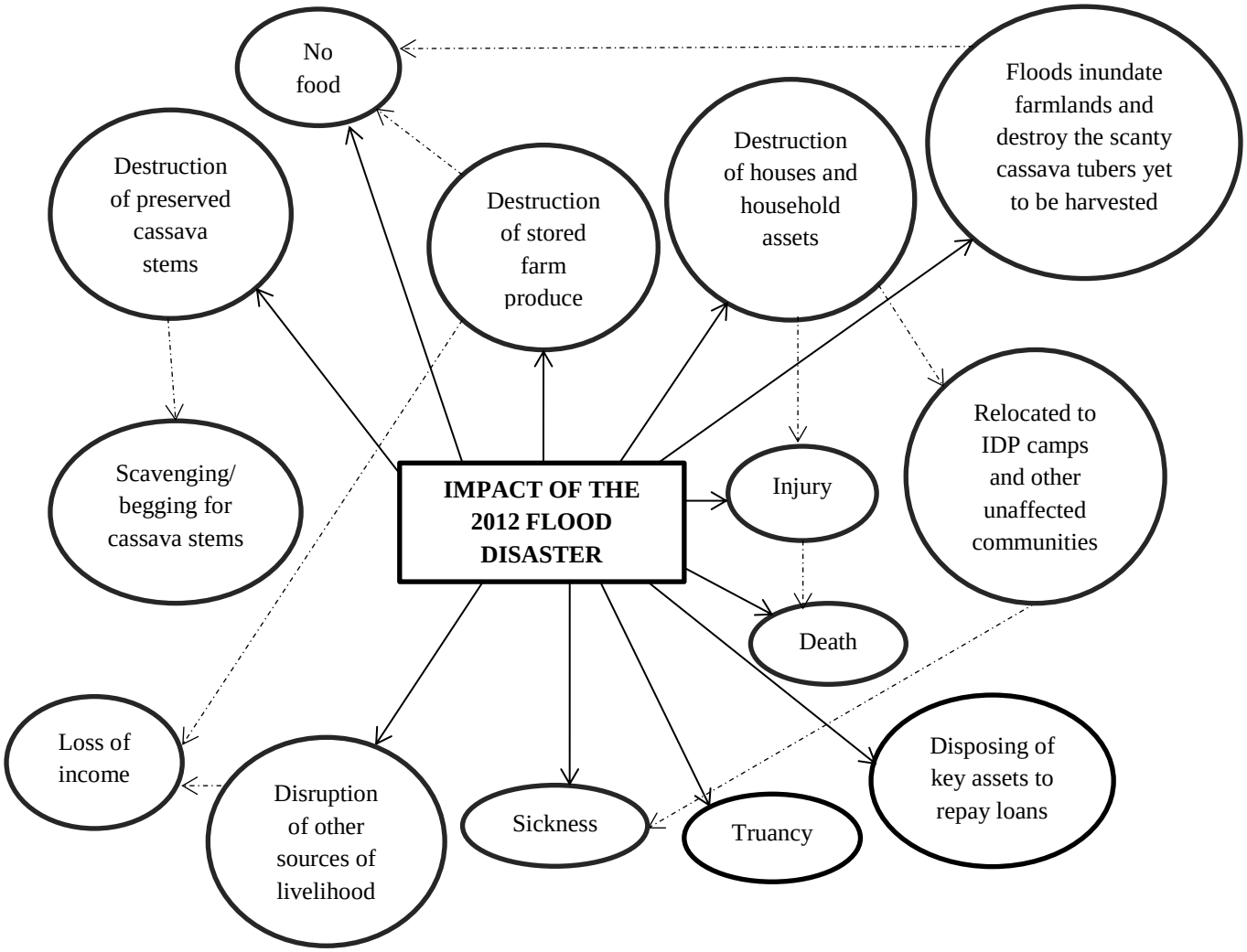


Figure 6: The impacts the 2012 flood disaster. The solid lines represent the direct impacts of the flood disasters on the farmers, while the broken lines represent the indirect impacts. Source: Fieldwork-based materials (2015).

In the face of the floods, however, the farmers were not passive actors. Numerous attempts were made to protect some household properties (see Table 4). Minimal erosion of household assets mean less financial capital to be spent replacing valuables, and thus, the ability to get back into their normal way of life after the disaster will be relatively less challenging. While

attempts were made to protect the harvested cassava tubers yet to be processed and *garri* as shown in Table 4, for the most part, these efforts were futile. This was because the slightest contact of the food with water either due to the desperate attempts to quickly protect these food items and other household assets or raindrops emanating from leaking roofs, irrespective of how little it was, resulted in the decay of the food.

In the aftermath of the flood, hunger was rife in virtually every household that depend primarily on food production for their livelihood. Scavenging and begging for food from neighbours especially from those with a steady source of monthly income became the order of the day for some. The hunger was so intense that some people who had been at loggerheads with each other had to eat together whenever someone caught a game meat. Some household breadwinners resorted to eating once daily, supplementing it with whatever they could get from friends and relatives within the community so that there can be enough food for their children. Others had to minimise their consumption of *garri*, as it became very expensive to purchase due to scarcity of the product (see, e.g., Dulal et al., 2010; Mavhura et al., 2013). For some of the elderly, however, their plight was eased due to remittances received from relatives, children and grandchildren. A few that worked for the State government who are now retired received monthly pensions. This made them relatively food secure after the floods.

Table 4: Asset adaptation strategies adopted during the 2012 flood disaster

Asset	Adaptation strategies
House	Constructed a barrier using cement of about 1m high both at the entrance and egress of a house in order to prevent the flood waters from entering the house. Attempted to drain water out of the house that emanated from ground due to soil saturation during the early stages of the flood.
Household properties (e.g. beddings, TV, DVD players, sofa, clothing, kitchen utensils and furniture's)	Broke the ceiling and placed some of their household properties in the space between the ceiling board and roof inside the house. Used plastic (nylon) to cover household furniture's. Hired vehicles to transport household properties to a relative or friend's residence in a nearby community. Also, an indigene of Igbide provided two lorries to assist members of the community move their properties to a nearby community before the impact of the flood became intense. Some used canoe to transport their properties to neighbouring communities when the flood became severe. Constructed emergency platforms using woods inside their respective homes where they placed chairs and tables. This was to prevent water, which was now emanating from the ground inside their houses, from coming in contact with the chairs. Others looked for metal drums. They brought it inside their houses and placed some household furniture's on top of the drums. Concrete blocks made of cement were used to erect temporary platforms above the floodwater in the inundated homes where beddings were placed (this method was adopted by those that refused to evacuate their premises during the floods).
Foodstuffs	Plastic (nylon) was used to cover the sack bags where *garri* was preserved and then placed on an elevated platform e.g. on top a refrigerator or the constructed emergency platforms. Similar process was adopted for the unprocessed cassava tubers.

Source: Fieldwork-based materials, 2015

In spite of numerous promises made by the State government to assist them in re-building their destroyed houses and bounce back to their usual way of life before the floods, "it never materialised". It became clear that the task of renovating and rebuilding their homes rested solely on them. In a desperate attempt to fix their homes, pay back loans and become food

secure, those who were unable to utilise their social capital to secure financial assistance from relatives, children and friends in diaspora, not only resorted to menial jobs like brick-laying in housing construction sites and hawking, but intensified the process (see also Chambers, 1983; Ellis, 2000; Scoones, 1998). Some had to dispose of their valuables to service their debts. In order to prevent the interest of farm loans from accruing, the farmers had to channel most of the income generated from off-farm activities to service their debts. This resulted in some female-headed households, especially those with little kids, to live in houses where there was virtually no form of renovation work carried out. It took some up to two years before they were able to partially renovate their homes. Servicing debts, renovating and rebuilding their houses inherently meant that other financial obligations had to be compromised. For instance, a lot of children had to drop out of school due to the inability of their parents to pay the tuition fees.

With regards to getting back into food production, *fadama* development project (an initiative of the World Bank) and a few NGO's provided seedlings, fertilizers and made finances available to the affected victims. Nonetheless, for the relief materials that got to the respective communities, patriarchy dictated the distribution process. The community leaders, for example, had some influence on those eligible to benefit from the scheme. Some without husbands or adult male children were also left out as there was nobody to act as intermediaries with the organisers. The women, not only expressing their disdain in the manner in which the relief items were distributed in the aftermath of the 2012 floods, but with regards to how incentives are distributed generally among farmers, bemoaned that in spite of the fact that they are the ones predominantly involved in food production, it is always the men that negotiate with NGO's and other parastatals on behalf of subsistence farmers. This made the plight of the female-headed households to get back into food production more problematic. Being resolved to get back into food production by any means necessary,

however, the women embarked on a journey to nearby communities to scavenge and beg for cassava stems. Their plight was eventually relieved in February 2013 when indigenes in diaspora in the various communities donated truckload of stems that was substantial enough to go round to almost every farmer.

2.6. Discussion

The people of Igbide, Uzere and Olomoro underlined heavy rainfall events, which lead to seasonal flooding of farmlands, as the main variable preventing them from engaging in more purposeful agricultural practices annually. This observation is consistent with the findings of. Ifeanyi-obi et al. (2012) and Adejuwon (2006), which suggest that heavy rainfall is the key variable impacting negatively on food production in the Delta State. Rising temperatures, on the other hand, a phenomenon usually known to affect food production only in the northern parts of Nigeria, has now become a major burden to farmers in the Delta State, a view that is consistent with the findings of Ike and Ezeafulukwe (2015). Furthermore, the perception of the farmers that oil exploration and exploitation activities have contributed immensely to the degradation of farmlands that are in proximity to the oil fields, is in line with several scientific observations (see Elum et al., 2016; Ite et al., 2013). Nonetheless, the findings from this study can be categorised into three main points.

First, against the backdrop of seemingly insurmountable adverse weather conditions that confront the farmers annually, they have learned to sniff out ways of maximising their asset portfolios in order to attain household food security. The manner in which the rural poor employed their human capital to grow cassava on the low-lying farmlands irrespective of their low levels of formal education (79% with only primary education), corroborates several findings which suggest that resource-constrained farmers are not stupid, clueless and incompetent with regards to confronting challenges that can have direct implications for their

livelihoods (Chambers, 1983; Moser and Stein, 2011). Thus, the need to always ensure that those on the grassroots conduct their own risk assessment and analysis is compulsory. This will prevent a misappropriation of policies that are necessary to prevent the erosion of the asset portfolios of the rural poor, since a major reason why development projects fail is due to a lack of understanding of how people get by and get things sorted (Botes and Van Rensburg, 2000). Also, by ensuring that the farmers are actively involved in the discourses with development practitioners in order to identify and create an enabling environment that can protect and strengthen the key assets the farmers use as production assets, it will likely facilitate the building of networking or linking social capital between the farmers and decision makers that have been comatose in the study areas for decades.

Further, the ability for some farmers to rake in financial capital through the use of bonding social capital (*Osusu*), as well as getting back into food production after the 2012 floods also through the utilisation of social capital implicitly reaffirms Adger's (2003) viewpoint. He echoed that "the ability of societies to adapt is determined, in part, by the ability to act collectively". Wherever bonding social capital exists, an inherent capability for individuals to easily access assets that can facilitate the protection of their livelihoods will almost certainly exist. It is, perhaps, findings like these that provoked Moser (2011) to echo that the accumulation of one asset usually facilitates the accumulation of others. It can, therefore, be argued that bonding social capital can be a lifeline for the resource-constrained farmers, as their inability to access financial capital, among other things, is a major driving force that is preventing them from completely becoming food secure.

Second, securing loans from money lenders and other unregulated groups is contributing significantly to some of the farmer's confinement in the poverty trap. A similar observation has been made in India by Balaiah (2015) who argued that borrowing from money lenders is a primary driver keeping the rural poor in poverty. This can become more problematic for

poorer households especially in the aftermath of an extreme weather resulting to a poor farming season as experienced by the farmers in 2012. This is because the poor are usually left with no viable alternative but to dispose of key assets in order to rebuild their lives and service their debts. While this measure tends to provide some respite, there is a high probability that their resilience to future extreme weather conditions will be further compromised due to limited assets at their disposal, which in turn can plough the resource-constrained farmers further down the poverty maze. Thus, the need for rural developers and policy makers in Nigeria to create favourable platforms specifically targeted to combat the financial difficulties some farmers have become trapped in is crucial. If financial schemes are meticulously targeted to the farmers it will make food production more appealing and meaningful. This, in turn, will likely cushion the rural-urban migration crisis currently plaguing the country (Ajaero and Onokala, 2013; Mberu, 2005).

Third, it was observed in all three communities that feminisation predominates in food production. Studies conducted in other parts of Africa and Asia contend that women are the primary engines propelling subsistence farming in the rural context (Binns et al., 2012; Mberu, 2005). Nonetheless, findings from the study did not contravene the notion that subsistence farming is still intrinsically associated with masculinity (Ajaero and Onokala, 2013; Perez et al., 2015; Thapa and Gaiha, 2011). While patriarchy is not the only determining factor that increases women's vulnerability (see Ajibade et al., 2013), the act of bestowing powers on men with regards to controlling and dictating the distribution of resources meant for farmers will almost certainly make the process for a female-headed household to attain food security in the face of climate change more problematic. This is because they usually have fewer assets than men (Buvinić and Gupta, 1997) and bear more of the burden of parenting. If women have equal access to resources including farmlands, they

will be better equipped to minimise the impacts of climate change on their livelihoods and have the potential to increase food production by a significant margin (FAO, 2011).

2.7. Conclusion

It is evident that climate variability and change is making life increasingly challenging for the farmers cultivating on the low-lying farmlands in Olomoro, Uzere and Igbide communities by posing significant threats to their primary source of livelihood activity. In responding to these threats, the farmers tirelessly and consistently employ their bundle of assets in order to continue producing food in the face of climate induced weather changes. The study also revealed that human and social capitals play prominent roles in facilitating the accruement of other assets, thereby ensuring that households become relatively food secure. As Simatele (2010) contends, the poor are not docile to the impacts of climate change and variability, but are constantly trying to carve out various ways to maximise their bundle of assets in order to become food secure. The study also showed that during a flood disaster, the farmers still made various attempts to protect key assets, as protecting key assets will most likely facilitate continuity in food production in the aftermath of an extreme weather. While the majority seem to be able to attain household food security almost on a yearly basis, they still live below the global poverty line.

This is largely due to their inability to access government loans. Thus, the only alternative some farmers have is to secure loans from unregulated sources. While it provides the farmers with a leeway to continue producing their food annually, it is counterproductive due to the astronomical interest rates attached to the loans. The study also reveals that in order for poorer households to service farm debts in the aftermath of an extreme weather, they cash in their valuable assets. This action will most certainly compromise their resilience to future extreme weather conditions because the fewer assets a household have, the less likely they

will be able to recover quickly from climate extremes and become food secure. Thus, if Nigeria is resolved to achieve food security by 2030, a core mandate of the 2nd Sustainable Development Goal (SDG), the enactment of pro-poor policies, including feminist policies since women are more actively involved in food production, that can facilitate the protection of the farmer's asset portfolio's and, simultaneously foster easy accessibility to key assets are paramount. This is because Nigeria is anticipated to be a hotspot for future extreme weather conditions as from 2030 (Shepherd et al., 2013). Thus, the tendency that the current adaptive strategies employed by subsistence farmers will be compromised is extremely high. Until policy interventions are hinged on the various ways in which indigenous people utilise their asset portfolios, the fight against climate induced weather changes will not be won.

CHAPTER THREE

Asset vulnerability and systems thinking: an integrated methodological framework to highlight factors undermining effective food production in the Delta State of Nigeria[8]

Abstract

It has been acknowledged that the assets in the portfolio of poor rural households in developing countries are highly susceptible to both climatic and non-climatic stressors. This has compromised the ability of the rural poor to maximise their livelihood assets during food production. The quest to comprehensively identify the myriad factors that impede the poor from maximising their livelihood assets during food production have provoked the search for more nuanced vulnerability methodologies. This is premised on the widespread recognition that poverty comprises multiple deprivations that include lack of capabilities, assets and entitlements. In acknowledging the importance of assets in facilitating household food security, we make a case for the asset vulnerability analytical framework and systems thinking as an integrated methodological imperative. Using the Delta State of Nigeria as a case study, this paper argues that the asset vulnerability analytical framework, on the one hand, will make it relatively easy for development practitioners to effectively identify the factors that undermine the poor's ability to maximise their livelihood assets in pursuant of their livelihoods. The systems thinking, on the other, will enable practitioners to visualise the long term consequences of the continued inability of the poor to maximise their livelihood assets in order to implement the appropriate policy interventions.

***Keywords**: Asset vulnerability analytical framework, systems thinking, Delta State, Nigeria*

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3.1. Introduction

Globally, climate variability and change have been argued to occur at unprecedented levels within the last two decades (Moser, 2014; Perez et al., 2015). Effectively and efficiently tackling issues of climate variability and change, as Lazarus (2009) puts forward, is one of the wicked problems that the world will have to contend with. This is arguably the case in SSA where low adaptive capacity, weak institutions and high levels of poverty, among other things, vis-a-vis increasing climate variability and change have combined to undermine effective food production (Chavas et al., 2009; Conway and Schipper, 2011; Perez et al., 2015; Thomas and Twyman, 2005). Consequently, studies have been conducted using various participatory methodologies in an attempt to ascertain how vulnerable the agricultural practices of the rural poor in SSA are to climate variability and change (Catley et al., 2008; Chambers, 1995; Mubaya et al., 2012).

Participatory methodologies, as observed by Chambers (1983; 1994), have been effective in illuminating the challenges confronting vulnerable people. This is because it provides a fertile platform for individuals to explicitly share their experiences regarding the ways in which their livelihood practices have been adversely affected by climate variability and change. The literature suggests that the most utilised participatory methodologies employed by researchers and development practitioners at grassroots level within the context of SSA include Participatory Impact Assessments (PIA), Vulnerability Mapping (VM), Participatory Vulnerability Assessment (PVA), Community-Wide Vulnerability and Capacity Assessment (CVCA), Climate Change Vulnerability Resilience (CCVR) and Participatory Rural Appraisal (PRA) (Chambers, 1994; Gibbs, 1987; Ibarraran et al., 2010; Kuban and MacKenzie-Carey, 2001; Leurs, 1996; Preston et al., 2011; Shahid and Behrawan, 2008). Despite the aforementioned being utilised to a great degree of success, Moser (2011)

contends that they have either neglected or only implicitly demonstrated how vulnerable the poor are from an asset-based perspective (see Table 5).

Table 5: Participatory methodologies employed in conducting vulnerability assessments

Name of method	Main users	Key objectives	Focus on assets
Vulnerability Mapping (VM)	Emergency/ relief development institutions e.g., Tearfund, and researchers	Analysis and mapping of vulnerabilities to identify strategies to reduce both climate and non-climate related risks	While it focuses on the asset portfolio of individuals and households, it is not detailed in explaining the dynamics and complexities of factors that facilitate the erosion of the aforementioned assets
Climate Change Vulnerability Resilience (CCVR)	Institute for Development Studies (IDS), International Institute for Environment and Development (IIED), Tyndall Research Center, Practical action	Increasing the ability of communities to withstand and recover from climate change related external shocks and stresses with an emphasis on economic well-being, stability of a community, social & political factors, institutional capacity, global interconnectivity and natural resource dependence	Assets addressed implicitly as approach attaches significance to governance quality at municipal and local levels
Participatory Impact Assessment (PIA)	Development institutions, Non-Governmental Organisations (NGOs), Community Based Organisations (CBOs) and researchers	Identifying intervention measures and action plans	Places more emphasis on communal, rather than individual assets, as donors are concerned with measuring the impact their intervention strategies will have in cushioning generic challenges
Participatory Rural Appraisal (PRA)	Development institutions, NGOs, CBOs and researchers	Focuses on local people's experiences of the ways climatic and non-climatic related risks impacts on their lives and livelihoods	Places more emphasis on communal, rather than individual assets
Participatory Vulnerability Assessment (PVA)	Emergency/relief institutions. E.g., ActionAid International	Analysis and mapping of vulnerabilities to identify strategies to reduce both climate and non-climate related risks	Focuses both on communal and individual assets, but trivialises the individual assets that does not affect the majority of vulnerable participants
Community-Wide Vulnerability and Capacity Assessment (CVCA)	Emergency/relief institutions. E.g., Red Cross Society, NGOs and CBOs	Analysis and mapping of vulnerabilities to identify strategies to reduce both climate and non-climate related risks	Focuses both on communal and individual assets, but trivialises the individual assets that does not affect the majority of vulnerable participants

Sources: Chambers (1994); Fazey et al. (2010); Kuban (2001); Moser (2011); O'Brien et al. (2004); Simatele (2009).

The focus on assets, as Moser and Stein (2011a) argue, are crucial due to the widespread recognition that poverty encompasses a multiplicity of "deprivation that includes lack of capabilities, assets and entitlements". Thus, by using the asset vulnerability framework as a methodological approach to conduct vulnerability assessment, it is asserted that it will explicitly highlight the factors that impede the maximisation of the fundamental or capital assets (i.e. human, financial, social, natural and physical assets) of the poor (Moser and Satterthwaite, 2008; Moser and Stein, 2011a; Simatele and Simatele, 2015b). Notwithstanding, getting a comprehensive picture of the complexities and interconnectedness of factors compromising the ability of the poor to maximise their bundle of assets during food production is equally essential. This will enable practitioners identify the appropriate leverage points to inject decisive policy interventions. The aim is to significantly minimise the adverse effects of both climatic and non-climatic stressors that prevents the poor from maximising their asset portfolios during food production.

Thus, it has been argued that systems thinking can provide development practitioners with an invaluable lens to visualise both the possible long-term consequences of the poor's inability to maximise their asset portfolios during food production, as well as their proposed policy interventions (Bradbury, 2003; Kunsch et al., 2007; Nguyen and Bosch, 2013). Kunsch et al. (2007) and Nguyen and Bosch (2013) further argued that systems thinking provides a useful framework for grasping and managing wicked problems "through the understanding of dynamic feedback embedded in complex human ecosystems" in order to trigger sustainable solutions. In light of this background, we make a case for the asset vulnerability analytical framework and systems thinking as an integrated methodological imperative. We argue that this methodological imperative can effectively foreground the factors that compromise the ability of the poor rural households in the Delta State from maximising their asset portfolios in pursuant of their livelihoods.

3.2. Methodologies used to highlight climate change vulnerability in developing countries

Mitigating the impacts of climate variability on food production in SSA has been a major focus of attention for development practitioners mainly because over 70% of the population rely on food production for their primary source of livelihood (Calzadilla et al., 2013; Shepherd et al., 2013). In a bid to "meticulously unpack" the factors that compromise the ability of the poor to produce food effectively, a plethora of methodological approaches have been employed by researchers and institutions over the past two decades (Chambers, 1994; Ibarraran et al., 2010; Preston et al., 2011).

However, the search for more nuanced vulnerability methodologies to effectively capture the factors that undermine the poor's ability to maximise their asset portfolio in an attempt to secure their livelihoods, may implicitly reflect practitioners dissatisfaction with pre-existing methodologies (Gibbs, 1987; Richards, 1995; Stadler, 1995). In proposing more effective methodologies, Moser and Stein (2011a) contend that if development actors use the asset vulnerability analytical framework, they will find it relatively easy to identify entry points aimed at protecting and creating viable platforms for the poor to accumulate assets in the face of a rapidly changing climate.

The advocacy for the use of the asset vulnerability analytical framework is premised on the widespread recognition that poverty comprises multiple deprivations that includes the "lack of capabilities, assets and entitlements" (Moser and Stein, 2011a). According to Bebbington (1999), assets "are not simply resources people use to obtain a livelihood; they also give people the capability to be and to act". Thus, by paying delicate attention to how vulnerable the fundamental assets (see Table 6) in the portfolio of the rural poor are, it will be relatively easy for development practitioners to get a clear picture of the fundamental assets they need

to fortify in order to ensure that the poor can continue to obtain their livelihoods. This is crucial because by looking at the fundamental assets in the portfolio of the poor, one can comprehensively deduce those that will be able to quickly bounce back into food production in the aftermath of an extreme weather event (Prowse and Scott, 2008). It is, therefore, not surprising to observe that Ebhuoma and Simatele (2017) and Schmidhuber and Tubiello (2007) have argued that until pro-poor policy interventions are geared towards strengthening the fundamental assets that play a pivotal role in the livelihoods of the poor, the battle to outwit climatic impacts will remain a utopian fiction.

Table 6: Definition of the five fundamental assets or capital

Asset or capital	Definition
Physical	This includes equipment, infrastructure such as road networks and other productive resources owned by individuals, households, communities or the country itself.
Financial	This refers to financial resources available and easily accessible to individuals, which includes loans, access to credits and savings in a bank or any other financial institution
Human	This refers to the level of education, skills, health status and nutrition of individuals. Labour is closely associated with human capital investments. Health statuses of individuals impact either positively or negatively on their ability to work, while skill and level of education is crucial because it influences individuals return from labour.
Social	This refers to the norms, rules, obligations, mutuality and trust embedded in social relations, social structures and societies' institutional disposition.
Natural	This refers to the atmosphere, land, minerals, forests, water and wetlands. For the rural poor, land is an essential asset.

Sources: Bebbington (1999); Thornton et al. (2008); Moser and Satterthwaite (2008); Moser (2011)

However, the use of the asset vulnerability analytical framework alone, we argue, might not comprehensively foreground how the causal factors that limit the poor from maximising their asset portfolios can compromise their ability to continue producing food in the future. We argue that systems thinking will provide a holistic picture of the causal factors undermining the poor's ability to maximise their asset portfolios during food production. Thus, systems

thinking is crucial to identify leverage points where policy interventions can be injected in order to avert the inability of future generations to grow their food. Thus, the utilisation of the integrated methodological approach will enable development practitioners to effectively address issues facilitating both the vulnerability of the poor's capital assets and unsustainable food production practices at its root cause (see, e.g., Bradbury, 2003; Koester et al., 2006). By tackling issues at its root cause, Bradbury (2003) and Koester et al. (2006) contend that development practitioners will be able to avoid formulating policies that could potentially result to maladaptation in the future.

3.3. Methodology

The study was conducted in Olomoro, Igbide and Uzere communities in Isoko South Local Government Area (ISLGA) of the Delta State (see Figure 1). Subsistence farming is the primary economic driver of these communities. The women are the primary drivers of food production (*Pers. Comm,* 2015d). The men, on the other hand, engage mainly in fishing, albeit some assist their wives in food production. Cassava and groundnut are the predominant crops cultivated in all three communities annually (*Pers. Comm,* 2015f). The farmlands in Igbide and Uzere are generally low-lying, while Olomoro comprises both low and high lying farmlands. The mean annual rainfall from March–October in the Delta State ranges from 2500 to 3000mm (Niger Delta Environmental Survey (NDES), 2000).

The high rainfall events and coupled with the fact that the study areas are nestled within the boundaries of the lower Niger floodplain, with its tributaries traversing a large portion of the land mass, is responsible for the seasonal inundation of the low-lying farmlands (Ajeluorou, 2013). The low-lying farmlands in each of the study areas are usually inundated from mid-June, at the earliest, to the last week in October every year. In extreme conditions, the low-lying farmlands remain inundated until the third week in November (Ebhuoma and Simatele,

2017a). Thus, Cassava, which requires a minimum of six months to attain maturity, is usually planted in December and harvested between June and August each year on the low-lying farmlands. The other staples that mature within four months are cultivated, under normal circumstances, anytime between the last week in February and March. Due to the fact that the data in this study was obtained qualitatively, it is important to bring to the fore the philosophical underpinning of this study.

Scotland (2012) argues that it is utterly impossible to conduct any type of research without committing oneself, either knowingly or unknowingly, to an ontological and epistemological position. However, Ormston et al. (2014) contend that the methods of conducting qualitative studies are not rigid. This view is substantiated by Denzin and Lincoln (2011) who assert that it is not totally feasible to identify qualitative research with a particular theory or paradigm due to its complexities in terms of approaches and methods that are embedded within various research disciplines. In this regard, qualitative methodologies, as argued by Ormston et al. (2014), are underpinned by the researcher's epistemological and ontological standpoints, among other things.

Epistemology refers to the ways of knowing and understanding our world and what forms the basis of our knowledge. One of the two major epistemological philosophies that have significantly influenced qualitative research is positivism. Positivism assets that methods employed to conduct research in natural sciences are appropriate for social research because human attitude is governed by law-like regularities. Thus, it is possible to conduct research that is objective, independent and void of any pre-existing values (Ormston et al., 2014). The other is interpretivism. Interpretivism, which forms the epistemological underpinning of this study, argues that the natural science methods should not be replicated when carrying out social investigation. This is because the social context is not governed by regularities that

hold law-like properties. Thus, the investigator has to understand the social world through the lenses of the participants (Ormston et al., 2014).

Ontology, is concerned with what exactly reality is, and what needs to be known about the world (Ormston et al., 2014). The field of social science has been largely influenced by two ontological positions –idealism and realism. Idealism holds the notion that reality can only be known through the human mind and through what has been socially constructed, and that any reality outside of this is impossible. Realism, however, posits that there is an external reality that exists outside the scope of our beliefs or understanding. While various forms of realism have been documented in the literature – naïve, cautious, depth and materialism – our ontological position is hinged on subtle realism. It asserts that there is an external reality, but it can only be known through the perceptions and socially constructed meanings of individuals (Ormston et al., 2014). Thus, the researchers acknowledge the importance of understanding the various ways the research participants interpret issues impacting negatively on their ability to produce food effectively and efficiently.

The asset vulnerability analytical framework, which identifies the linkages between different vulnerabilities and the fundamental assets in the portfolio of the rural poor, and the systems thinking, were the methodological tools used in this study. FGD and semi-structured interviews facilitated the use of the asset vulnerability framework, which includes Venn (institutional) diagrams, transect walks, brainstorming, causal flow diagrams, community risk mapping, and historical timelines among others. The study comprised 35 FGD and four face to face semi-structured interviews (two in Olomoro, one in Igbide and Uzere) conducted between June and October 2015. Of the 35 focus groups, 24 were made up of female participants, five were made up of male participants, while six comprised both male and female participants. Each FGD was made up of three to 12 participants. The ages of the participants ranged from 20 to 85. The rationale behind separating most of the male groups

from the female groups was to avoid related cultural issues where women might not be able to express themselves freely without the consent of their male counterparts, as they could be misinterpreted as being disrespectful if they do so (Ebhuoma & Simatele, 2017a). The qualitative data were analysed using the thematic content analysis technique.

The participants in each community were identified using purposive sampling based on age, gender, years of farming in the study areas, those whose household assets and livelihoods were severely affected by the 2012 flood disaster, as well as those cultivating on low-lying farmlands. The identification process of the participants was facilitated by key informants that have been residing in each of the communities for over 40 years, and an agricultural extension worker in ISLGA.

3.4. Results

3.4.1. Using the asset vulnerability framework to reveal factors undermining food production

Fieldwork revealed that the degradation of natural capital, as well as the erosion of both financial and physical capitals has made food production an uphill task for the rural poor. In the context of natural capital, most of the participants argue that due to the seasonal inundation of their low-lying farmlands, they are constrained to cultivate for approximately eight months in a year. For instance, a farmer from Uzere, in his 80's, explained:

> *The problem with our farming system is the seasonal planting that we are constrained to embark upon annually. Thus, we must harvest all our produce before our farmland becomes inundated. This usually exacerbates food insecurity when a household gets a poor harvest in a particular season…This is the advantage farmers in neighbouring communities, who cultivate on high ground, have over us. "They do not lack garri (processed cassava) at any point in time throughout the year"* (*Pers. Comm,* 2015i).

As if the aforementioned is not already limiting their ability to transcend the global poverty index, the farmer's argued that the quality of food they have been producing over the last two decades have declined abruptly due to "oil exploration-led dispossession". Over 70% of the elderly (≥ 50 years) asserted that prior to the commencement of oil exploration activities in their respective communities, the *garri* produced in the aforementioned communities were known in the Delta State for its high starch content. However, since oil exploration activities started over four decades ago, the farmer's noticed, from the early 1980's, that the starch content of their *garri* has reduced significantly. The resultant effect of this, as argued by the farmers, is that consumers now prefer to purchase *garri* produced in neighbouring communities' void of oil exploration activities because it of its "higher starch content". Along this continuum, a participant from Igbide, in her 50's, lamented:

> *There has been a significant reduction in the nutritional value of the garri we produce due to the oil exploration activities that have been going on for over four decades…Before Shell Oil Company started drilling oil from our community, we were promised that remedial actions would be carried out regularly to ensure that the soil does not lose its nutrients. Up till today, no remedial action has been carried in this community* (*Pers. Comm,* 2015j).

There is evidence to suggest that the degradation of the natural environment in ISLGA, which has severely compromised the quality of food produced by the farmers, is largely due to oil exploration activities (Elum et al., 2016; Ite et al., 2013). Despite the adverse effects of oil exploration activities on food production, the participants bemoaned that have not been recipients of any form of compensation. Consequently, this issue has, in part, triggered the proliferation of militancy activities such as illegal oil bunkering, for example, among some indigenes especially the youths in the Niger Delta (Adusei, 2015; Ikelegbe, 2005). However, not all participants were in total agreement with this line of thought.

A few of the elderly participants pointed out that while oil exploration activities might have contributed to a decline in the quality of food produced, their inability to practice bush fallowing is also a major factor that has hampered the quality of food produced. Some explained that in the past decades they could leave some farm plots to undergo bush fallowing for about three – seven years before cultivating on it. However, due to massive population growth, their ability to practice bush fallowing has been severely hampered. This is due to the conversion of farmlands to secure shelter, thereby making arable farmlands a relatively scarce commodity (see also Ellis, 2000; Rigg, 2006).

From a human capital perspective, physical abuse in Olomoro in particular, was underlined as a factor that impedes women's ability to engage optimally in food production because it reduces labour force drastically. A few explained that this had become a regular occurrence for some women in the community, with their husbands as the perpetuators of the crime. When probed about the role of the police in attempting to cushion the plight of the women, a participant from Olomoro, in her 30's, explained:

> *Do we have a police station in this community? When the men are arrested, with a bribe of #1, 000:00 ($3:00 US) they are released. I don't know what we have in this community but it is certainly not a police station* (*Pers. Comm* 2015d).

Within the context of financial capital, the participants lamented that irregularities and inconsistencies surround the disbursement of farm loans. All but one farmer, for example, claimed that they have never been a beneficiary of any agricultural loans. This is despite the loans that both microfinance institutions and the government have been providing for subsistence farmers for over two decades (Anyanwu, 2004; Olaitan, 2006; Philip et al., 2009). Some stated that they only hear of farm loans and other incentives meant for farmers after it has been disbursed.

With regards to physical capital, the farmers bemoaned that despite the enormous contributions that their communities have made to the nation's foreign revenue for over four decades, their communities have remained incomprehensively underdeveloped. The lack of good road networks within each community, for example, usually erode the financial capital of the farmers, albeit insidiously. To illustrate, during the rainy seasons, it can be excruciating for motorists to weave their way through the aforementioned communities. This is because of the numerous potholes that are usually engulfed with floodwaters, which makes it difficult particularly for those not familiar with the road to swiftly navigate their way through it. This makes access to market, where they have to sell some of their farm produce, difficult and expensive.

It is noteworthy to mention that Shell Oil Company and the government have not been oblivious to the plight of the people. The challenge, however, is that whenever the government and Shell want to fix the roads or carry out some of its co-operate social responsibility, for example, some of the affluent people in the Delta State will bid for the contracts to be awarded to them or their affiliates. After being awarded the contracts, they often use inferior materials to carry out the contract like road repairs, for example, which in no distant time wear out. Consequently, the community goes back to square one. The farmers perceive the ability for most contractors to carry out jobs that are under par with impunity as ineptitude on the part of the government. This, among other issues, has amplified their grievances against the state and federal government.

It was also highlighted that for those privileged to have access to large hectares of farmlands enough to engage in commercial farming, their inability to access farm machinery have continued to dampen their fight to transcend the boundaries of a subsistence farmer. A male participant in Uzere, for example, explained that while the Delta State government have been providing farm equipment's for subsistence farmers, "it never gets to the farmers". The

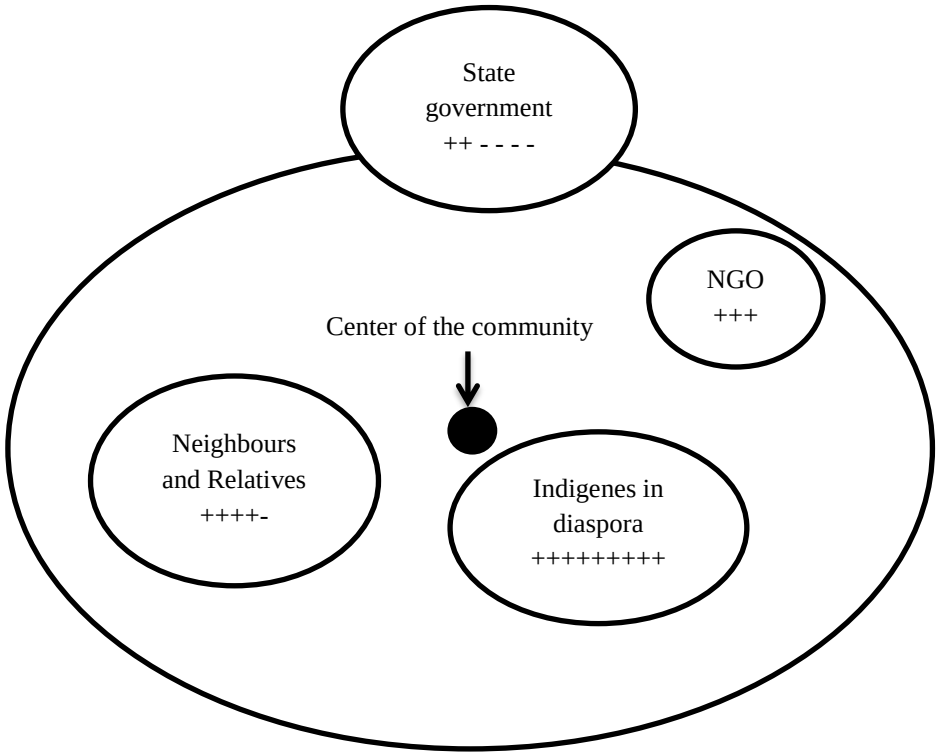
participant further argued that these equipment's are "always hijacked" by dignitaries and close associates of key politicians in the Delta State for their selfish interest. Some farmers argued that this might be the resultant effect of a lack of social capital i.e. because they lack indigenes from their communities that hold key positions in the society like being a member of the Delta State house of assembly, for example. Perhaps, this might explain why some of the farmer's felt they were neglected by the government in the aftermath of the 2012 flood disaster (see Figure 7).

The 2012 floods, classified as the most devastating in the history of Nigeria, severely compromised household food and nutrition security in 2013 (Ebhuoma and Simatele, 2017a). While the participants acknowledged that the State government made provision for items like cassava stems to be distributed to the farmers, they lamented that most of the affected victims did not get anything. Instead, it was indigenes in the diaspora, individuals and relatives in neighbouring communities that were unaffected by the flood, and *fadama*, an NGO, that came to their rescue.

3.4.2. Application of systems thinking to unravel factors impeding effective food production

In spite of the myriad challenges that the farmers have to contend with on an annual basis, they still manage to produce food annually, although not without certain challenges (Ebhuoma and Simatele, 2017a). It has been acknowledged that food production is interwoven in a complex web of political, social, environmental, economic and cultural factors (Banson et al., 2016). Thus, the asset vulnerability framework alone will not suffice in presenting a holistic description and the long-term implications of the farmer's current food production practices. In this regard, systems thinking is pivotal to enable development

practitioners get a holistic picture of the various factors that hampers the rural poor from maximising their asset portfolios during food production (Banson et al., 2016).



Key: ++ = Extremely helpful; - - - = Less helpful

Figure 7: Venn diagram showing important institutions that enabled farmers in Uzere, Igbide and Olomoro communities in the Delta State of Nigeria get back into food production after 2012 flood disaster incidence. *Source:* Field-based materials (2015).

Causal loop modelling was used to produce a systems thinking model to highlight the interconnections and interdependencies among the various factors compromising effective food production in Igbide, Uzere and Olomoro communities (see Figure 8). As shown in figure 8, each variable can either progress in parallel or opposite directions. If an increase in the preceding variable leads to a decrease or adverse effect in the next variable where the arrow head is facing, it is denoted by '-' (negative) sign close to the arrow head. Conversely, if an increase in one variable results in a positive effect in the next variable where the arrow

head is facing, it is denoted by the '+' (plus) sign close to the arrow head (Nguyen and Bosch, 2013). The systems thinking, as observed by Flood (2010) and Kunsch et al. (2007), is analysed through feedback loops. Feedback loops can be either balancing or reinforcing. Balancing loops seeks to stabilise a system or return it back to normal. Reinforcing loops, on the other hand, usually represents increasing or decreasing actions (Nguyen and Bosch, 2013). Figure 8 identified eight reinforcing (R) loops and one balancing (B) loop. For the purpose of this paper, however, I am only going to shed light on the issues that could potentially result in the inability for future generations to grow their food.

A glaring issue that is impacting negatively on food production is the abuse of the substance *tramadol* (see Figure 8). The abuse of *tramadol* has compromised household's ability to engage in effective and efficient food production practices mainly through the depletion of their workforce. Some participants explained that while the sale of the medication is illegal, some pharmaceuticals still make it readily available for those in desperate need of the substance. It was alleged that the reason the substance is highly sorted after is because it "prolongs sexual intercourse". The side effect associated with the drug is that some consumers of the substance usually collapse after taken the substance in overdose. Consequently, spouses, relatives and friends usually rush the victims to nearby hospitals. This implicitly impedes their ability to produce food optimally. This can have severe implications for household food security especially in circumstances where households have not harvested all their cassava tubers on the low-lying farmland before the seasonal inundation occurs, and are unable to return within the next two days to harvest the inundated tubers in order to prevent them from rotting away.

From a political perspective, political instability has, in part, stemmed from the federal government introduction of a policy in 2016 that allowed the currency to trade freely in a move to curtail the currency crisis. This led to a significant devaluation of the naira, thereby

limiting the purchasing power of most consumers of *garri*. This is because Nigeria depends largely on foreign goods and therefore, the soaring of the US dollars in the market heightened the prices of imported goods. This had a ripple effect on other sectors within the country such as the transportation and agricultural sectors. Also, the state government's inability to pay their workers' salaries regularly, with workers owed over six month's salaries in some cases, have significantly reduced the purchasing power of most state government workers. This, in turn, reduces the financial capital of subsistence farmers who depend on the sale of their surplus farm produce to address other pressing needs.

It is also evident from Figure 8 that some of the farmers rely on IKS not limited to cloud observations and the flowering of specific trees. For instance, a farmer from Olomoro, in her 70's, stated that the constant flaring of gases into the atmosphere, courtesy of oil exploration activities, distorts her vision when attempting to observe the cloud. This, as she further emphasised, hampers her ability to make farming decisions that are based on "concrete indigenous evidence". Also, some of the participants emphasised that gas flaring has impacted negatively on the trees e.g., the rubber trees the farmers rely upon to predict future weather events accurately. This is because "some of the trees no longer flower at the time they are naturally supposed when compared to the time they usually did in the past". When this happens, the tendency for their predictions to be inaccurate becomes relatively high.

In an unrelated vein, while the majority lamented that seasonal flooding of their farmlands hamper their ability to produce food throughout the year, an elderly participant from Uzere, in his 80's, argued that the seasonal flooding is, in part, a blessing in disguise. This is because it brings along with it alluvial soil, which helps to replenish the soil's lost nutrients. This, according to the participant, helps to improve the quality of food they produce as the current food quality would have been worse off in the absence of alluvial soil. Nonetheless, the

participant concluded that oil exploration activities are facilitating the loss of soil's nutrient at a much faster rate than the alluvial soil can replenish the lost nutrients.

In addition, massive population growth has facilitated the conversion of arable farmlands into housing units. This, in turn, has resulted in the inability for farmers to leave farmlands to undergo bush fallowing as they usually did between the 1960's and 80's and has set in motion a process of stiff competitions among farmers to secure arable farmlands. The increase in population has also triggered rapid deforestation, which has been observed to contribute to climate change (see Malhi et al., 2008).

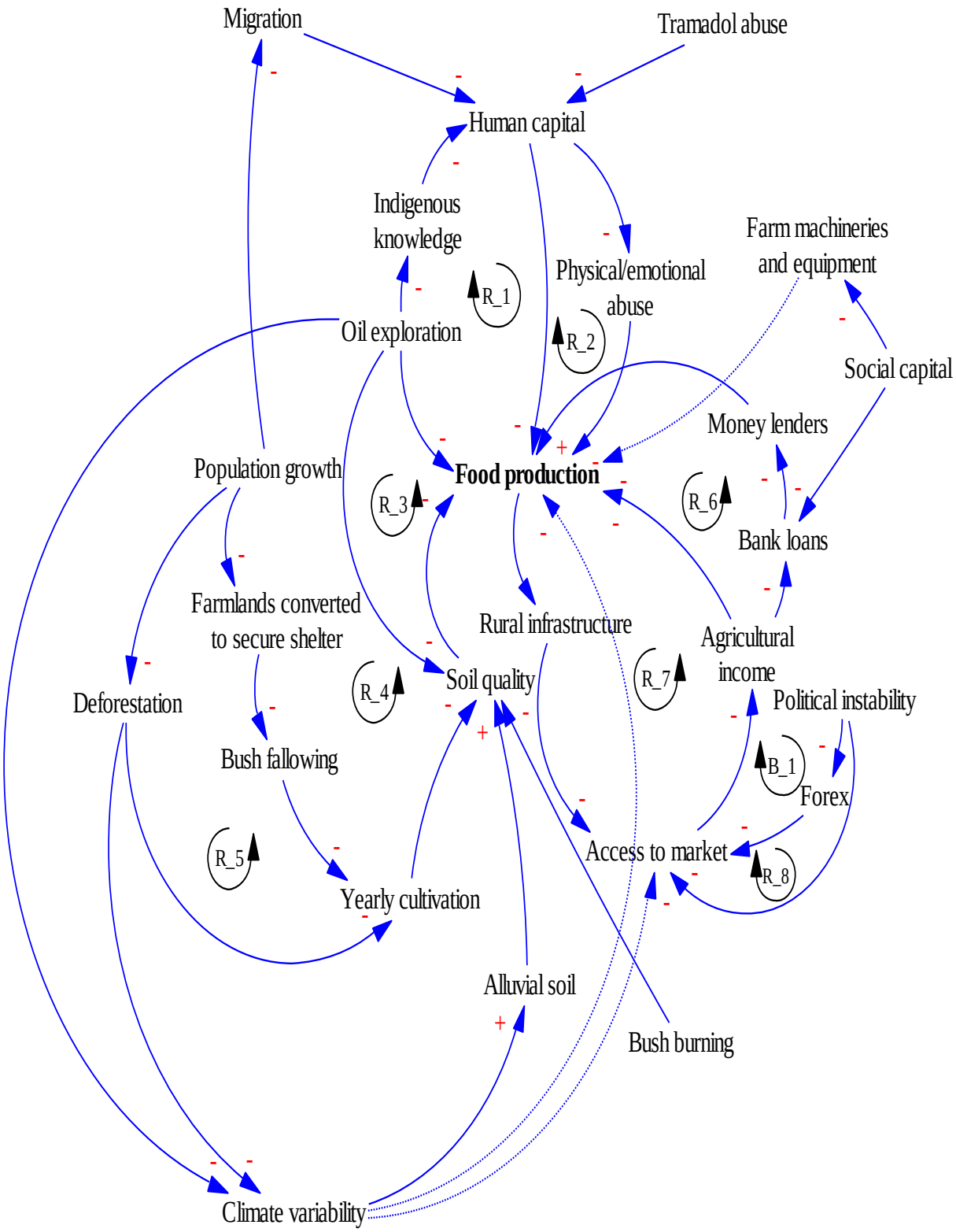


Figure 8: Systems thinking diagram highlighting the factors undermining effective food production in Igbide, Uzere and Olomoro communities in the Delta State of Nigeria. Dashed lines are used to indicate that they have no influence on the loop they pass through. *Source:* Field-based materials (2015; 2016).

3.5. Discussion

The influence of various participatory vulnerability methodologies in revolutionising how most social scientists conduct research cannot, for the most part, be contested (see Chambers, 1994; Leurs, 1996; Stadler, 1995). Nonetheless, they have not explicitly highlighted how the multidimensional aspects of socioeconomic factors, for example, have compromised the poor's ability to maximise their asset portfolios during food production (Moser, 2011). While it is crucial to understand how the aforementioned factors impede the poor's ability to maximise their asset portfolios, development practitioners stand the risk of failing to get a holistic view of the ways this might amplify the challenges for rural households to produce food in the future. Consequently, and as revealed in the results section, systems thinking serve to compensate for the deficit. It also helps to set the scene for understanding rationales behind some of the decisions taken by the farmers.

For instance, the farmers could not reconcile the lack of rural infrastructures in their respective communities with the significant contributions their communities have made to the nation's foreign reserve, via crude oil exploration, for over four decades. The farmer's argued that they deserved to be duly compensated especially with durable infrastructures since the oil exploration activities are responsible for the decline in food quality and the reduced effectiveness of Indigenous Knowledge Systems (IKS). Perhaps, this might explain their unwillingness to utilise Seasonal Climate Forecast (SCF) provided by the government despite acknowledging that their IKS have not been accurate as it has been in the past few decades (see Ebhuoma and Simatele, 2017b).

Their reluctance to utilise SCF might also be rooted in previous sour experiences with the government. Some of the elderly participants (≥ 50 years old) acknowledged that in the 1960's they used to produce rice. This is due to the swampy nature of their farmlands during

the rainy season, and because the government provided rice milling machines to enable household process the produce after harvesting. However, since the 1970's till date, no provision has been made to provide rice milling machines for farmers. Thus, rice cultivation has long been abandoned. While it is not exactly clear what could be responsible for this, figure 8 suggests that this might be rooted in a lack of social capital with those at the helm of affairs in the Delta State. With future weather conditions expected to worsen for SSA, proponents of SCF argue that food production will be aggressively compromised if farmers continue to rely solely on IKS (Roncoli et al., 2002).

Also, political instability has, in part, had a ripple effect on the farmers as those responsible for disbursing farm loans to farmers are government workers, who often go for months without being paid their salaries. It can be argued that this has, in part, facilitated the creation of ghost schemes aimed at defrauding farmers by constraining them to purchase cassava stems and other items, for example, as pre-requisites for accessing farm loans. If these issues are not adequately addressed, and with "financial poachers" like money lenders consistently exploiting this window by making their loans readily available but at exorbitant interest rates, the tendencies that people will dump farming as the major source of livelihood for blue collar jobs within and outside their communities is not unrealistic. This will have adverse consequences for rural and urban household food security in Nigeria. This is because 80% of the calories consumed in urban areas are produced in rural areas (Attah, 2012).

It is noteworthy to mention that these sorts of issues are not peculiar to Nigeria. In fact, some studies, by employing several vulnerability methodologies as earlier highlighted, have underlined political instability and corrupt practices as major bottlenecks impeding the trickling down of resources that can significantly improve the welfare of farmers in the developing South (see, e.g., Bird and Shepherd, 2003; Frost et al., 2007; Fazey et al., 2010). However, by failing to utilise the systems thinking approach, development practitioners

might not be able to envision the long term consequences of the ways in which the aforementioned issues might result in the total collapse of the system that caters to the rural poor's livelihood. Systems thinking, I argue, are a simple yet sophisticated way of visualising the important components of a system and how they interrelate in a holistic way. Thus, the utilisation of the asset vulnerability analytical framework and systems thinking methodologies will enable practitioners to come up with more meaningful interventions that can ensure households will be able to continue obtaining their livelihoods in a sustainable manner.

Findings from this study reinforce Yin et al. (2002) viewpoint. They argued that the use of an integrated approach is crucial to reduce vulnerability to climate change and ensure environmental sustainability. While we argue that this integrated approach is pivotal for contemporary vulnerability research, it is important for researchers not to allow the euphoria of this integrated methodology overwhelm them to the point where they ignore DeWalt (1985) assertion. He emphasised that every newly found methodology initially undergoes a euphoric appeal among social scientists, to the stage of critical evaluation and debates about its usefulness in illuminating issues of vulnerability before it finally ends up in the buzz word refuse dump. Avoiding this dilemma will, largely, depend on highlighting its limitations (Gibbs, 1987). The integrated approach, unfortunately, ignores the historical perspective of the ways in which legislations that govern the natural resources, for example, have contributed to the inability for households to currently obtain their livelihoods without difficulties.

3.6. Conclusion

Various methodological imperatives have been developed within the last three decades in a bid to carve out the most effective and efficient method for conducting vulnerability

assessments. Methodologies such as PRA, RRA PIA, VM, CCVR and CVCA have been utilised. However, these methodologies have not explicitly been able to highlight factors that could compromise the ability for future generations to produce food from an asset-based vulnerability perspective. The focus on assets are crucial because the more asset people have, the better equipped they will be to bounce back into their livelihood activities in the aftermath of an extreme weather condition (Prowse and Scott, 1998). Thus, by utilising the asset vulnerability analytical framework and the systems thinking approach, this study underlined issues not limited to political instability, oil exploration activities, which are contributing to increasing irregularities of IKS, and abuse of the illegal medication *tramadol* as factors compromising households' ability to engage effectively in food production. Without radical policy interventions being implemented, these issues will impede household's ability to grow their food in the future.

It is, however, important to note that the asset vulnerability analytical framework and systems thinking is not portrayed as an unparalleled integrated methodology in comparison to other vulnerability methodologies when attempting to ascertain household's vulnerability. This is because it has its own shortcomings. The integrated methodology ignores the historical perspective of the ways in which legislations enacted to govern the natural resources for decades have implicitly and explicitly amplified the difficulties associated with obtaining livelihoods. Nonetheless, in a time where practitioners have recognised that poverty is multifaceted, creating avenues for the poor to accumulate asset is pivotal. Thus, the asset vulnerability analytical framework, on the one hand, will enable practitioners easily identify the fundamental assets of the poor that are vulnerable to both climatic and non-climatic stressors. The systems thinking, on the other, will enable practitioners to visualise the long term consequences of the continued inability of the poor to maximise their livelihood assets in order to implement the appropriate policy interventions.

CHAPTER FOUR

Rethinking the mediums for effective communication of extreme weather warnings in the Delta State of Nigeria[9]

Abstract

High-resolution models used in monitoring sea surface temperature perturbations have made it possible for scientists to predict future weather events several weeks to months before they occur. Nonetheless, the most accurate forecasts will be worthless if it fails to reach those susceptible to the anticipated weather event, as this will impede their ability to act pro-actively. Prior to the 2012 flood in Nigeria, for example, which had severe implications for 30 out of the 36 States, the flood was forecasted by the Nigerian Meteorological Agency (NIMET). However, fieldwork conducted in Igbide, Uzere and Olomoro communities in the Delta State, which were adversely affected by the flood, revealed that the warning failed to reach the inhabitants of these predominantly rural communities. This was attributed to the failure of NIMET to utilise the various forms of local techniques that community members employ when disseminating vital pieces of information within their community. Thus, there is an urgent need to reconsider contemporary systems of disseminating early warnings and incorporate more pro-poor mediums of communication that are rooted within traditional systems and cultures. Until such mediums of communication are utilised, communicating extreme weather warnings to the rural poor will continue to yield little result.

Keywords*: Seasonal climate forecasts, Extreme weather warnings, Communication, Nigeria*

[9] This chapter has been submitted for publication in its current form: Ebhuoma, E and Simatele, D. Rethinking the mediums for effective communication of extreme weather warnings in the Delta State of Nigeria. *International Journal of Disaster Risk Science*.

4.1. Introduction

Early warning systems are crucial because they can save lives and minimise loss of assets (Demeritt et al., 2010; Penning-Rowsell et al., 2000). Early warnings are arguably a necessity for developing countries. This is because both natural and anthropogenic induced disasters are not only becoming increasingly rampant but have been associated with devastating consequences both in terms of mortality rate and financially (Ahmad and Ahmed, 2003; Chowdhury et al., 1993; Turner et al., 2014). Cyclone Gorky, for example, a Category IV storm IV storm which struck Bangladesh on April 29, 1991, resulted in about 140, 000 fatalities (Paul, 2009). Similarly, in 2012, Ebhuoma and Simatele (2017) acknowledged that Nigeria suffered its worst ever flood disaster in its entire history since becoming a republic in 1960. The flood, according to Agbonkhese et al. (2014), affected 30 out of the 36 States in the country, which the Nigerian Emergency Management Agency (NEMA) estimated to cost over $8 billion USD worth of damages (Punch News, 2013). Building on parallel observations, Hallegatte (2012) argues that if developing countries investment in flood warnings are on par with that of the developed world, it could potentially avert asset losses that could range between $300 million and $2 billion USD annually. Hallegatte (2012) further pointed out that investment in effective flood warning systems could result in an additional $3 to $30 billion USD annual worth of economic benefits for developing nations.

However, for flood warnings to avert or significantly mitigate and reduce the loss of lives and properties, Moser (2010) and Moser & Dilling (2011) assert that it must be communicated through the right channels to those anticipated to be affected by the flood. However, communicating flooding warnings effectively to vulnerable people is one of the greatest challenges that risk communicators continue to grapple with (Löfstedt, 2003; Moser, 2010). This view has been buttressed by Demeritt et al. (2010) and Hansen et al. (2011), who argue that what has been achieved with early warning systems at an operational level is a far cry in

comparison to the massive technological advancements that have taken place over the past few decades. Notwithstanding, on the one hand, there is evidence of how flood warnings triggered vulnerable people to embark on planned adaptation strategies in order to protect their lives and valuable assets (Kreibich et al. 2016; Paul, 2009; Rogers and Tsirkunov, 2010). On the other, there is evidence of a flood disaster being predicted accurately, yet those susceptible to the flood were caught unawares, thereby making it relatively easy for the flood to wreak havoc on lives, livelihoods and assets (Hellmuth et al., 2007). This was, in part, attributed to the utilisation of inappropriate mediums of communication by the relevant authorities (Hellmuth et al., 2007).

Thus, Moser and Dilling (2011) have argued that those saddled with the responsibility of communicating early warnings must avoid the misconception that a one size fits all approach will suffice for different vulnerable groups and communities. In order words, what might be perceived as an effective means of disseminating extreme weather warnings in one community might be grossly ineffective in another community. Which is why Moser & Dilling (2011) advocate for a deeper understanding of the various groups of people that are expected to be susceptible to an anticipated extreme weather condition, as this will unravel the most efficient channels that will resonate with the specific target group.

In light of the above, it can be argued that the relevant authorities in Nigeria failed to heed the advice of scholars like Moser & Dilling (2011) before disseminating the 2012 flood forecasts (Agbonkhese et al., 2014; Ebhuoma and Simatele, 2017). This is because the Nigerian Meteorological Agency (NIMET) stated that massive flooding might be inevitable for some parts of the country, especially coastal communities and regions close to river catchment areas (Vanguard 2012; Agada and Nirupama 2015). The forecast, which was publicised through the mass media, also highlighted that the Delta State was expected to receive one of the highest amounts of rainfall (Vanguard, 2012). Despite the warning, individuals residing in

several rural communities in the Delta State were caught off-guard (Ebhuoma and Simatele, 2017).

It is against this background that this paper seeks to illuminate the frailties of relying on the mass media alone, as a means of communicating flood warning to poor rural households in the Delta State. As argued by Shepherd et al. (2013), extreme weather conditions are expected to become the new normal for Nigeria as from 2030. With the Nigerian government investing in meteorological services, it is important to reconsider contemporary systems of disseminating early warnings. It is, however, not the intention of this paper to argue that the use of the mass media should be abolished when disseminating early warnings to poor rural households in the Delta State or anywhere in developing countries, as radio and television (TV) jingles have, and will always remain crucial in disseminating climatic risks (see Harvatt et al., 2011). Rather, this paper seeks to illustrate why it is important to pay delicate attention to specific contexts and incorporate the various local strategies that are rooted within traditional systems and culture into contemporary systems of communication.

4.2. Communicating extreme weather warnings in developing countries: exploring the literature

With extreme weather conditions now becoming increasingly rampant on a global scale, it is argued that early warnings are crucial to minimise the adverse effects of an anticipated disaster (Ahmad and Ahmed, 2003; Parker et al., 2007). On the one hand, there are documented evidence of early warnings averting what would have resulted in catastrophic events (Hallegatte, 2012; Paul, 2009; Turner et al., 2014). Cyclone Sidr, for example, a Category IV storm that affected the southwestern coastal areas of Bangladesh on the 15th of November 2007 resulted in the death of 3, 406 persons (Dolnick, 2007; Paul, 2009). This death toll was nothing compared to Cyclone Gorky, also a Category IV storm that made

landfall in Bangladesh on the 25th of April 1991, killing approximately 140, 000 people (Paul, 2009). On the other hand, there is evidence of extreme weather warnings being forecasted accurately, yet failed to significantly prevent loss of assets and provoke vulnerable people from relocating before the flood made landfall (Ajibade and McBean, 2014; Hellmuth et al., 2007).

In December 1999, for example, the Mozambican meteorological institute forecasted a high probability of a flood disaster between January and March 2000, albeit not in the magnitude in which the flood occurred. Yet, residents in some rural communities along the coastal regions were caught unawares (Hellmuth et al., 2007). As a result of the flood, about 4.5 million people were severely affected (Hellmuth et al., 2007). Further, an estimated 350, 000 livestock were lost to the floods, while assets worth approximately 270 million USD were destroyed (Gall, 2004; Hellmuth et al., 2007; SARPN, 2002). Among other things, inappropriate channels of disseminating the warning were highlighted as one of the reasons for the numerous death casualties as many failed to evacuate their homes before the flood descended (Hellmuth et al., 2007). A somewhat similar observation was made by Ajibade and McBean (2014) in the aftermath of the July 2011 flood that affected Badia communities in Lagos State, Nigeria. They argued that while the flood was forecasted a few months beforehand mainly through the mass media, over half of the study participant's claimed they never received the forecast.

It is, however, important to acknowledge that in the context of the developing world, there is scanty evidence in the literature regarding how a predicted disaster warning shaped the behaviour of vulnerable people. Nonetheless, a systematic review of the literature suggests that the mass media is the most preferred medium for disseminating disaster warnings to the targeted end-users in developing countries (see Table 7). What is particularly striking about most of the studies in Table 7 is that the use of the mass media has not been very effective in

provoking planned adaptive measures by those vulnerable to the imminent disaster. This inherently raises a pertinent question; why is the mass media still one of the most highly prioritised mediums for communicating disaster warnings?

In proposing plausible explanations, Harvatt et al. (2011) argue that it is because the mass media can reach out to a large number of people within the shortest timeframe, thereby making it extremely cost-effective. In fact, several studies from developed countries have shown how effective the mass media can be in facilitating behavioural change in the wake of an anticipated disaster (Ebi et al., 2004; Teisberg and Weiher, 2009; Thielen-del Pozo et al., 2015). Unfortunately, the same cannot be said of the developing world. From a developing world perspective, entrenched poverty, which makes gadget such as TV and radio sets a luxury particularly for those residing in remote rural communities, and lack of constant power supply are some of the factors that dampens the effectiveness of TV and radio as effective channels for disseminating vital information (Ebhuoma and Simatele, 2017a; Mushengyezi, 2003; Sharma, 2011). In the 1991 cyclone in Bangladesh, Chowdhury et al. (1993) argued that the use of radio and TV to disseminate the anticipated cyclone only proved effective in areas that were in proximity to major cities than those farther from the cities. Within this context, National Oceanic and Atmospheric Administration (NOAA) (2016) and Padgham et al. (2013) pointed out that an adequate understanding of the ways in which the target audience prefers to receive messages and the way information is disseminated among community members are pre-requisites for communicating climatic risks effectively.

It can also be argued that the overwhelming reliance on the mass media is because most risk communicators in the developing world have been trained under Western scientific knowledge and therefore, this greatly influences their ways of doing things. Pilot studies conducted in rural spaces in developing countries, for example, have acknowledged the potential of utilising the local channels as an effective means of communicating climate-

related messages. In reality, however, they tend to be pushed to the periphery at the expense of the mass media (Ajibade and McBean, 2014; Hellmuth et al., 2007; Mudombi and Godwell, 2014). As Mushengyezi (2003) eloquently points out:

> "*African governments and their development partners often tend to extrapolate communication models from the developed world and apply them wholesale in local environments in Africa that are unique*".

The majority of the rural people in developing countries are illiterate and resource constrained (Milder et al., 2010; Olawuyi and Adetunji, 2013). Thus, have limited or no access to mass media technology such as television, radio and newspapers. Consequently, relying on the mass media alone will be a huge mismatch. Therefore, for important messages to get across to rural people, Mushengyezi (2003) asserts that it must be contextualised to suit both their local settings and cultural dialectics.

Table 7: Mediums used to disseminate early warnings to vulnerable people in developing countries

References	Study site and year of study	Study design	Mediums used to communicate disaster warnings	Key findings
(Ajibade and McBean 2014)	Badia communities, Lagos, Nigeria (2011)	Questionnaire (*n*=607), focus group discussions (FGDs) (*n*=20)	Television (TV), radio, newspaper, and bus-advocacy system	59.3% of the participant's claimed they never received the forecast before the flood occurred in July 2011.
(Hallegatte, 2012; Paul, 2009)	Bagerhat, Barguna, Patuakhali, and Pirojpur, Bangladesh (2008)	Questionnaires, informal and formal conversations with local leaders, NGO workers, etc.	Radio, TV, volunteers rode motorbikes to convey the forecast to people residing in remote villages without good road networks, house to house contact, bicycle-mounted loudspeakers, and hand-held bullhorns	Over 85% of households were aware of the cyclone *Sidr* warning (which descended in November 2007).
(Hammer et al., 2001)	Zimbabwe (1997-98 El Niño year) and 1998-99	Based on secondary data	Radio and TV	In 1998-99, it was documented that the number of people who received the seasonal forecast plunged from 90% in the previous year to less than 40%. This was attributed to lack of interest in the mass media.

(Mudombi and Godwell, 2014)	Murewa and Seke, Mashonaland East province in Zimbabwe (2011)	Interviews (*n*=150 in each study sites)	Radio, TV, extension services and direct inquiry from the weather station	36% in Murewa and 30% in Seke got a timely warning about the forthcoming violent storm.
(Chowdhury et al. 1993)	12 villages and neighbourhood in the Parishad, Bangladesh. Half of the Parishads were on the offshore island of Kutubdia and Sandwip. The other half were from the coastal sub-districts of Chakoria and Banshkhali (1991)	Structured questions (*n*=2000)	Radio (37.3%), megaphone (19.4%), and interpersonal communication (43.3%)	Almost everyone residing in the offshore island of Kutubdia and Sandwip received the warning before the cyclone descended in April. In the coastal region of Banshkhali and Chakoria, approximately 60% received the warning.
(Turner et al., 2014)	Punjab, Pakistan (2013)	Questionnaires (*n*=640)	TV, radio, and face to face warning	Face to face warning significantly facilitated proactive flood mitigation actions during the 2010 summer Pakistan flood. TV and radio did not have any significant effect in facilitating proactive flood mitigation actions.
(Jibiki et al., 2016)	Tacloban City, Palo Municipality, and Tanauan Municipality, Philippines (2014).	Questionnaires and interviews (*n*=642).	TV, radio, newspapers, and house to house warning	It was estimated that only 1.7% of the affected individuals did not receive the warning of the forthcoming Typhoon Haiyan.

(Hellmuth et al., 2007)	South and central Mozambique (2000)	Based on secondary data	Mass media	It was argued that it appeared that the role of the press was uncertain as they did not broadcast the forecast until the disaster started occurring. Further, it was asserted that the risk was not well understood by those vulnerable to the floods. Consequently, most of them chose not to leave their houses, which resulted in mortality for some.

Source: Author's compilation 2017

4.3. Methodology

This study was conducted in Olomoro, Igbide and Uzere communities situated in Isoko South Local Government Area (ISLGA) of the Delta State (see Figure 1). Subsistence farming constitutes the primary economic activity (over 90%) in these predominantly rural communities, with the women mostly involved in the practice (Ebhuoma and Simatele, 2017a). The men, however, primarily engage in fishing, albeit some do assist their wives in crop production. Cassava and groundnut are the predominant staples cultivated in all three communities on a yearly basis. Other staples planted in the study areas include yam, cocoyam, potato, pepper and plantain (Ebhuoma and Simatele, 2017a).

The farmlands in Igbide and Uzere are generally low-lying, while Olomoro comprises both low and high lying farmlands. The mean annual rainfall from March–October in the Delta State ranges from 2500 to 3000mm (Niger Delta Environmental Survey (NDES), 2000). The low-lying farmlands in each of the study areas are usually inundated from mid-June, at the earliest, to the last week in October every year. In extreme conditions, the low-lying farmlands remain inundated until the third week in November. Thus, Cassava, which requires a minimum of six months to attain maturity, is usually planted in December and harvested between June and August each year on the low-lying farmlands. The other staples that mature within four months are cultivated, under normal circumstances, anytime between the last week in February and March.

Focus Group Discussions (FGDs) and semi-structured interviews were the main methodological tool used to collect data for this study. In total, the study comprised 35 FGDs and four face to face semi-structured interviews (two in Olomoro and one each in Igbide and Uzere), which were conducted between June and October 2015. Of the 35 focus groups, 24 were made up of female participants, five were made up of male participants, while six

comprised both male and female participants. Each FGD was made up of three to 12 participants. The age of the participants ranged from 20 to 85. The rationale behind separating most of the focus group participants based on gender was to avoid related cultural issues where women might not be able to unreservedly express themselves without the consent of their male counterparts, as they can be misinterpreted as being disrespectful if they do so (Ebhuoma and Simatele, 2017).

The participants in each community were identified using purposive sampling based on age, gender, those who have been farming in the study area for over ten years on the low-lying farmlands, and those whose household assets and livelihoods were severely affected by the 2012 flood disaster. The identification process was facilitated by key informants that have been residing in each of the communities for over 40 years, and an agricultural extension worker in ISLGA. Also, open ended questionnaires were administered to 15 senior agricultural extension officers that operate within ISLGA. The extension officers were identified purposively through the assistance of the agricultural extension officer that assisted in identifying some of the farmers that took part in this study. Furthermore, semi-structured interviews were conducted with a senior NIMET official in the forecasting unit situated in the NIMET headquarters, Abuja and a NIMET official in the Delta State in charge of disseminating daily rainfall and temperature data's to media outlets in the State. In addition, a semi-structured interview was also conducted with a senior official of the Nigerian Red Cross Society in the Delta State, who was actively involved in the search and rescue operation during and in the aftermath of the flood, as well as ensuring that displaced residents were successfully registered and camped in Internally Displaced Person's (IDP) camps provided by the Delta State government. The qualitative data were analysed using the thematic content analysis technique.

4.4. Results

4.4.1. The mediums used to disseminate the 2012 flood warnings and why it proved less effective

In March 2012, the NIMET, during the official presentation of the Seasonal Rainfall Prediction (SRP) report at a stakeholder forum in Abuja, predicted massive flooding for some parts of the country (Agada and Nirupama, 2015). The SRP report also revealed that heavy downpour was expected to commence from the last week in June, and further stressed that adequate steps would be required to minimise damages to assets and livelihoods (Vanguard, 2012). In spite of the ample time that the forecast was disseminated, most of the affected States in the country were caught off-guard (Vanguard, 2012). Between July and October 2012, Nigeria experienced arguably its biggest flood disaster ever since the nation gained independence in 1960. Approximately 600, 000 houses were destroyed courtesy of the flood, thereby resulting in the displacement of over 7 million people (Agbonkhese et al., 2014; Reliefweb, 2012). One of the most severely affected areas in the Delta State, as observed by Omohode (2012), was ISLGA.

Fieldwork exercise revealed that Igbide, Olomoro and Uzere communities situated in ISLGA were adversely affected to the point that some of the flood victims who refused to evacuate their homes for fear of theft had to rely on makeshift boats and canoes just to move from one point to another within the same community. Few days to some hours before the flood affected most houses in the aforementioned communities, some household heads had to quickly relocate household members to IDP camps situated either in Oleh or Kwale in the Delta State. A few decided to flee with their families to relatives houses in unaffected rural communities also in ISLGA that are situated on higher ground as well as nearby urban areas such as Warri and Ughelli in the Delta State. In narrating the impact of the flood on his

household assets including the steps he took to protect and rescue some household properties, a participant from Olomoro, in his 50's, explained:

> *When I heard that the floodwater had inundated some houses roughly 30 km away from my house, I quickly called a bricklayer to construct a barrier, about 70cm high, at the entrance and exit of my home. The aim was to prevent the floodwater from inundating my house. However, this measure proved futile as the floodwater started emanating from the ground and thus, started affecting household properties. Consequently, my wife, kids, and I had to embark swiftly on an emergency evacuation process. The few items we could evacuate, we moved to a neighbour's house that was unaffected. He was so kind to provide shelter (a room) for my family in his apartment. Other household items were lost as the tide became so strong that we had to neglect the evacuation process in order to preserve our lives. The entire ordeal was terrible and painful. It is not something I pray to experience again* (*Pers. Comm,* 2015k).

Figure 9: A focus group participant in Uzere revealing the height of the floodwater in 2012. Photo by Eromose Ebhuoma (2015).

When participants in this study were asked if they ever received the 2012 forecast, all but one participant claimed they never received the forecast. The participant who argued that she heard of the flood warning, a lady from Igbide, in her late 40's, pointed out that it was broadcasted through the radio. Her opinion was corroborated by a senior official of the Nigerian Red Cross Society in the Delta State. The official, in his 30's, commented:

> *The 2012 Flood warning was disseminated to the general public via radio, television and also through the use of flyers* (*Pers. Comm*, 2015h).

However, a female participant from Igbide who took part in the FGD where a lady affirmed that the forecast was aired on the radio, in her 50's, expressed disdain at the medium of communication. She remarked:

> *Do all these women listen to the radio? We leave for our farmlands first thing in the morning, and by the time we get back home, we have to prepare dinner for the family. When we finish cooking, we become fatigued, and thus, the only thing on our mind is to get some sleep so that we can get re-energised for the next day's activities. What time do we have to listen to the radio?* (*Pers. Comm,* 2015l).

Table 8: Why the mass media proved ineffective in enlightening households in the study areas about the forthcoming flood in 2012

Reasons	**Frequency of citations**	**No. of citations**	**%**
On the farm or carrying out other livelihood activities	IIIII IIIII IIIII IIIII IIIII IIIII IIIII II	47	44
Lack of constant electricity to listen to the radio and television	IIIII IIIII IIIII IIIII IIIII IIIII IIII	34	31
Do not own radio and television sets	IIIII IIIII IIIII IIIII III	23	21
Others	IIII	4	4
Total		**108**	**100**

Source: Field-based materials, 2015

For those privileged to own either TV and/or radio sets, the lack of constant power supply severely hampered the effectiveness of this medium. For instance, during a FGD in Olomoro, the participants stated that there had not been electricity for the past two weeks. This is symptomatic of the power situation in most part of the country. The Economist (2016), for example, identified Nigeria as "one of the world's darkest nations". It further highlighted that Nigeria, a nation with a population of 170 million people, generates a meagre 2, 800 megawatts of electricity, which is just about the same amount of power used by Edinburgh, the capital of Scotland with a population of approximately 500, 000 people. In fact, it will not

be an exaggeration to state that virtually every private business in Nigeria has a standby generator. Simply put, if you do not have a standby generator, your business is headed for an iceberg.

In light of the above discussions and arguments, it can be argued that the NIMET failed to take into cognisance and integrate the various local and traditional techniques that the rural people employ when disseminating vital information's within their community. In explaining why the use of the mass media was a total catastrophe, the Red-Cross official stated:

> *You simply cannot employ the same strategy for conveying a message to people residing in urban spaces and an 80-year-old woman residing in a rural community. You have to find, for example, the most suitable language the elderly woman is fluent in and not assume that everybody understands English. Also, it is well known that most rural dwellers in Nigeria cannot read and write. So what's the logic behind printing flyers as a means of warning people about the flood?* (*Pers. Comm*, 2015h).

4.4.2. Mediums employed to disseminate crucial information in Igbide, Uzere and Olomoro communities

The participants in the aforementioned communities argued that the most effective ways of disseminating messages within their communities are through town-hall meetings and the use of town criers. With regards to town-hall meetings, the participants emphasised that it has been instrumental in ensuring that most community members get the information being passed across, irrespective of how swamped they are. A participant from Uzere, in his early 30's, commented:

> *When you call for a town-hall meeting, of course, not everybody will be able to make it. But there is always the tendency for a household member or a neighbour to be present who will help divulge the information to the absentees* (*Pers. Comm,* 2015m).

In the context of both developed and developing countries, town-hall meetings and other participatory forms of engaging with rural households and the general public have been effective in ensuring that the intended message gets to the target individuals or group (Broadcasting board of governors (BBG), 2014; Gegeo and Watson-Gegeo, 2001; Lukensmeyer and Brigham, 2002). As argued by Lukensmeyer and Brigham (2002), town-hall meetings create a fertile platform for in-depth dialogue between citizens and decision makers or intermediaries of policy makers. After perusing the literature, it can be argued that what parliament meetings are to members of parliament and senators almost mirrors what town-hall meetings and related participatory meetings are to poor rural households in developing countries. This is because such meetings tend to articulate rural households as people with agency as they become opportune to unreservedly express their views and opinions, which they perceive will get to the necessary authorities and decision makers and consequently inform decisions taken that are pertinent to their welfare (see Gero et al., 2011; Mercer et al., 2008). Thus, at the call for such meetings, some rural households will strive to ensure that none of their livelihood activities or other social obligations intersects with the meeting.

The use of town-criers entails an individual walking through the community with a gong and an iron rod that produces a resonant, vibrating sound when struck to get the attention of community members after which they pass on the necessary information. The participants pointed out that this medium has been highly effective in the past and it's still heavily relied upon in keeping members abreast with events and happenings within the community. Their views were concretised by the red-cross official who stressed that the most efficient ways to

enlighten rural households are through frequent town-hall meetings, use of town-criers and door to door enlightenment.

In countries such as the Philippines, Bangladesh and Pakistan, for example, this localised technology has been modified and upgraded to handheld bullhorns, bicycle-mounted loudspeakers and a public address system situated in strategic locations within a community (Hallegatte, 2012; Jibiki et al., 2016; Paul, 2009; Turner et al., 2014; Zahari and Ariffin, 2013). Due to the utilisation of this localised technology in the Southwestern coastal region of Bangladesh, Paul (2009) argued that over 85% of households became aware of the forthcoming Cyclone Sidr and evacuation order when the warning signal was raised to four, classified as a precautionary signal, by the Bangladesh Meteorological Department (BMD). He further asserted that this simple technology saved countless lives, despite the lack of maintenance of shelters, with only 60% of them deemed habitable.

It is also worthwhile to mention that due to the fact that the majority in the aforementioned communities are Christians and are devoted members of their respective churches, the church can be used as a resource in disseminating extreme weather warnings. However, with regards to using religious groups as a resource since they are usually more trust worthy than most government institutions, with the exception of Murphy et al. (2016), the church remains one of the most underexploited avenues in enlightening rural households on issues relating to climatic risks in developing countries. Some advocates of risk communication argue that religious narratives can be a viable platform to enlighten people about issues relating to climate change (Moser, 2010). This is because Christianity, as acknowledged by Jenkins (2007), is moving at lightning speed into the Global South.

Table 9: Effective channels of communicating important messages to rural households

Channels	Frequency of citations	No. of citations	%
Town-criers	IIIII IIIII IIIII IIIII IIIII IIIII IIIII IIIII I	41	42
Town-hall meetings	IIIII IIIII IIIII IIIII IIIII IIIII IIIII I	36	37
Church	IIIII IIIII IIIII III	18	19
Mass media & text message on mobile phones	IIIII II	2	2
Total		**97**	**100**

Source: Field-based materials, 2015

It has been projected that by 2025, the continent that will have the largest number of Christians will be fiercely contested between Africa and Latin America (Jenkins, 2007). In the context of Nigeria, anecdotal evidence suggests that it has the highest number of churches per capita on a global scale (Jemiriye, 1998). It is, however, noteworthy to mention that risk communicators should not be quick to assume that utilising the church as a medium to communicate early warnings will simply be a walk in the park. This is because some clergies from developing nations are not convinced of scientist's ability to accurately anticipate the weather, which they believe is solely in the hands of God (Wolf and Moser, 2011). For instance, a reverend from Igbide who is also a farmer, in his 50's, explained:

> *About 9 o'clock this morning it was threatening to rain. Now it's 4: 40 pm and the sun is shining, how do you predict God?* (*Pers. Comm,* 2015n).

In light of the above therefore, enormous stride must be made as early as possible to enlighten these clergies on the ability for scientists to anticipate future weather conditions to a satisfactory degree of accuracy and thus, do not impede risk communicators from using the church as a resource to pass these sort of vital messages in the future. This is because most of the members are likely to incorporate the viewpoint of their respective clergies (see also Leiserowitz, 2006). It is, however, important to mention that for the aforementioned localised strategies to be highly effective, it is crucial for NIMET to partner with the agricultural

extension officers as the fieldwork data revealed that they are not involved in the process of disseminating scientific weather predictions. It is also important for NIMET to partner with NGO's or other organisations with firm grassroots base and who are well known to these farmers. This is because this has proved efficient in saving lives in the case of Cyclone Sidr, which occurred in Bangladesh in 2007 (Paul, 2009).

4.5. Discussion

Communicating early warnings in a manner that can easily be understood and provoke proactive measures by those expected to be susceptible to the anticipated extreme weather condition are no small feat. From the results, it is evident that the use of the mass media to disseminate the 2012 flood warning to households in Igbide, Uzere and Olomoro communities proved grossly ineffective. This observation is in stark contrast with several findings, which suggest that the use of radio, for example, is an effective tool for communicating climate related issues to poor rural households in developing countries (see Merline et al., 2015; Bisht 2013; Bisht and Ahluwalia 2015).Writing from an Indian context, Bisht and Ahluwalia (2015) contend that community radio transcends barriers such as illiteracy, accessibility, affordability and local relevance, which impedes the flourishing of other channels of communication in rural spaces. In the aforementioned communities, however, there are no community radio stations. Even if they were community radio, its effectiveness, as the only medium of communicating extreme weather warnings, cannot be totally guaranteed.

This is based on two premises: firstly, the lack of constant electricity supply in Nigeria will hamper the effectiveness of community radio. For instance, the July 2011 flood disaster that inundated most houses in Badia communities in Lagos, Nigeria, it was acknowledged that 59.3% of respondents (where N=607) did not receive the flood warning due to lack of

electricity supply (Ajibade and McBean, 2014). Secondly, although farming remains the primary source of livelihood for most poor rural households in SSA, they are, however, deeply entrenched in a complex web of non-farming activities in order to obtain the livelihood they aggressively pursue (Chambers, 1995, 1983; Scoones, 1998). In this regard, the farmer's reiterated that the only days they are not fully engaged in trying to obtain their livelihoods are during the community's market day, which occurs every four days, and Sundays. Their regular day entails that they set out before daybreak and return home in the evening completely exhausted. Thus, they rarely have "any ounce of energy" left in them to watch TV or listen to the radio when they get back home, as the only thing on their mind is to get a befitting rest (e.g., see Ngimwa et al. 1997).

In proposing effective mediums to reach out to the rural poor, Chowdhury et al. (1993); Kolawole (2012); Mushengyezi (2003); Paul (2009) and Turner et al. (2014), among others, have emphasised the need to utilise local communication channels, which is consistent with the findings of this study. This is because most rural communities have certain customs and traditions that shape the ways in which the inhabitant's conduct themselves and get things sorted (Gegeo and Watson-Gegeo, 2001; Janke, 2005; Kolawole, 2012). Nonetheless, a plausible explanation that, perhaps, might have convinced the NIMET officials not to factor and utilise local techniques and practices to disseminate the flood warning, is due to the impacts of globalisation that has deeply infiltrated the urban spaces in the Nigerian society.

The manner in which the urban areas have, and are still undergoing a radical technological transformation, for example, is such that most urban dwellers depend on electronic gadgets to carry out some of their daily businesses and transactions including getting latest news update within Nigeria and abroad. This might have persuaded the NIMET officials, whose offices are firmly rooted in the urban areas, to conclude that most rural spaces might have experienced such sporadic transfigurations in parallel wavelengths to that in urban regions.

Consequently, extra efforts aimed at paying delicate attention to specific contexts and also employ the techniques they rely on to publicise vital pieces of information will, perhaps, be "a waste of valuable time and resources". This is because the NIMET have implicitly and explicitly bemoaned the lack of funds as key factors preventing them from effectively carrying out their mandated tasks and set of objectives (Daily Trust, 2012; This Day, 2016).

It is, arguably, this sort of perception that might be responsible for the failure of several meteorological agencies in developing countries from incorporating local strategies in communicating forecasted extreme weather warnings (see Table 7). Perhaps, what the NIMET failed to take into cognisance is that the ongoing transformation being observed in urban spaces have been at a snail's pace in most rural communities (Ebhuoma and Simatele, 2017; Ugwuanyi and Chukwuemeka, 2013). The farmers argue that their local ways of communication would have had huge significant impacts as against the complete reliance on the mass media. In fact, the literature suggests that most rural households in SSA continue to rely on, and still prefer their local ways of getting things sorted over technological advancements, which they perceive is a threat to their local way of life (Janke, 2005). This view is substantiated by Kolawole (2012) who argued that:

> "*The hypothesis that local people will continue to rely on most of the innovations and initiatives developed by their forefathers, which informed the ways they got things sorted, after years of experimentation and cross-validation has continued to remain valid*" *(Kolawole, 2012).*

Consequently, some attempts to introduce technologies that have the potential to improve their general welfare might be perceived as a deliberate and systematic attempt for their children and future generations to eventually neglect their culture and identity, and no longer rely on the ways in which their ancestors got things sorted. Thus, they are often quick to repel

any “suspicious” technological advancement. From their lenses, some technological advancements have the potential to infiltrate and consequently cripple their traditional ways of doing things that, over the years have been tried, tested and endorsed as effective in addressing complex issues for decades (Kolawole 2012; Murphy et al., 2016). Thus, when decision makers in Africa use some ideologies and epistemologies from the Western world as a benchmark for how things should be done in Africa, they stand the risk of trivialising or completely neglecting the societal and cultural values that most rural inhabitants hold in high esteem. This could potentially become counterproductive as the people might not be motivated and willing to act in the manner anticipated by the decision makers upon receiving an extreme weather forecast.

4.6. Conclusion

High-resolution models used to monitor the sea surface perturbations has made it possible for scientists to predict future weather events such as floods a few weeks to months ahead. While this is a tremendous feat since has the potential to save lives and minimise loss of assets, it can only be achieved if the risks are adequately communicated to those likely to be affected by the disaster. As revealed in this paper, the 2012 flood forecasted by the NIMET failed to reach those residing in Igbide, Uzere and Olomoro communities primarily because NIMET ignored the various ways these rural communities publicise vital pieces of information within their community. My message is not that the use of the mass media should be abolished when disseminating early warnings to rural households in developing countries as it has proved overwhelmingly useful in spreading vital information to the rural poor (see Bisht and Ahluwalia, 2015; Merline et al., 2015). Rather, I advocate for due attention to be paid to specific contexts and also incorporate the local ways rural households publicise useful information within their community if the aim of communicating extreme weather warnings

is to ensure the message is effectively understood by the rural poor. As Mushengyezi (2003) eloquently puts forward, “as African governments continue to usher their population more and more into the cyber world and cyberspace, the pumpkin in the old homestead should not be uprooted”.

CHAPTER FIVE

"We know our Terrain": Indigenous Knowledge Preferred to Scientific Systems of Weather Forecasting in the Delta State of Nigeria[10]

Abstract

It is acknowledged that subsistence farmers in developing countries rely on Indigenous Knowledge Systems (IKS) to determine the appropriate time, the types and quantity of food to produce in a particular farming season. Due to the unprecedented rate at which climate variability is occurring globally, there are concerns that IKS will become unreliable to predict future weather events accurately, which will compromise the ability for farmers to secure their livelihoods. Nonetheless, some scholars are optimistic that if farmers rely on Seasonal Climate Forecast (SCF), it will facilitate the adoption of planned and more efficient adaptation strategies, thereby ensuring that they continue effectively in food production. While most countries in sub-Saharan Africa (SSA) have been investing in meteorology, farmers still rely heavily on IKS. Drawing on fieldwork conducted in the Delta State of Nigeria, this paper discusses the factors that contribute towards farmer's willingness to adhere to IKS. The results suggest that being misled by an inaccurate scientific forecast, and the inability to comprehend how anthropogenic activities contribute to climate change, among others, have contributed to the farmer's continued reliance on IKS. These issues have been explored within the broader contemporary theoretical arguments and debates revolving around IKS and SCF.

Keywords: *Climate variability, indigenous knowledge, seasonal climate forecast, Nigeria.*

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5.1. Introduction

Climate variability and change undermines effective agricultural practices globally (Adger et al., 2009; Challinor et al., 2007; Conway and Schipper, 2011; Conway, 2011). However, food production in developing countries have been more adversely affected by climate variability partly because it is predominantly rain-fed (Challinor et al., 2007; Conway, 2011). Yet, poor rural households have not only been actively involved in adapting to climate variability, but have continued producing food through the use of Indigenous Knowledge Systems (IKS) (Al Mamun et al., 2014; Bola et al., 2014; Nkomwa et al., 2014; Nyong et al., 2007; Pareek and Trivedi, 2011). IKS such as sky and astronomical observations, animal behaviours and wind direction, for example, have played a huge role in determining when farmers prepare the fields, the nature and quantity of crops that they plant in a particular season. Due to the unprecedented rate at which climate variability is occurring, and with global climate expected to continue changing well beyond this century, there are growing concerns that it will overwhelm the ability for IKS to anticipate future weather patterns accurately (Intergovernmental Panel on Climate Change (IPCC), 2014b; Roncoli et al., 2002).

Wisner et al. (1977) argue that the vast wealth of knowledge local people in developing countries possess about their environment have become distorted under the capitalist mode of production. This mode of production, as observed by Ding (2003), has resulted to the overexploitation of natural resources, thereby facilitating increased environmental degradation and change where environmental legislations are either weak or absent. The changes in environmental condition vis-à-vis climate variability have combined to facilitate the decline and/or loss of IKS (Budnuka et al., 2015; Crawhall, 2005; Ding, 2003; Adger et al., 2005; Thomas and Twyman, 2005; Wongbusarakum, 2005). This has culminated in a situation referred to as “decision pathology” by Wisner et al. (1977). Decision pathology involves a scenario where farmers make decisions pertaining to their livelihoods by relying

on scanty pieces of information. Such pathological decisions can shrink the assets in the portfolio of farmers, which in turn can compromise their adaptive capacity and resilience to future shocks and stresses.

With climate variability now becoming the new normal globally, it is expected that food production will be more challenging for subsistence farmers in developing countries that continue to rely predominantly on IKS (Ajani et al., 2013; Fabiyi and Oloukoi, 2013). Consequently, scientists and scholars alike posit that Seasonal Climate Forecast (SCF) can provide a platform whereby farmers can harness opportunities for adapting and building their resilience to climate variability (Choi et al., 2015; Klopper et al., 2006; Spence and Pidgeon, 2010; Ziervogel and Downing, 2004). This is because the development of high-resolution models used to monitor the ocean-atmosphere interactions, and increased investment in monitoring the tropical oceans have made it possible for scientists to generate SCF a few weeks to approximately a year ahead (Ash et al., 2007).

Despite increased investments in meteorological services by various developing countries, the literature suggest that subsistence farmers in developing countries still rely heavily on their IKS (Eakin, 1999; Roncoli et al., 2002; World Bank, 2015). In Nigeria, for example, in the aftermath of the 2012 flood disaster that plagued various rural farming communities in 30 of the 36 States, one would expect that subsistence farmers will, henceforth, utilise SCF when making farming decisions since their IKS failed to predict the flood. This is because the Nigerian Meteorological Agency (NIMET) predicted the flood, which nobody took seriously (Agbonkhese et al., 2014). However, a recent fieldwork conducted in Igbide, Uzere and Olomoro communities in the Delta State where the majority had to flee their homes to seek shelter in Internally Displaced Person's (IDP) camps as a result of the flood suggest otherwise. For instance, one of the study participants from Uzere, in his 40's, stated:

> *If the government is keen on improving our welfare, they should provide loans for us so that after we have planted, harvested and sold some of the produce we can remit the loan. This will make more positive impacts on the lives of farmers instead of "wasting" resources on SCF. "We know our terrain"* (*Pers. Comm*, 2015b).

In light of the above, this paper pursues two objectives. Firstly, it explores the various forms of IKS used by farmers in the Delta State to anticipate future weather patterns. Secondly, it seeks to identify the factors that contribute to the continued resistance of subsistence farmers in adopting and utilising SCF (see also Holden et al., 2011). It is, however, important to emphasise that extreme caution must be applied when interpreting the results in this paper, as the barriers underlined might not necessarily be the only stumbling blocks preventing resource-constrained farmers in the global South from utilising SCF.

5.2. Indigenous weather forecasting in the developing world

IKS have also been referred to as local, folk, farmers' or traditional knowledge (Hiwasaki et al., 2014; Nkomwa et al., 2014; Orlove et al., 2010; Roncoli et al., 2002). It refers to place-based knowledge that is distinct to a particular culture or community. IKS normally stems from day to day observation and cumulative experience that have been tried and tested with real life scenarios and is usually passed on from one generation to the next via oral communication and repetitive engagement (Warren, 1991; Orlove et al., 2010). It forms the basis for local level decision-making in agriculture and natural resource management in most rural communities (Warren, 1991).

Due to the fact that the livelihoods of resource-constrained farmers are overwhelmingly tied to the natural environment, they utilise various local indicators to predict future weather events in order to ascertain the "appropriate" time to plant and the quantity of food to produce in the cultivating season (Eakin, 1999; Roncoli et al., 2002; Kalanda-Joshua, Ngongondo,

Chipeta, & Mpembeka, 2011; Nkomwa et al., 2014). A key indicator heavily relied upon is animal behaviour. Orlove et al. (2010), for example, document that the sudden appearance of migratory birds in southern Uganda is an indication for some farmers that the rains will commence in a few weeks' time. Similarly, Eakin (1999) illustrated how a farmer in Tlaxcala, Mexico predicts the weather. The farmer stated that whenever the swallows fly high, it is an indication that the weather will remain dry. But when they fly low, it is indicative of a forthcoming rain. For other farmers in the same study, ants fleeing underground colony is an indication of a forthcoming windy weather condition, usually within a few hours or days' time (Eakin, 1999). But for farmers both in Chagaka village, Southern Malawi and in Rajasthan, India, the migration of ants from their colony suggest that there will be sufficient amount of rainfall for planting (Nkomwa et al., 2014; Pareek and Trivedi, 2011).

Literature also suggests that sky and celestial observations, wind direction, and variation in temperature have been used by farmers to predict oncoming rain and droughts (Eakin, 1999; Orlove et al., 2010). In some rural coastal communities in Ondo and Delta States of Nigeria, for instance, the appearance of the full moon is an indication that coastal flooding is about to occur (Fabiyi and Oloukoi, 2013). Thus, they start preparing to harvest their farm produce. Also, Nkomwa et al. (2014) acknowledged that the flowering of trees and shredding of leaves have been used by farmers in Chagaka village, Southern Malawi to predict the onset of the rainy season.

The above case studies suggest that, although local farmers lack a thorough understanding of the processes that leads to the climate variability and change they are experiencing, they possess a detailed understanding of their local environment as well as the indigenous flora and fauna (Eakin, 1999; Pareek & Trivedi, 2011). Nonetheless, there are growing concerns that future climate-related events will most certainly overwhelm the IKS of farmers in

developing countries (IPCC, 2014b; Kalanda-Joshua et al., 2011; Roncoli et al., 2002; Shepherd et al., 2013). Within this context, advocates of SCF strongly perceive that it is a technology that can enable farmer's make more informed decisions regarding their agricultural practices (Hansen et al., 2011; Phillips et al., 2001; Vogel, 2000). Consequently, numerous countries in SSA whose rural economies are underpinned by farming have been investing in meteorological services (World Bank, 2015).

However, the dearth of studies underlying how farmers have been able to improve their welfare through the ability to engage in more purposeful agricultural practices and engage in well mapped out adaptation strategies through the use of SCF may, perhaps, suggest that there are roadblocks impeding its uptake and utilisation.

5.3. Factors impeding the uptake and utilisation of SCF

Simulation studies conducted within developing countries reveal that SCF have the potential to facilitate household food security (Roudier et al., 2014; Ziervogel & Calder, 2003). However, the literature on climate change adaptation suggests that this technology has rarely been embraced by the resource-constrained farmers. Some scholars have, in part, attributed this to the fact that SCF are not usually tailored to meeting the needs of end-users (Soares and Dessai, 2016; Ziervogel et al., 2010). This is because SCF, in most cases, have been developed from a top-down approach with scientists concluding that it is inconsequential to incorporate the views of resource-poor farmers to find out their needs and aspirations prior to SCF production.

Unfortunately, this trend of thought is symptomatic of several other technologies that have been developed with the view of enhancing the adaptive capacity of agriculturally dependent communities (Asoegwu and Asoegwu, 2007; Chambers and Ghildyal, 1985). Thus, when such technologies are proposed to poor rural farmers as an invention that can enhance

agricultural productivity, such promptings rarely strike a nerve as the poor cannot relate to them or confirm their source (Sideridis et al., 2010). Thus, they become reluctant to hinge decisions that are pertinent to the livelihood they pursue on something that cannot be trusted or understood (Sideridis et al., 2010; Sillitoe, 2000).

Another crucial factor that can impede the uptake of SCF, according to Agrawala et al. (2001), is when it contravenes indigenously generated forecast underpinned by historical narratives. Individuals residing in spaces highly susceptible to climate extremes often distant themselves from the associated extreme weather phenomena, by expecting it to have negligible or no impact on their assets and livelihoods based on lived experiences (Burningham et al., 2008; Kellens et al., 2011; Lieske et al., 2014). Broad and Agrawala (2000), by contrast, contend that when individuals have been agonisingly affected by a wrong forecast, it has a high tendency to hinder future uptake and utilisation of SCF.

Although there have been tremendous improvements in ENSO-based seasonal forecasts since its inception, it is still not 100% perfect and thus, prone to errors (Klopper, 1999). In the event of an imprecise forecast, regaining the confidence of those affected especially the subsistence farmers can become a daunting task. Broad and Agrawala (2000) argue that subsistence farmers can be highly susceptible to inaccurate forecasts partly because they have limited resources to withstand a poor harvest. Thus, when resource-constrained farmers have been agonisingly affected by a wrong forecast – particularly when concerted efforts were not made by the relevant authorities to explain to those affected the reasons for the error, and possibly compensate them for adhering to the forecast – the likelihood that the farmers trust in future forecast will wane, especially when it is disseminated by the same communicator, is extremely high. As argued by Slovic (2000), despite tremendous efforts invested in risk communication process, its limited effectiveness can be largely attributed to lack of trust in the source and the communicator.

If you trust the communicator, for instance, communication becomes relatively easy. Conversely, where trust is non-existent, no method of communication will suffice (Sellnow et al., 2008). Since it is a lot easier to lose than to build trust, otherwise referred to as "the asymmetry principle", commitment, competence, care and predictability are core ingredients necessary to build and maintain trust (Kasperson et al., 1992). Finally, the inability to comprehend how anthropogenic activities contribute to climate change have also been identified as a key factor that impedes the uptake of SCF (Somerville and Hassol, 2011). It has been argued that those not convinced by the relationship between anthropogenic activities and climate change are more likely to embrace the standpoint of those with whom they share similar socio-cultural values, and leaders they hold in high esteem (European Commission, 2014; Leiserowitz, 2006; Slovic, 1986). If a religious leader, for example, tags climate change as an "act of God" and there is nothing humans can do to minimise future climatic changes, the tendency that the partisans will cleave to this notion is extremely high.

5.4. Methodology

This paper is based on fieldwork data obtained from Olomoro, Igbide and Uzere communities situated in ISLGA of the Delta State in Nigeria (see Figure 1). The Delta State is one of the nine States in Nigeria that makes up the oil-rich Niger Delta region. *Isoko* is the local dialect spoken in the study areas. The Delta State have a mean annual rainfall of about 2500 – 3000mm (Niger Delta Environmental Survey (NDES), 2000). The weather patterns can be categorised into rainy and dry seasons (Adejuwon, 2012). Under normal circumstances, the rainy season commences fully in June and last until October. Prior to this, the early rainfall usually commences between the third week in February and second week in March and continues until the last week in May every year. The end of the rainy season is closely followed by the dry season. The dry season commences from November and lasts until early

March, with dry and dusty conditions referred to as *harmattan*, occurring between mid-December and late January. In extreme conditions, *harmattan* can continue until the first week in March.

Subsistence farming is the primary economic driver of these three communities. The farmers stated that cassava and groundnut are the crops that "must" be produced by every farmer annually. Other crops also produced annually in all three communities include okra, pepper, sweet potatoes, yam and plantain. Except for cassava, the crops mentioned above depend predominantly on the early rainfall for production. The farmlands in Igbide and Uzere are low-lying, while Olomoro comprises both low and high lying farmlands. The low-lying farmlands in each of the study areas always experience seasonal flooding from mid-June, at the earliest, to the last week in October every year. In extreme conditions, the low-lying farmlands remain inundated until the third week in November. Thus, Cassava, which requires a minimum of six months to attain maturity, is usually planted in December and harvested between June and August each year on the low-lying farmlands.

Focus Group Discussions (FGDs) were the main methodological tool used to collect data as it embodies a rich participatory means of obtaining data due to its ability to generate both qualitative and quantitative data's (Chambers, 2007). The study comprised 35 FGDs and 14 face to face semi-structured interviews conducted in the study areas between June 2015 and July 2016. Of the 35 focus groups, 24 were made up of female participants, five were made up of male participants, while six comprised both male and female participants. Each of the FGD consisted of about three to twelve participants. The rationale for having about two-thirds of the FGDs made up of women is because they are primarily responsible for agricultural production. The age of two-thirds of the participants ranged from 42 to 85. The participants in each community were identified using purposive sampling technique based on age, the number of years they have been residing in the study areas, farmers that have been

cultivating on the low-lying farmlands for over ten years, farmers whose agricultural practices was affected by the 2012 flood disaster and gender. The data were analysed using the thematic content analysis technique.

5.5. Results and discussion

5.5.1. Local indicators used to predict the weather

Indigenous people pay close attention to their immediate environment including the biodiversity situated within it because their very existence is overwhelmingly tied to the environment (Eakin, 1999). It is these meticulous attentions that usually inform the ways in which poor rural households in most developing countries engage in food production (Orlove et al., 2010). Within this context, participants in the aforementioned communities, particularly the elderly (≥ 50years), argued that observing the behaviour of specific animals are essential to ascertain the appropriate time to start preparing the fields as well as the quantity of food to produce in a particular farming season. As acknowledged by the farmers, the croaking of frogs play a pivotal role in determining how they grow their food every planting season (see also Kalanda-Joshua et al., 2011). The farmers emphasised that the croaking of the frogs, which is used to predict both the early rains and the rainy season, is a "call for the rain".

Furthermore, a few farmers in Uzere explained that whenever the ducks start flapping their wings repeatedly against the ground, usually observed in the months of May and June, it is an indication that the rainy season is imminent. In fact, an elderly male farmer vociferously echoed that the croaking of frogs and ducks repeatedly flapping their wings against the ground have been extremely effective in predicting the weather. Another indicator used to predict the onset of the rainy season in all three communities is the appearance of red-like millipedes, locally referred to as *ebighwri*, in groups. For one farmer in his late 60's in Uzere,

it implies that the cultivated crops are getting matured. But for some of the farmers, however, the presence of the millipede means something completely different. A farmer in her 70's in Olomoro, for example, argued that it is an indication that something terrible has occurred in the community such as the death of a prominent chief. A somewhat similar finding has been documented by Orlove et al. (2010). The study, which was conducted southwestern Uganda, revealed that the emergence of a vast number of red ants in a courtyard indicates that a member of the family will pass away in less than a week's time.

Some farmers in Uzere and Igbide asserted that observing how the weaver birds, indigenously referred to as *orieka*, construct its nest provides an indication of how severe the flooding on the low-lying farmlands will be in a particular year. They demonstrated that whenever the birds build their nest on the branch of a tree very close to the ground between February and March, it is a sign that the flooding on the low-lying farmlands for that planting season will not be severe. But whenever the weaver birds build their nest on a branch that is well elevated above ground level, they emphasised that it is a sign that the flooding on their low-lying farmland for that season will be ferocious. However, the farmers acknowledged that this has not always been 100% accurate as there have been instances where the birds have built their nest at the apex of a tree but the floods were not severe in that particular year.

Also, a few elderly farmers in Uzere further asserted that for years now they have noticed that the swamp chicken, locally referred to as *omoko*, usually makes strange sounds between February and March. What was particularly intriguing from the farmer's point of view is that these distinct sounds produced by the swamp chicken always coincided with the period in which the early rain commences, i.e. in a weeks' time or less. As argued by the farmers, these peculiar sounds made by the swamp chicken have proved to be efficient and reliable in informing the ways in which the farmers embark on the production of food such as groundnut and okra, for example, which relies on the early rainfall. A participant also from Uzere, in his

early 30's, argued that he usually observes the cloud between the first and second week in December every year in order to determine how regular the early rains will be in the following year. He demonstrated:

> *Whenever the cloud appears to be thin and further apart, it is a sign that the early rains will not be regular. But when the cloud seems to be a little bit closer to the earth's surface and thick, it is a sign that the early rains will be regular* (*Pers. Comm,* 2015o).

After generating his forecast, he stated that usually communicates the outcome to his mother, advising her on the quantity of groundnut to produce in the forthcoming season. According to the participant, "this method of predicting the weather has always been 100% accurate". Table 10 shows other local indicators used by the farmers in each community to predict the weather.

Although most of the farmers admitted that their indigenously generated forecasts have not always been completely accurate, they still rely enormously on their locally produced forecast. According to the farmers, this is because it has always been customary for them to rely on IKS. Thus, tradition must be respected. In this regard, a farmer from Olomoro, in his late 60's, stated:

> *While our local ways of predicting the weather have not always been 100% accurate, it has, over the years, proved extremely useful to those who respect and obey tradition. When the people follow instructions from nature, they get a bountiful harvest* (*Pers. Comm*, 2016a).

Table 10: Indigenous knowledge used by farmers to predict the weather in Uzere, Olomoro and Igbide communities

Indicators	Specific items	Forecast	% in Uzere N=87	% in Olomoro N=90	% in Igbide. N=76
Animal behaviour	Croaking of frogs	Arrival of early rain and rainy season	41	34	38
	Ducks flapping their wings	Onset of the rainy season	8	-	-
	Appearance of tiny red-like millipedes (*ebighwri*) in groups	Onset of the rainy season	21	11	13
	Weaver birds (*orieka*)	When nest is built very close to the ground, it means that the floods on the low-lying farmlands for that season will be negligible. But when they build their nest at the middle or apex of a tree, it indicates heavy flooding for that season	9	-	12
	Moorhen, commonly known as swamp chicken (*omoko*), makes strange sounds	Onset of the rainy season	6	-	-
Weather	Heavy thunderstorms	Arrival of the early rain	65	62	51
	Strong winds	Onset of the rainy season	47	51	45
	Harmattan	If the *harmattan* stays till March, it indicates that there will be less rainfall than usually observed for the forthcoming planting season. But, if it ends in January, there will be adequate rainfall	16	11	8
	The sun becomes really intense	Arrival of the rainy season	37	41	48
	Cloud becomes dull	Onset of the early rains and the rainy season	62	68	58

	Elevated and thin clouds or low and thick clouds, observed in December	Low amounts of early rains for the next planting season when the cloud is elevated and thin and vice versa	2	-	-
Trees	Flowering of rubber trees (*ficus elastic decora*)	Onset of the early rains	34	17	29
	Cultivated cassava leaves (*manihot esculenta*) becomes fresh	Arrival of the rainy season	10	13	26
Historical knowledge	Understanding the seasonal patterns of their respective communities	The early rains usually commence between February – March. The rainy season between May – October	73	75	77

Source: Field-based materials, 2015; 2016.

When asked what they perceive might be responsible for the inconsistencies surrounding their IKS in some occasions, some of the farmers did not attribute it to any particular issue. A few echoed that only God can determine the actual cause of the failures they are confronted with occasionally. Within this context, a participant from Olomoro, in her 70's, remarked:

> *The failure of our local ways to predict the weather accurately in some occasions cannot be attributed to any particular issue. It is only natural for the weather to change. All we can do is pray to God so that our indigenous ways of anticipating the weather remains accurate at all times* (*Pers. Comm*, 2016b).

Perhaps, the participant's perception identifying God as the only Supreme Being that can provide justifiable reasons regarding why their local indicators are occasionally marred by inconsistencies is because most of them are Christians (Jemiriye, 1998). Consequently, they have come to terms with the fact that most, if not all, weather related issues they are currently confronted with are consistent with God's perfect will and plan. With the overwhelming proliferation of churches in Nigeria as observed by Jemiriye (1998), it can be asserted that it is in the church that "valid and justifiable" explanations are being sought after whenever locally produced forecast goes awry. By contrast, some participants vociferously attributed the inaccurate forecasts they experience occasionally with IKS to the oil exploration activities that have been ongoing in Igbide, Uzere and Olomoro communities for over four decades. They further argued that gas flaring activities that have been taking place in Oleh, a community less than 20 km from the aforementioned communities, have also contributed to the inconsistencies of IKS. A farmer from Olomoro, in her 70's, commented:

> *Due to gas flaring in Oleh, thick dark fumes are constantly emitted into the atmosphere. Thus, when attempt to observe the cloud to determine how soon it will rain, I am not always 100% certain with my verdict because my vision becomes*

> *impaired by the thick fumes. I need the cloud in its natural state to predict the weather accurately. Also, we depend on the flowering of specific trees to anticipate the weather (see Table 10). Gas flaring, however, has impacted negatively on the trees we rely upon to predict the weather, as, occasionally, the trees do not flower at the time they are naturally supposed to. When this happens, the tendency for our predictions to be inaccurate becomes relatively high* (*Pers. Comm*, 2016c).

Some of the farmer's assertion that oil exploration activities have compromised the accuracy of IKS reinforces the notion of Wisner et al. (1977); Wongbusarakum (2005) and Crawhall (2005). These scholars posit that the exploitation of natural resources within specific communities have contributed to the loss of IKS. Further, the perception that gas flaring is contributing to the inconsistencies of IKS is not mind-boggling. This is because of the long-standing tensions that have existed in past decades between members of ISLGA and the defunct Shell oil company, before Shell sold all its oil wells to the Integrated Data Services Limited (IDSL), a subsidiary of the Nigerian National Petroleum Corporation (NNPC) in 2014 (Ebhuoma and Simatele, 2017a). Environmental degradation in ISLGA, which has severely compromised the quality of food produced by the farmers, has been mainly attributed to oil exploration and exploitation activities (Elum et al., 2016; Ite et al., 2013).

In fact, approximately 89% of the farmers underlined oil exploitation activities as the primary factor responsible for compromising the nutritional value of the *garri* (processed cassava) they currently produce. In spite of these negative impacts brought about by oil exploration and exploitation activities on food production, the farmers echoed that they have not been beneficiaries of any form of compensation whatsoever. Unfortunately, these grievances are not peculiar to the farmers in the study areas alone, but to virtually all indigenes of the Niger Delta (Ikelegbe, 2005; Paki and Ebienfa, 2011). These grievances, as argued by Ikelegbe (2005) and Adusei (2015), have led some youths in the Niger Delta to engage in militancy

activities such as illegal oil bunkering and kidnapping of those working for multinational oil companies in order for ransom to be paid for their release.

It is, however, noteworthy to mention that in spite of their IKS are not being as accurate as it has been in past decades, most of the farmers are not keen on utilising SCF, which contradicts the findings of Roncoli et al. (2002). They echoed vehemently that in circumstances when IKS are at odds with SCF, IKS must be adhered to. The reasons for these assertions are highlighted in the next section.

5.5.2. Why farmers in Igbide, Olomoro and Uzere continue to rely on IKS

5.5.2.1. Calamitous forecast

Between August and October 2012, Nigeria was affected by a flood disaster described as the most fatal in its entire history since gaining independence in 1960. Some communities in ISLGA were devastatingly affected to the point where anyone without prior knowledge of the region will hastily conclude that the region has always been an ocean (Omohode, 2012). Most houses in the affected communities in ISLGA were either partially or totally submerged by floodwater. The study participants argued that most residents of Uzere, Igbide, and Olomoro had to flee their homes to reside with relatives and friends in unaffected neighbouring communities. Others had to seek shelter in Internally Displaced Person's (IDP) camp provided by the Delta State government. Barely five months after the flood, in March precisely, when members of the affected communities were still struggling to rebuild their partially destroyed houses and get on with their lives, the NIMET predicted that another flood disaster expected to be of the same wavelength or worse than what was experienced in 2012, was imminent in 2013. According to Floodlist (2013), the Delta State was listed as one of the hotspots where the worst scenarios of the anticipated flood disaster were expected to occur.

In the aftermath of the scientific flood forecast for 2013 and with the impacts of the 2012 flood disaster still very visible in the study areas, the farmer's explained that they had no other alternative but to disregard their local forecast, which suggested that there will be adequate rainfall in the 2013 farming season. Arguably, the farmer's verdict seemed justified because their IKS failed to predict the 2012 flood disaster and because it was relatively easy for them to re-imagine the reoccurrence of another flood disaster immediately after the 2013 forecast was disseminated (see also Fischhoff, Bostrom, & Quadrel, 1993; Richard Eiser et al., 2012). Consequently, approximately 83% of the farmers vehemently echoed that they had to embark on an inconvenient but inevitable task of not planting cassava and other staples on the low-lying farmlands. This observation is consistent with the findings of Jackson (1981), which stated that vulnerable people only adopted precautionary measures after they were casualties of an extreme weather condition.

A noteworthy feature, however, is that despite the level of trust that have deteriorated significantly between residents of the Delta State and government (local and federal) within the last decade (Diamond, 2007; Iroghama, 2012), they still adopted pro-active measures upon receiving the 2013 forecast. This clearly demonstrates that trust in the communicator of a forecast or risk message is not the ultimate factor that hinders the utilisation of SCF. Rather, it was fear or what Slovic et al. (2004) referred to as *affect*, hinged on previous flood experience that propelled them to desert their low-lying farmlands. Nonetheless, 11% of the farmers admitted that they planted crops like corn, groundnuts and other staples that mature within four months on the low-lying farmlands, albeit in negligible quantities. This was due to the difficulties of hiring and securing high-lying farm plots in neighbouring communities that were unaffected by the 2012 flood disaster.

Sadly, after undertaking various precautionary measures, the anticipated flood never occurred. The farmers were disgruntled by the fact that they were disenfranchised by the misleading forecast. A farmer residing in Igbide community, in her 50's, lamented:

> *This community has always supplied garri (processed cassava) to most of the States in the Niger Delta region of Nigeria. Due to the 2013 forecast, we were afraid to plant cassava. The only alternative we had was to buy garri from some of the States we usually supply in the past and had to pay almost twice the amount that we normally sell to them* (*Pers. Comm,* 2015p).

Consequently, 79% of the farmers stated that in the event of a predicted flood forecast in the future, which contradicts the forecast generated using IKS, they will disregard the scientific forecast and rely on IKS. The calamitous forecast has, unfortunately, succeeded in concretising the standpoint of some participants who believe that scientists cannot predict future weather conditions with surgeon's precision. This perception is further compounded by the fact that the closest weather station to the study areas is situated in Warri, a city approximately 80 km away. Nevertheless, a possible explanation that might have contributed strongly to the farmer's unwavering assertion in not willing to heed future SCF was not to provide them with any form of incentives for relying on the forecast.

5.5.2.2. Disillusioned about the science of climate change

It defies logic for 87% of the participants particularly the elderly that anthropogenic activities are, in part, responsible for climate variability. Similar observations have been made by Mertz et al. (2009) and Simatele & Simatele (2014) in Senegal and Zambia respectively. The participants argued that the erratic rainfall pattern and rising temperatures, which has become the norm in their respective communities including the 2012 flood disaster, is an "act of God". The perception of climate extremes as an "act of God" is not uncommon. Studies from

Nigeria, Zambia and Bangladesh have, for instance, highlighted people's perception of climate extremes as God's retaliation for human's sinful habits (Bankoff, 2004; Byg & Salick, 2009; Simatele & Simatele, 2014). For example, a female participant in her 30's from Olomoro remarked:

> *Our pastor said that the change in weather conditions we have been experiencing in this community, including the poor harvest we occasionally get, is due to what our ancestors buried in the ground* (*Pers. Comm,* 2015d).

These are the sort of explanations, I argue, that the majority of people in the southern part of Nigeria are exposed to, due to the overwhelming proliferation of churches in virtually every available space in the Delta State (Jemiriye, 1998). While Gandure et al. (2013) have overtly emphasised the need for climate science education for poor rural households in developing countries, this has been at a snail's pace in the Delta State. Thus, when the rural poor consume such clerical views that attribute climate change to God's own making, it is likely going to create a tunnel vision that will make them dismiss future SCF since they cannot comprehend how scientists can predict future weather events to a satisfactory degree of accuracy.

It can also be asserted that the advice of scholars like Chambers and Ghildyal (1985) was deemed irrelevant by the producers of SCF in the Delta State context. Chambers and Ghildyal (1985) aptly pointed out that technologies that can improve the farming practices and welfare of the rural poor would be readily utilised only when they are consulted before production with the aim of meeting their needs and addressing their physical, social and economic conditions. If this statement is anything to go by, which I strongly believe it is, it is recommended that a top-down approach of generating SCF for rural poor households should be abolished.

Another factor that may be contributing to the elderly people not believing in anthropogenic related weather changes is because climate change discourse only started anchoring global policy debates and discussions from the late 20th century. Thus, there is a high tendency for even the educated ones to disregard the rhetoric that climate variability and change are, in part, human induced. An 81-year-old farmer residing in Uzere, for example, who attained tertiary education posited:

> *There has definitely been a change in the weather conditions. This year (2015), for example, the early rain did not come in February, but in March…the change in weather patterns we are experiencing is not human influenced. It is natural. I studied geography in high school so I am well informed* (*Pers. Comm,* 2015i).

As the earth's landscape continues to evolve, science will probably continue to undergo metamorphosis. Therefore, educating individuals whose livelihoods are intertwined to the natural environment on the science of climate change is paramount to facilitate behavioural change.

5.5.2.3. Trust issues

A key issue brought to the fore during the FGDs was the overwhelming distrust farmer's in Igbide, Uzere and Olomoro have for both arms of government in Nigeria. This can, arguably, result to participants interpreting SCF heuristically, which can have huge implications for their assets and livelihoods. When messages are interpreted heuristically, Tversky and Kahneman (1974) argue that enormous emphasis is placed on the messenger's identity and the frequency at which such events can be easily remembered, without adequately factoring the evidence on the ground. For farmers in Igbide, Uzere and Olomoro, however, heuristic interpretation will probably stem from two factors; first, despite the enormous contribution that crude oil, which has, and is still being obtained in substantial quantities in the

aforementioned communities (they have 62 oil wells collectively), have made to the nation's foreign revenue for over four decades, their communities have remained inconceivably underdeveloped. The lack of infrastructures (e.g. good roads and constant power supply), for example, have over the years insidiously eroded the meagre financial capital of the farmers.

The farmer's also pointed out that is extremely difficult and expensive for them to transport their farm produce to nearby communities to sell due to the deplorable conditions of their main roads, which can best be described as death traps particularly during the rainy seasons due to the numerous pot holes that are engulfed by floodwater. Also, while subsistence farming has remained the primary driver of their economy, the government, from the farmers lens, has rarely ever made provision for the farmers to have easy access to resources such as land and finances that can play pivotal roles in their fight to transcend the global poverty index of living on less than two (2) USD a day (see Livingston et al., 2011).

The aforementioned, *inter alia*, have made it utterly impossible for the farmers to push beyond their cognitive boundaries in concluding that there must be underlying agendas the government is seeking to achieve – perhaps trying to patronise the outside world of their "intensified efforts in attempting to pull its citizenry out of the poverty maze" – in channelling its resources and attention to "inconsequential" issues like forecasting hydro-meteorological hazards. In fact, from the farmer's lenses, the provision of, and seamless accessibility to fundamental assets such as finances and natural, for example, far outweighs the benefit of SCF (Afriyie et al., 2017).

In view of the above, it can be argued that any forecast disseminated by NIMET officials is likely going to hit an emotional brick wall that has been erected by the farmers. As Fischhoff (1995) puts it, "in risk (or other) communication, the damage can be irreversible if relations with one's communicants are poisoned". Thus, if swift and robust measures are not taken by

government officials to re-build trust, this could prove highly detrimental not only for the vulnerable people but also for the government. This is because, according to the Nigerian Emergency Management Agency (NEMA), the 2012 flood disaster cost the Nigerian economy an estimated 7.3 billion USD, excluding the total assets destroyed by the floods (Federal Government of Nigeria, 2013). For a nation that is "relentlessly striving" to transcend the boundaries of a developing economy, such financial losses in the near future can become its Achilles' heel.

5.5.2.4. "It will not happen again" syndrome

When historical matrix exercises were conducted with the farmers in all three communities, they asserted that with the exception of 2012, the seasonal floodwater has never transcended the low-lying farmlands. Consequently, they are optimistic that their communities will not be inundated by flood disasters that can agonisingly impact their assets and livelihoods in a similar magnitude as experienced in 2012. Their unwavering viewpoint, which arguably emanates from heuristic interpretation, is reinforced by the 2013 and 2014 seasonal floods that only inundated the low-lying farmlands. Thus, the "it will not happen again" syndrome hinged on historical narratives might have become ingrained in the minds of the people.

Historical narratives, as argued by Burningham et al., (2008); Fischhoff et al. (1993) and Richard Eiser et al. (2012), play a prominent role in the way climatic risks are construed. In this study, however, the farmer's denial of the likelihood of future floods events could, perhaps, be hinged on the psychological attachment they have with their environment, especially because it enables them to meet their needs and provides the people with a feeling of uniqueness and self-worth (Anton and Lawrence, 2014). But this may not be the entire picture. By accepting the possibility of future flood disasters occurring in their respective communities in the future, this could essentially mean that they need to relocate from an

environment they have become fully accustomed to for decades, a mission seemingly impossible for them to achieve due to their limited financial resources.

5.6. Conclusion

SCF is a tool that can facilitate the adoption of planned adaptation strategies in order to build the resilience of subsistence farmers in the face of climate variability. However, from this study, it is clear that subsistence farmers do not rely on SCF to determine when and the quantity of food to be produced in any particular season. Instead, they rely predominantly on IKS despite acknowledging that some local indicators have not been as effective as it used to be in the past decades. Their reasons for the continued reliance on IKS are because they suffered severely from an imprecise scientific forecast in 2013. Others include lack of trust in governance, the inability to comprehend how anthropogenic activities are contributing to climate change and the fact that a flood disaster, which had devastating consequences for household assets and livelihoods, has only occurred once in their lifetime.

In light of this revelation and with Nigeria identified as a hotspot for extreme weather conditions from as early as 2030 as acknowledged by Shepherd et al. (2013), it is imperative that the relevant stakeholders and policy makers should devote critical attention to these issues that could serve as a stumbling block to SCF in the future. Finally, it is also important to point out that whatever strategies that have to be put in place to rebuild farmer's trust in SCF must avoid a top-down approach, engage with the farmers before the production of SCF to find out their needs and aspirations and integrate their IKS in the forecast generating process**.**

CHAPTER SIX

Conceptualising an operational framework for integrating scientific forecasts with indigenous systems of forecasting in the Delta State of Nigeria[11]

Abstract

In the Delta State of Nigeria where agriculture is predominantly rain-fed and climate variability is occurring at unprecedented levels, rural livelihoods are constantly threatened. Reducing the impacts of climate variability is crucial for subsistence farmers if they are to continue effectively in food production and secure their livelihoods. Information about future weather conditions can help subsistence farmers in developing countries adapt more effectively to the impacts of climate variability. While future weather information is usually available from both Indigenous Knowledge Systems (IKS) and Seasonal Climate Forecast (SCF), subsistence farmers in the Delta State still rely on their IKS. However, the IKS of the farmers have some limitations that prevent them from engaging more effectively in food production. With Nigeria expected to become a hotspot for extreme weather conditions, the need to ensure that farmer's complement their IKS with SCF when making farming decisions is pivotal. To achieve this, we propose a framework that builds on the Multiple Evidence Based (MEB) approach. The MEB approach can be crucial in building farmer's trust in SCF because it does not undermine the value of any knowledge system. Thus, it creates a fertile platform for each knowledge based system to self-validate itself without external interference.

Keywords: *Indigenous knowledge systems, climate variability, seasonal climate forecasts, multiple evidence based approach, Nigeria.*

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6.1. Introduction

Globally, there is substantial evidence to suggest that climate change has occurred at unprecedented levels (IPCC, 2014a; Moser, 2014; Perez et al., 2015). The literature further reveals that the social, economic, environmental and agricultural sectors have been negatively affected by climate change in various parts of the world (Chavas et al., 2009; Perez et al., 2015; Schmidhuber and Tubiello, 2007). However, it has been argued that no sector has been adversely affected like agriculture particularly in sub-Saharan Africa (SSA) where food production remains predominantly rain-fed (Bandara and Cai, 2014; IPCC, 2014b). Furthermore, future climate predictions reveal that increased occurrence of climate variability and change will be the norm for various regions in SSA (Shepherd et al., 2013). Under the current state of affairs, future climate events will likely have severe consequences on many rural communities in SSA where subsistence farming remains the primary economic driver. If individuals and households residing in rural communities in SSA are to continue effectively in food production in the face of a changing climate, minimising and adapting to the impacts of climate variability and change is now crucial than ever before.

Access to information about future climate events, as acknowledged by Klopper et al. (2006), can help farmers adapt more effectively by ensuring they make better decisions regarding their farming practices. Weather information is usually available from both Indigenous Knowledge Systems (IKS) and Seasonal Climate Forecast (SCF) (Ziervogel and Opere, 2010). The literature on climate change adaptation suggests that subsistence farmers in SSA rely heavily on their IKS to anticipate future weather occurrences (Mahoo et al., 2015; Orlove et al., 2010; Ziervogel and Opere, 2010). As argued by Ebhuoma and Simatele (2017b), IKS determines when the farmer's prepare the fields, the types of food to produce as well as the quantity of food to produce in a particular planting season. It has, however, been documented that the IKS of farmer's in SSA is becoming unreliable to predict the weather accurately due

to the unprecedented rate at which climate variability has been occurring (Roncoli et al., 2002). In this regard, advocates of SCF have overtly emphasised the need for subsistence farmers in the context of the developing South to take advantage of this technology because the high-resolution models used to generate SCF can anticipate future weather conditions a few months to a year ahead (Ash et al., 2007; Hansen et al., 2011; Hill et al., 2002; Klopper et al., 2006).

However, farmers in some part of the developing South are sceptical about scientists ability to anticipate future weather events accuracy (Huda et al., 2004; Vincent et al., 2016). In Igbide, Uzere and Olomoro communities in the Delta State of Nigeria, for example, where approximately 90% of the households are directly and indirectly involved in food production, the farmers still rely heavily on their IKS to anticipate future weather conditions. While most of the farmers in the aforementioned communities admitted that their IKS have not been as effective as it used to be in the past, the majority expressed disbelief on scientist's ability to generate accurate SCF with pinpoint accuracy (Ebhuoma and Simatele, 2017a). In fact, the idea that scientists can actually forecast future weather events accurately for some of the farmers was perceived as guesswork. For instance, a participant residing in Igbide community, in his 50's, commented:

> *About 9 o'clock this morning it was threatening to rain. Now it's 4: 40 pm and the sun is shining, how do you predict God?* (*Pers. Comm,* 2015n).

Future climatic projections suggest that Nigeria will become a hotspot for extreme weather conditions by 2030 (Shepherd et al., 2013). If these climatic predictions are anything to go by, then the tendencies that future climate variability will render the IKS of the rural poor in the Delta State more ineffective than what it already is are not unlikely. This will further plough the farmers deeper into the food and nutrition insecurity maze as their ability to

engage effectively in food production will be severely compromised. With the Nigerian Meteorological Agency (NIMET) "relentlessly striving" to ensure they generate SCF that can be relied upon and practically utilised by various end-users including subsistence farmers, the need to build farmer's trust in SCF requires urgent attention.

It is against this background that this paper seeks to construct a framework that integrates SCF with the IKS of subsistence farmers in the Delta State of Nigeria. This paper argues that SCF should aim to compensate for the limitations of the farmer's IKS as a useful starting point to convince the farmers of scientist's ability to generate both weather and climate forecasts to a satisfactory level of accuracy. This, in turn, will likely facilitate the utilisation of SCF when making farming decisions. It is, however, important to emphasise that extreme caution should be applied when interpreting the proposed framework as it might not necessarily be an end in itself. Thus, I suggest that pilot studies should be conducted in the respective communities where this framework is intended to be operationalised in order to identify potential challenges that could arise before vehemently advocating for the use of the unified forecast. Nonetheless, the paper is an attempt to provoke meaningful discussions about the need to re-think the position of Western scientific knowledge when collaborating with IKS especially in projects that can have direct implications for the livelihoods of indigenous people.

6.2. Reconciling the divide between IKS and scientific knowledge: exploring the literature

In the literature, indigenous knowledge has also been referred to as traditional science, folk, local, traditional and farmer's knowledge (Hiwasaki et al., 2014; Orlove et al., 2010; Senanayake, 2006). According to Senanayake (2006), and supported by Orlove et al. (2010), indigenous knowledge refers to place-based knowledge that is peculiar to a specific culture,

which often stems from the close observation of local signs and cumulative experiences that have been tried and tested with real life scenarios. As argued by Agrawal (1995), the concept of IKS began to feature more prominently in the work of various scholars between the 1950's and 60's due to the enormous wealth of knowledge in the portfolio of indigenous people. This view is supported by Senanayake (2006) who pointed out that IKS formed the basis for agricultural production and natural resource management for resource-constrained farmers in various parts of the developing world. Nonetheless, McGloin et al. (2009) acknowledged that power dynamics often advanced Western scientific knowledge as the only credible means of producing knowledge that is both theoretically and practically relevant, to the detriment of the knowledge systems of indigenous people.

As argued by Laws (1994) and Sillitoe (1998a), indigenous people including their knowledge systems were often side-lined in the discourse and process of knowledge production even in issues that was pertinent to their welfare. In the last few decades, however, literatures from scholars like Chambers (1983), Dekens (2007) and Morrison et al. (1994), among others, have adequately illustrated the enormous role that IKS played in enabling local people build their resilience to both external and internal stressors in order to obtain their livelihood, which can hardly be seen through the lenses of Western scientific knowledge as a viable lifesaving strategy. For example, it has been documented that indigenous people in the semi-arid regions of some sub-Saharan African countries such as Niger, Nigeria, Burkina Faso, Mali, Kenya and Ethiopia successfully conserved their soil in order to prevent the soil from losing its nutrients, something that scientists have had a woeful record of achieving in SSA (Critchley et al., 1994).

Thus, proponents of indigenous knowledge began to solicit for indigenous people to be provided with a legitimate platform where their voices and opinions can be explicitly heard within the discourse of development, particularly in issues that can have direct implications

for their welfare (Sillitoe, 1998b). In view of this observation, it can be deduced that this call will be pleasing to indigenous people who have watched helplessly, for decades, how development practitioners have been perpetuating and reinforcing epistemological injustices by alienating their ways of addressing real-life problems from the discourse of development.

In order to successfully engage with indigenous knowledge within the discourse of development, Agrawal (1995) asserts that policy makers and developers should look beyond the power dynamics that have always relegated indigenous knowledge to the background at the expense of Western scientific knowledge. He further emphasised that the overall aim should be to create a bilateral relationship between both arms of knowledge so that each knowledge system will compensate for the limitations of the other (Mahoo et al., 2015). In recognising indigenous people as a vital source of knowledge production, scholarly articles from various fields such as Disaster Risk Reduction (DRR), Climate Change Adaptation (CCA), desertification, soil conservation, forestry, land use/land cover change and marine conservation have started to emphasise the need to merge IKS with Western scientific knowledge (e.g., see Critchley et al., 1994; Hiwasaki et al., 2014; Mackinson, 2001; Mercer et al., 2010; Motsumi et al., 2012; Nyong et al., 2007; Thapa et al., 1995; Udmale et al., 2014). In fact, some studies have successfully integrated IKS and scientific knowledge as a more comprehensive approach to enhance the resilience of vulnerable people that are highly susceptible to myriad environmental issues in some developing countries (Hiwasaki et al., 2014; Mercer et al., 2010, 2009; Walker et al., 1995).

However, it can be argued that the call to integrate indigenous knowledge with Western scientific knowledge when generating weather and climate forecasts has not been audible enough in comparison to other fields. Perhaps, this can be attributed to the fact that Western scientific knowledge "will always produce more accurate forecasts in predicting future weather and climate occurrences in comparison to IKS", and therefore, the need to ignore

IKS seems justified. Nonetheless, scholars like Roncoli et al. (2001) hold contrasting views. They argue that prior to the 1997 food shortages in Burkina Faso, the resource-constrained farmers were already aware of a looming crisis six months before an official forecast was disseminated. It is within this context that there have been a few passionate pleas to integrate IKS with SCF partly because contemporary literature suggests that the majority of subsistence farmers in SSA still rely heavily on IKS (see Mahoo et al., 2015; Ziervogel and Opere, 2010; Ebhuoma and Simatele, 2017b; Kolawole et al., 2016). In addition, it has been argued that farmers who rely extensively on IKS may only require certain information that IKS fails to provide in order to complement what they already have (Mahoo et al., 2015; Ziervogel and Opere, 2010).

To integrate indigenous and Western scientific knowledge in such a way that dismantles the hegemony that has always been attributed to Western scientific knowledge, Tengö et al. (2014) proposed the use of the Multiple Evidence Base (MEB) approach. The MEB approach (see Figure 11) acknowledges that both indigenous and scientific knowledge systems have the potential to generate their own unique forecast that is valid and useful, which in turn can provide key insights relevant for producing a more inclusive and comprehensive forecast. One of the greatest strengths of the MEB approach, as argued by Tengö et al. (2014), is that it promotes self-evaluation within each knowledge system, instead of using Western scientific knowledge as the benchmark to determine the validity and accuracy of different knowledge based systems. In order words, it attributes equal currency to each knowledge systems, which in turn can facilitate trust between meteorological agencies and their predictions as well as resource-constrained farmers in places like Igbide, Uzere and Olomoro communities in the Delta State, for example, that still rely overwhelmingly on IKS.

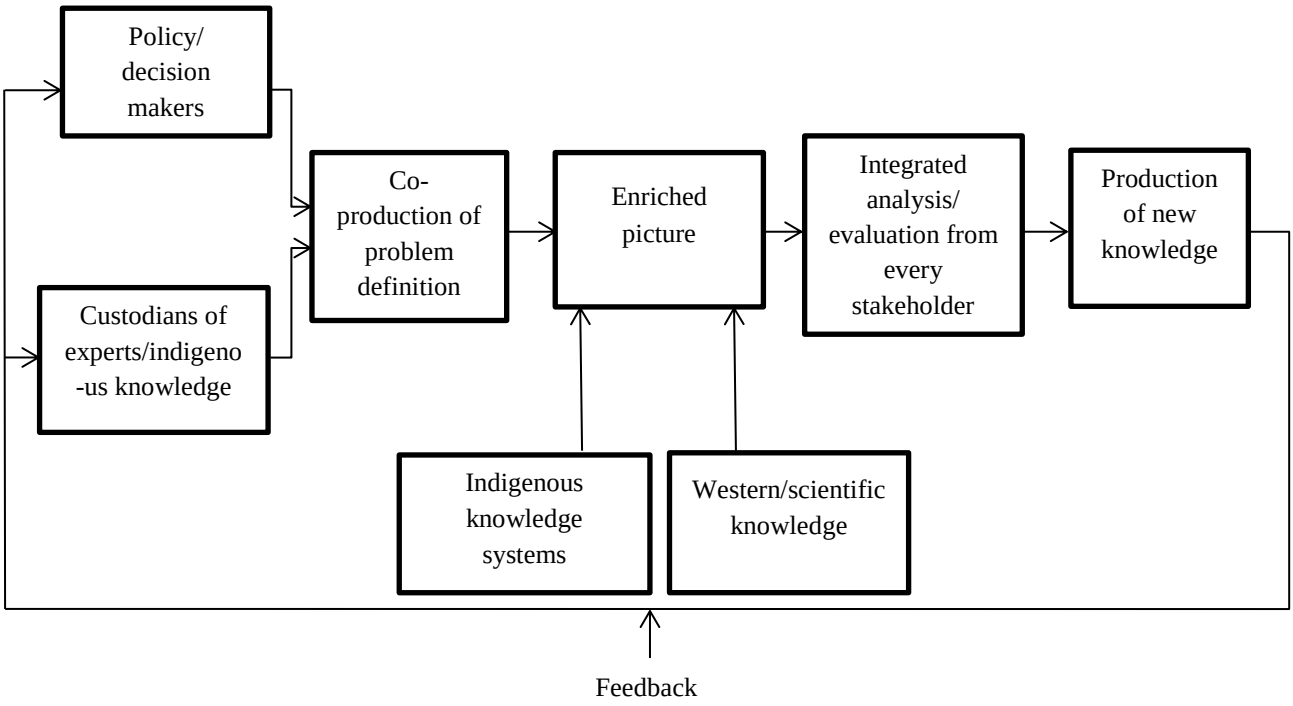

Figure 10: Multiple Evidence Base (MEB) approach. Source: Tengö et al. (2014)

6.3. Why the MEB approach for merging the IKS of farmers in Igbide, Uzere and Olomoro communities with scientific forecast?

The MEB approach, as a viable means to successfully integrate the IKS of farmers in Igbide, Olomoro and Uzere communities with SCF, is proposed on two premises; firstly, the farmers rely heavily on IKS to predict the weather, even though IKS has never been included in the curriculum of both primary pupils and high school students in Nigeria. Secondly, the farmers were victims of an imprecise flood forecast in 2013, which had severe implications for household food security and other social obligations (Floodlist, 2013). Up until 2013, the farmers have never relied on SCF. However, their willingness to rely on scientific forecast in 2013, as argued by Ebhuoma and Simatele (2017b), was because they were victims of the 2012 flood disaster that plagued 30 of Nigeria's 36 States with devastating consequences, an event the farmers IKS failed to predict.

The 2012 inundation forced most of the residents in the aforementioned communities to seek shelter in Internally Displaced Person's (IDP) camps provided by the Delta State government. Others migrated to residents of friends and relatives within and outside their communities that were not affected by the flood. Some houses in the respective communities were destroyed and most household assets were lost to the floods even though attempts were made to protect them, thereby making it extremely difficult for majority to continue in food production in the aftermath of the flood. What was particularly striking about the 2012 flood, according to Agbonkhese et al. (2014), was that while the flood was forecasted by the NIMET, the relevant authorities and stakeholders including those in the Delta State completely ignored the warning.

Barely five months after the flood disaster, in March precisely, when most farmers were still struggling to gather the pieces of their lives together, the NIMET predicted that another flood disaster, anticipated to be of the same magnitude in comparison to what was experienced in 2012, would occur in 2013. As documented by Floodlist (2013), the Delta State was identified as a hotspot where the worst scenarios of the predicted flood disaster were expected to occur. This time around, the forecast spread like wild fire via interpersonal networks and the mass media to virtually every community that was severely affected by the 2012 flood. For the first time in the history of the aforementioned communities, Ebhuoma and Simatele (2017b) argued that the decision regarding where to plant, when to plant and the quantity of food to produce in 2013 was totally hinged on the scientific forecast. Due to the forecast, most of the farmers completely abandoned their low-lying farmlands. This is because the low-lying farmlands always experience seasonal flooding annually partly because of heavy rainfall events (Adejuwon, 2011).

The forecast resulted in a trek to secure high-lying farmlands because they were not affected by the 2012 floods. For those able to secure high-lying plots, they deliberately refused to

plant cassava in large quantities but laid more emphasis on crops like cocoyam, corn and groundnut, for example, which mature within a short timeframe. The few that were unable to secure high-lying farm plots also cultivated corn and other staples that mature within four months on their low-lying farmlands, albeit in negligible quantities. Unfortunately, after embarking on a series of proactive measures, the anticipated flood disaster never occurred, at least in the Delta State. The erroneous forecast further exacerbated the ongoing food shortages brought about by the 2012 floods. Aggrieved that they were led astray by the erroneous forecast and with no form of compensation given to them for heeding the warning, 79% of the study participants echoed vociferously that, henceforth, whenever IKS contradicts scientific forecast, scientific forecast will be annulled.

It can be argued that the farmer's willingness to cling to IKS, irrespective of its inability to forecast the 2012 flood disaster, is because it is deeply rooted in tradition. As a result, tradition must be respected. In this regard, a farmer from Olomoro, in his late 60's, stated:

> *While our local ways of predicting the weather have not always been 100% accurate, it has, over the years, proved extremely useful to those who respect and obey tradition. When the people follow instructions from nature, they get a bountiful harvest.*

With Nigeria identified as a hotspot where extreme weathers will become the usual as from 2030 (Shepherd et al., 2013), the majority's perception regarding the reliability of scientific forecasts cannot be taken for granted. If a core mandate of the NIMET (2016) is to facilitate effective livelihood practices, the protection of lives and assets in the face of a rapidly changing climate, then concerted effort must be made to restore the credibility of its forecast among end-users.

In addition to incentives been provided to resource-constrained farmers for heeding scientific warnings, we argue that a crucial step likely to persuade the farmer's to rethink their current

standpoint regarding the use of SCF is when it compensates for the limitations of the their IKS. It can be asserted that the MEB approach will be the most viable tool as it ensures that each knowledge system remains within the confines of its boundaries during the course of forecast production and not meddle in the affairs of other systems of knowledge (Tengö et al., 2014). Fieldwork conducted in the aforementioned communities revealed that the major drawbacks of the farmers IKS is that it does not provide a precise indication of the early Rainfall Onset Date (ROD), the total amount of early rainfall and the Rainfall Cessation Date (RCD) in any particular farming season.

It is important for these groups of farmers to know precisely when the early rains will commence and the total amount of early rainfall. This is because groundnut, which is a staple every farmer cultivates annually, relies predominantly on the early rains (Ebhuoma and Simatele, 2017a). Thus, cultivating groundnut in contrast to precise early ROD and anticipated total early rainfall can hamper optimal yield and productivity as the staple is highly sensitive to the slightest variation in total amount of the early rainfall. Knowing the precise RCD, on the other hand, is equally important for some farmers that migrate out of their respective communities at the heart of the rainy season as part of a livelihood strategy. If these groups of farmers who are actively involved in migration get the forecasted RCD for the year, they will able to predict, by virtue of historical matrix, when the floodwater will recede the low-lying farmlands. This will enable them to determine the most appropriate time to relocate back to their respective communities in order to commence the cultivation of cassava, which is also a major staple produced annually, by relying on the moisture left in the soil as the floodwater recedes the low-lying farmland (Ebhuoma and Simatele, 2017a).

6.4. The framework for integrating scientific forecast into the IKS of farmers in Igbide, Uzere and Olomoro communities

The proposed framework (see Figure 12) is specifically tailored to farmers in Igbide, Olomoro and Uzere communities in the Delta State of Nigeria. The framework is not an attempt to identify new knowledge systems for predicting the weather. Rather, it is to provide a stepwise guide regarding the ways in which both IKS and SCF can complement each other in order to enhance the adaptive capacity and resilience of the farmers to climate variability (Mercer et al., 2010). Of course, societal and cultural protocols must be respected in projects such as this as it can either facilitate or dampen the level of trust between project developers and community members (Gero et al., 2011). The rest of the paper will shed more light on the framework.

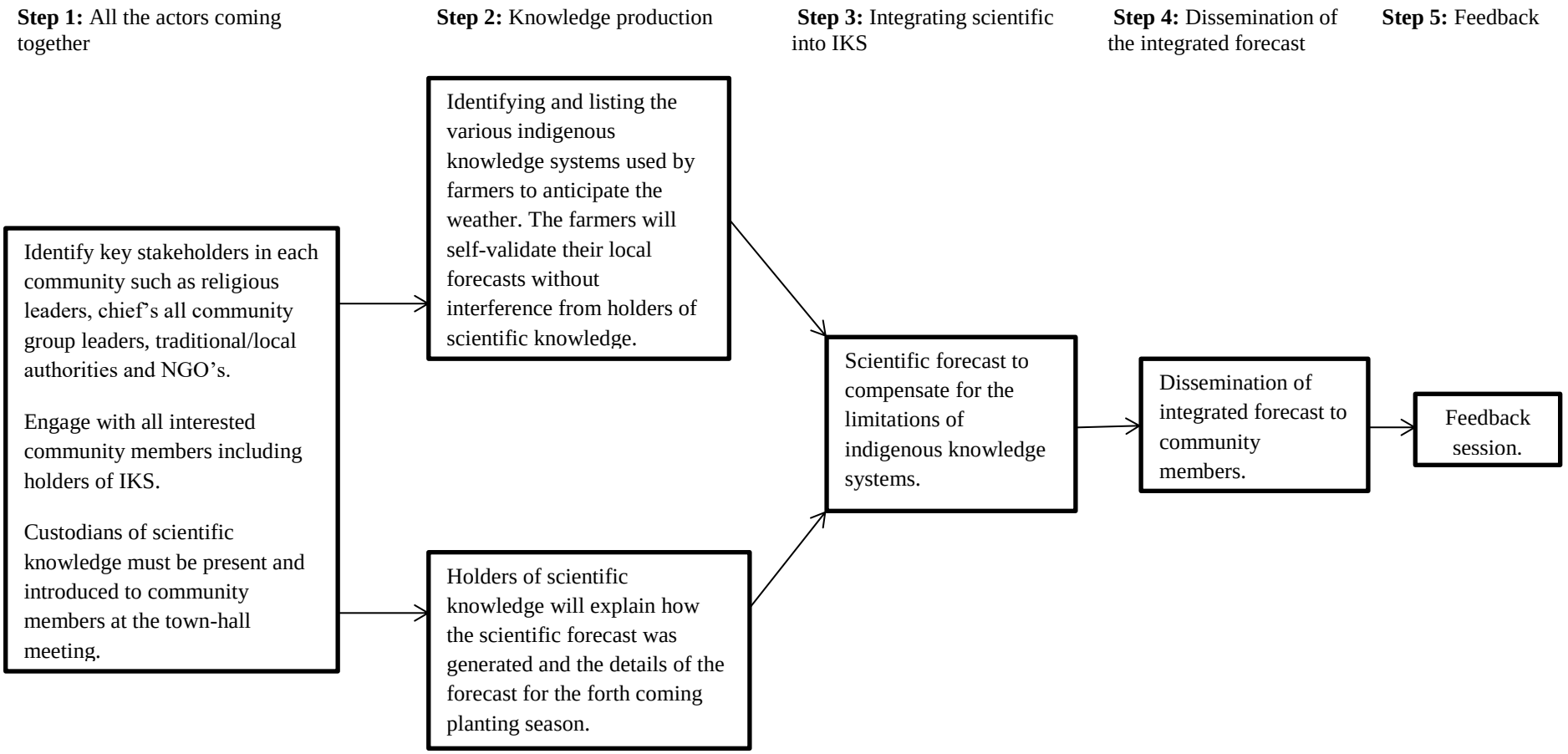

Figure 11: The proposed framework for integrating Seasonal Climate Forecast into Indigenous Knowledge Systems. *Source*: modified after (Mercer et al., 2010).

6.5. Unpacking the proposed framework for knowledge systems integration

6.5.1. Bringing all the actors together

It can be argued that the first step will be to seek the approval and participation of relevant stakeholders such as community leaders, chiefs, religious leaders and members of each community. In projects like these where community members are meant to participate voluntarily, the role of community leaders, chiefs, religious leaders and other relevant stakeholders are pivotal in determining the success or failure of such rural based community projects. This is primarily due to their overwhelming ability to influence the people within their jurisdiction as they are usually the ones the people look up to in their community (Gero et al., 2011; Mercer et al., 2008). In Baliau, a coastal community in Papua New-Guinea governed through a chieftaincy system, for example, the chief's approval of a project aimed at merging indigenous and scientific knowledge systems with the aim of generating effective DRR strategies was instrumental in facilitating participation among members of the community (Mercer et al., 2008). While soliciting for the approval of influential people within each community is crucial to fostering participation, facilitators must avoid the misconception that it is going to be the only fundamental factor necessary to foster participation.

Getting community members to trust project facilitators, as pointed out by Botes and Van Rensburg (2000), is also crucial in ensuring the participation of community members because it prevent project facilitators from being tagged as outsiders. In a project in Navua, Fiji, that sort to build the resilience of the locals to climate related weather events, for example, the facilitators had to reside in the community in order to get a comprehensive and detailed understanding of the people's culture. In so doing, it enhanced the co-operation of community members with the facilitators since they were not perceived as intruders (Gero et al., 2011). Furthermore, by using indigenes employed by the NIMET, agricultural extension

workers and Non-Governmental Organisations (NGO's) that are well known in the respective communities who possess a vast wealth of experience in community engagement and can interact with the locals in their native dialect, where possible, will contribute significantly to the overall success of the project (Gero et al., 2011). This is, in part, because local communities usually have their unique terminologies for describing certain items and creatures that are pivotal to their indigenous ways of predicting the weather (Mercer et al., 2008). Thus, if facilitators external to these communities are used, the tendency that they might misinterpret some vital pieces of information, which can jeopardise the overall success of the proposed project, is extremely high.

Possible limitations

A key limitation that will likely prevent subsistence farmers from participating in the project is due to the fact that most of them live in abject poverty. This is in spite of the abundant wealth of crude oil, which forms the mainstay of Nigeria's foreign revenue that has been explored by multinational companies from their respective communities. The three communities, en masse, continue to play host to 62 oil wells where oil exploration activities have been ongoing for over four decades (allAfrica, 2014). In spite of the enormous wealth of natural resources they possess, these communities have remained inconceivably underdeveloped. For instance, they cannot boast of basic social amenities such as portable water supply, constant power and good roads. Some of the farmers argue that the lack of basic social amenities have exacerbated their inability to transcend the global poverty index of living on less than $1.90 a day (World Bank, 2017). To illustrate, after contesting fiercely with climate variability and change in order to produce food, transporting some of their produce to nearby markets to sell is usually an expensive and mammoth venture. This is due to the deplorable conditions of the roads, which can best be described as death traps

particularly during the rainy seasons as the numerous potholes are usually engulfed by rainwater resulting from heavy downpour events.

Also, the lack of constant power supply is a stumbling block that prevents some farmers from cultivating perishable crops like okra and pepper in large quantities. This is because of their inability to preserve the perishables in a refrigerator for a lengthy spell of time. Consequently, they are forced to sell these produce at significantly low prices in order to prevent the crops from rotting away. All these *inter alia* have eroded the people's trust in most government initiatives and schemes. It can, therefore, be argued that a vital ingredient that can propel the people to participate in the project will be to provide some form of incentives, economic or otherwise for the participants. Under the Communal Areas Management Program for Indigenous Resources (CAMPFIRE) in Chapoto district, Zimbabwe, for example, the shift from fortress conservation (one that alienates local people from land they once had access to) of wildlife to community based conservation succeeded partly because incentives were provided for the locals (Murphree, 1997). Incentives should be tailored to address the pressing needs of the farmers such as easy accessibility to more arable farmlands and adequate access to financial resources that are necessary to ensure they engage more effectively in food production throughout the year.

6.5.2. Knowledge production

This stage entails that the farmer's brainstorm amongst themselves in order to produce their forecasts using their local indicators without interference from facilitators of the project and representatives of the NIMET. The MEB strategy will help to counter the theoretical and practical standpoints that have often been accorded to Western scientific knowledge as the only credible and reliable means of validating all knowledge based systems irrespective of their epistemological underpinning. Furthermore, it will instil in the minds of indigenous

people a feeling of satisfaction because they can now be identified as producers or custodians of knowledge that is both valuable and useful. Also, since they have been victims of an erroneous scientific forecast in the past, any attempt to validate IKS based on Western epistemologies will likely be interpreted as disrespectful to their indigenous ways of producing forecasts (see Janke, 2005).

Table 10 shows the various IKS used by the farmers in all three communities to predict the weather. We recommend that this exercise should be carried out in the third week of February as this is when the indicators of IKS are mostly observed. It is also recommended that the exercise should be conducted either on a Sunday or on a market day, which occurs every four days. This is because those are the days that the women, who are primary drivers of food production in each of the communities, will have ample time to participate. This will help to avoid or significantly reduce patriarchal tendencies during the process of indigenous forecast production.

It is imperative at this junction for officials and representatives of the NIMET to explain to every stakeholder present at the forum the reason(s) for the incorrect forecast in 2013. More importantly, they must highlight the measures that have been taken to ensure that such event does not re-occur in the future. This action might play a pivotal role in convincing both the farmers and the various institutions mandated with the task of mitigating the impacts of disasters on people's lives and assets in the Delta State of the concerted efforts made by the NIMET to ensure the forecast they disseminate can be confidently relied upon. In the aftermath of a wrong 1997/98 El Nino based forecast of drought in Mozambique, for example, the country's meteorology department organised an international conference and invited renowned meteorologists to ascertain the reason(s) why the forecast went awry especially since the department did not act in isolation when producing the forecast (Hellmuth et al., 2007). By virtue of the conference, they were able to identify lapses in the

forecast generating process and made necessary adjustments. It appears this measure proved fruitful in re-building trust in the nation's meteorological institute. This is because when another flood forecast was disseminated by the Mozambican meteorological institute in 2000, the relevant agencies mandated to manage flood in Mozambique acted proactively by carrying out various preparatory exercises (Hellmuth et al., 2007). However, a breakdown in communication resulted in a significant number of casualties being recorded (Hellmuth et al., 2007).

It is equally important for the NIMET representatives to explain to the farmers the reason(s) for relying on the weather outlook produced for Nigeria by the International Research Institute for Climate and Society (IRI), in partnership with the National Oceanic and Atmospheric Administration (NOAA)/Climate Prediction Centre (CPC) model in *isoko*, which is the local dialect. NIMET officials must avoid going into details regarding the technical jargons enshrined in SCF, as this have been observed to impede understanding (see Hansen et al., 2011). Further, it is crucial to emphasise to the various stakeholders that the weather outlook generated by the IRI/CPC model is from scientists based in the Netherlands (Pers. Comm, 2017a). This might help to allay the fears of the farmers when contemplating whether to utilise the forecasts or not. This is because the majority of Nigerians tend to tag products and services coming from the developed North as genuine or authentic, and therefore, more reliable in comparison to local products and services (e.g., see Ogenyi, 2004).

In addition, the NIMET officials should not fail to communicate the limitations of their forecast. Failure to do so might compromise future participation of the farmers in this project particularly in circumstances where something goes wrong after the farmers' plant according to the forecast. As experienced by farmers in Igbide, Uzere and Olomoro communities in 2013, the consequences of an inaccurate forecast for poor rural households can be catastrophic. In this regard, it is absolutely essential for facilitators to state the sort of

compensations that the farmers will be entitled to if they are misled by the scientific aspect of the forecast.

Possible limitations

Participatory approach, as Mercer et al. (2008) argue, will likely undermine the paternalistic tendencies that often relegate the voices of those with low societal status to the periphery. It is, however, not implausible for those with low societal status to find it almost impossible to challenge the viewpoint of those with higher societal powers during the course of generating their forecast. This perspective is supported by Botes and Van Rensburg (2000) who pointed out that initiatives in any participatory forum will usually come from those with higher societal status. This can be primarily attributed to the fact that politics is everywhere (Siebers, 2006). If this is the case, which we insist it is, then the production of the farmer's forecast using their IKS will also not be exempted from politics (see Agrawal, 2005). This can be a very complex issue which facilitators must pay delicate attention to during the course of indigenous forecast production.

It is also important to note that while participatory approach proposed here could ensure that the indigenous people become full custodians of the project, the reality is that external facilitators will often have an underlying agenda (Mercer et al., 2008). Mercer et al. (2008) further argued that facilitators will often exercise some form of control in the way the project will be conducted, which can have severe implications for the final outcome. This was vividly captured by Gegeo and Watson-Gegeo (2001) in a project that aimed to illustrate how villagers in West Kwara'ae, Malaita, Solomon Island created their indigenous epistemologies and theorise knowledge solely from their personal experiences and beliefs. The villagers were infuriated by the manner in which the facilitators, who were outsiders, carried out their work, stating that it was nowhere near the Kwara'ae way of doing things. This was largely

attributed to the fact that the facilitators already had pre-conceived methodological approaches embedded in Western knowledge that had to be strictly adhered to throughout the course of the project (Gegeo and Watson-Gegeo, 2001). To avert such occurrences, it will be ideal to incorporate representatives from NGO's and extension workers, for example, which have long standing relationships with the farmers in each community. This will enable the farmers to come out of their shells and freely express their concerns in situations where they not pleased with the way the facilitators are carrying out the process.

6.5.3. Integrating scientific forecasts into the IKS of the farmers

This step entails that scientific forecast compensates for the frailties of IKS in order to produce a "unified" forecast. As earlier highlighted, the scientific forecast will provide farmers with the precise ROD, the total amount of early rainfall and the anticipated RCD for the rainy season in a particular year. Extreme caution is required on the part of the facilitators when carrying out this action in order not to mistakenly impute ROD data as RCD, for example. If this occurs, it will not only reinforce the perception of most of the farmer's that "scientists cannot predict future weather occurrences accurately", but will jeopardise the willingness of the farmer's to participate in the process in the future as the entire process will likely be classified as "a complete waste of time".

Possible limitations

A major challenge is the fact that the farmers do not have any iota of trust in any government parastatals. In this light, the tendency that the farmers might be sceptical on utilising the scientific aspect of the forecast is not unlikely. Even when the incentives for any potential wrong scientific forecast has clearly been stated to the farmers, the moment the farmer's call to mind the ordeal they had to go through due to the inaccurate forecast in 2013, otherwise referred to as availability heuristic by Tversky and Kahneman (1973), it might prevent some

from heeding to the scientific aspect of the forecast. Nonetheless, if socioeconomic development is clearly visible in their respective communities, this might help to persuade the farmers of its government good intentions towards members of the aforementioned communities.

6.5.4. Dissemination of "unified" forecasts to community members

Producing accurate forecasts are essential because of the unprecedented rate at which climate variability is occurring on a global scale. Nonetheless, it has been argued that the most precise forecast will be of little or no value if it is not communicated on time and in a manner that the associated risks can be easily understood by those expected to be susceptible to the anticipated extreme weather condition (Barrett 1998; Demeritt et al., 2010; Hammer et al., 2001). The literature suggests that the mass media is one of the most widely used mediums for conveying forecast to end-users (Löfstedt, 2003; Moser, 2010; Pelletier and Sharp, 2008).

The use of radio and TV have been observed to be effective in communicating vital messages to rural dwellers in the developing world (see Mubaya et al., 2012). A major drawback, however, is that the use of both the radio and TV can be ineffective in circumstances where the communicator disseminates the message in a language that its listeners are not fluent in (Uzuegbu, 2016). Further, these mediums cannot guarantee uniformity of information as people are free to tune the radio to whatever frequency they like or watch whatever TV program that appeals to them (Uzuegbu, 2016). As vividly illustrated by the participants in Igbide, Uzere and Olomoro communities, radio and TV are not the most effective channels of disseminating important messages across to households. This is because they are deeply entangled in a complex web of activities almost on a daily basis just to obtain and secure their livelihoods. The farmers explained that under normal circumstances, they leave their homes first thing in the morning and come back late in the evenings totally exhausted. Thus, they

usually do not have any “iota of strength” left in them to listen to the radio or watch TV for those privileged to have these gadgets. Furthermore, the lack of constant power supply does not permit the effective use of these gadgets.

In light of these observations, it is imperative for risk communicators to neglect the ways in which indigenous people disseminate vital pieces of information within their community, which have been tried, tested and have been endorsed as extremely effective for the rural households in the aforementioned communities. This will ensure they avoid a misalignment of valuable information that has the potential to protect valuable assets and human lives. In fact, several African scholars have argued that our ways of doing things should, at all times, be prioritised over Euro-American theories and epistemologies. However, it appears that most risk communicators in Africa are still suffering from what Danchin and Wagner (1997) referred to as coloniality because their ways of conveying risk messages to rural dwellers, for example, continues to prioritise Western over indigenous means of communication. In so doing, they undermine the identity and the intellectual capabilities in the portfolio of indigenous people.

During the Focus Group Discussion (FGD) sessions, the farmer’s echoed that the most efficient ways of disseminating information within their respective communities are through town-hall meetings and the use of town-criers. The use of town-criers entail that an individual walks round the community with a gong and an iron rod that produces a resonant, vibrating sound when struck to get the attention of community members after which the necessary information is being passed across. It, therefore, becomes imperative for risk communicator to explore and utilise these avenues to convey the unified forecast to the various communities. This does not mean that the use of TV and radio, as means of communication, should be neglected. When utilising these mediums, however, it is important for the message

to be conveyed in the local dialect because the majority of the farmers find it extremely difficult to understand what is being said in English language (see Omogor, 2013).

Possible limitations

Eradicating "technical" jargons associated with SCF in order to make it easily understandable to farmers with no formal education can be a difficult task (Barrett, 1998). The literature on SCF has revealed that the inability for subsistence farmers to adequately grasp and interpret scientific forecasts have been one of the factors impeding its utilisation of among subsistence farmers in developing countries (Hansen et al., 2011; Klopper et al., 2006; Ziervogel and Calder, 2003). In spite of the accurate flood forecast generated by the Mozambican meteorological department in 2000, for example, communicating the flood warning in a manner that could have been easily understood by those vulnerable to the anticipated flood proved to be an uphill task. Consequently, most of the vulnerable people did not evacuate their homes and thus found themselves in a precarious situation when the flood occurred (Hellmuth et al., 2007).

6.5.5. Feedback

The importance of receiving feedbacks have long been recognised for its ability to stimulate corrective behaviours, measures and improve overall performance in many development projects (Broadbent, 1990). Feedback sessions in a project such as this will create a platform for local people to air their voices regarding how beneficial the unified forecast have been to them in terms of improving food yield and productivity. It will also create an avenue for the farmers to suggest ways that the exercise can be improved in the future (Broadbent, 1990). This will enable facilitators easily identify shortcomings that they would normally not be able to identify easily. This, in turn, would ensure that they incorporate timely adjustments to improve the project in the future (O'reilly and Anderson, 1980). In addition, this will foster

co-operation from local people in the future once they perceive that their concerns are being given due attention. In reality, however, it will be almost impossible to integrate every suggestion into the proposed project. In such a situation, facilitators must provide valuable and justifiable reasons to the farmers why they think it might not be necessary to integrate such suggestions into the unified forecast generating process.

6.6. Concluding remarks

Due to increasing climate variability, the IKS of subsistence farmers in developing countries are becoming less reliable to predict the weather. Within this context, SCF is perceived as a technology that can ensure farmers continue to grow their food more effectively. For farmers in Igbide, Uzere and Olomoro communities in the Delta State, however, their unwavering standpoint to continue relying on IKS is due to the fact that they were victims of an imperfect forecast in 2013 with devastating consequences. With Nigeria identified as a hotspot where climate variability will become the usual from as early as 2030, as acknowledged by Shepherd et al. (2013), the tendencies for future climate variability to overwhelm the ability for IKS to predict future weather events accurately for farmers in the aforementioned communities is not unlikely. As a matter of urgency, it is crucial to build the farmers faith in SCF. A useful starting point that can help to boost the farmer's confidence in scientific forecast, I argue, is if SCF compensates for the limitations of the farmer's IKS. Thus, I propose the use of the MEB approach as a method for merging SCF and IKS in order to produce a unified forecast primarily because a few of the farmers affected by the wrong forecast stated that there might be some element of truth in scientific forecasts.

But for farmers to actively participate in the proposed project and utilise the unified forecast when making farming decisions could potentially be a daunting task. This is, in part, because they do not have any iota of trust in most government agencies and associated parastatals.

This can be attributed to the fact that despite their respective communities being nestled in one of the most affluent regions in the country (the Niger Delta) where crude oil has been explored and contributed substantially to the nation's foreign revenue for over four decades, their communities have absolutely nothing to show for it. Thus a pivotal element that can persuade the farmers to incorporate the unified forecast into their farming decision making process is if socioeconomic development are clearly visible in their respective communities. This might convince the farmers of the government good intentions to improve their welfare. Further, incentives, economic or otherwise, must be provided for the farmers in a bid to lure them to participate as it will likely be an uphill task to get rural dwellers to participate in the project and utilise the generated forecast without any form of incentives (see Roncoli et al., 2001).

Finally, facilitators must not be oblivious to the fact that while it is always easy to start a project, sustaining it is even the bigger challenge. This can be made worse if the farmers perceive that the benefits of utilising the generated unified forecast in determining how they produce their food are insignificant in comparison to a farmer that relies solely on IKS. It is, therefore, important for facilitators to conduct pilot studies with some groups of farmers that are willing to utilise the unified forecast against those that rely only on IKS. This will help development actors to effectively ascertain the benefits of utilising the unified forecast as against those that are not willing to compromise on their IKS.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.1. Introduction

This study examined the extent to which Climate Change Risk Communication (CCRC) facilitated effective food production practices, asset protection and adaptation of subsistence farmers in the rural Delta State of Nigeria. It has been acknowledged that subsistence farmers in developing countries rely on Indigenous Knowledge Systems (IKS) in order to determine when they prepare the fields, the types and quantity of food to produce in a planting season (Al Mamun et al., 2014; Eakin, 1999; Kolawole, 2012; Nyong et al., 2007). However, it is asserted that the IKS of subsistence farmers in developing countries have become increasingly unreliable to predict future weather conditions accurately as it have always done in the past (Orlove et al., 2010; Roncoli et al., 2002). Wisner et al. (1977), for example, attributed the loss and increased unreliability of IKS to the capitalist mode of production. The capitalist mode of production, as buttressed by Ding (2003), has facilitated the loss of key indicators in specific locations in countries where environmental legislations are either weak or absent. This has culminated into a situation whereby rural households depend on scanty pieces of information to make informed decisions regarding the livelihood they aggressively pursue (Wisner et al., 1977). The increasing unreliability of IKS have been further amplified by the increased occurrence of climate variability and change (Roncoli et al., 2002).

With frequent episodes of extreme weather conditions now becoming increasingly rampant in sub-Saharan Africa (SSA), and coupled with the fact that the region has been projected to be highly susceptible to extreme weather conditions in the future, many believe that this will compromise the ability for IKS to anticipate future weather events accurately (Shepherd et

al., 2013). Consequently, the call for poor rural households to utilise Seasonal Climate Forecast (SCF) in order to build their adaptive capacity and resilience has bourgeoned in the last decade (see, e.g., Klopper et al., 2006; Spence and Pidgeon, 2010). It is argued that the use of SCF will not only make food production for the rural poor more effective in the face of a rapidly changing climate, but will minimise the loss of assets in anticipation of an extreme weather condition (see Demeritt et al., 2010; Moser and Dilling, 2011; Padgham et al., 2013).

Pilot studies conducted in SSA have revealed that the utilisation of SCF can enhance more meaningful food production practices. Roudier et al. (2014), for example, observed that by utilising SCF, farmers in southwest Senegal were able to boost food production by one-third in comparison to those that cultivated normally based on previous experiences. Roncoli et al. (2002) concluded that resource-constrained farmers are yearning for reliable pieces of weather information in order to produce food more efficiently. However, contemporary literature suggests that the majority of the rural poor continue to rely heavily on their IKS (Kalanda-Joshua et al., 2011; Nkomwa et al., 2014).

It is also important to mention that there have been instances where extreme weathers have been predicted accurately but failed to trigger the adoption of proactive measures among those susceptible to the anticipated extreme weather conditions (Ajibade and McBean, 2014; Hellmuth et al., 2007). Inappropriate channel of communication has been highlighted as a major factor that impedes the adoption of proactive measures (Hellmuth et al., 2007). As Demeritt et al. (2010); Moser and Dilling (2011) and Padgham et al. (2013) aptly put forward, extreme weather warnings are only useful when it is communicated through mediums that are familiar with the end-users. While it has been documented that the rural poor in SSA still rely and prefer their indigenous systems of conveying information within their community, the preferred means of communication by most risk communicators has been via the mass media (Hammer et al., 2001). It is argued that using the mass media to

convey vital pieces of information to the rural poor can be a huge mismatch due to poverty, which makes gadget like television and radio sets a luxury for some households (Mushengyezi, 2003).

In light of the above arguments and using the Delta State of Nigeria as a case study, this study sought to make theoretical and methodological contributions regarding the ways in which resource-constrained farmers continue to produce food in the face of climate variability by drawing on their asset portfolios. The study further aimed at understanding the extent in which SCF facilitates effective food production, as well as the most effective and efficient routes of communicating climatic risks to the poor rural households.

7.2. Key findings

Objective I

Heavy rainfall events and floods were identified by 92% of the participants as the most crucial weather phenomenon that adversely affected food production in the study areas. Due to increased precipitation in the Delta State and coupled with the low-lying farmlands in Igbide, Uzere and Olomoro communities situated in Isoko South Local Government Area (ISLGA), the farmers were unable to engage in food production throughout the year. This is because the farmlands must be flooded (1 – 2m above ground level) from mid-June to the last week in October annually.

On the other hand, 62% of the participants pinpointed increase in temperature, particularly between February and April, as another factor that has negatively impacted food production. The participants argued that in the last seven years, the temperatures in the aforementioned months have become agonisingly scorching. The participants were of the view that the negative impacts of the warmer climate are mainly felt in groundnut production, a major

staple produced by every farmer annually. An elderly participant from Igbide, in her 70's, for example, argued that due to the increase in temperature in the aforementioned months, they are barely able to harvest up to five bags (5kg bags) of groundnut, which is in stark contrast to the 10 – 12 bags they used to harvest in the 1960's. It is noteworthy to mention that the majority echoed that the change in weather condition is an "act of God" and not as a result of human's sinful habit as other literatures that have emerged from the developing South suggest (see Bankoff, 2004; Byg and Salick, 2009; Simatele and Simatele, 2015).

With regards to drawing on their asset portfolios to produce food, human and social capitals have been highly instrumental in ensuring household food security. The farmers usually drew on their human capital, hinged on indigenous knowledge, to produce cassava on their low-lying farmland by employing a strategy indigenously referred to as *elelame* (follow-water-go).

Elelame is initiated between the first and second week in December when the seasonal floodwater starts retreating disproportionately from the farmlands. Immediately some portions of the farmland become visible and moist, they start planting cassava. As the floodwater continues to retreat in other portions of the farmlands, they employ the same process. Next, after the full commencement of the rainy season in the following year, the floodwater starts inundating the farmlands unevenly from mid-June, although some argued that this event commences in July in other farmlands. Just before the floodwater begins to inundate the farmlands, the farmers usually harvest the produce closest to the point where the farmlands are expected to be first inundated, to about 5 – 20 meters away from the anticipated starting point (depending on the slope of the farmland). The main reason for adopting this strategy is that in the eventuality of not being opportune to return to the farmland within the next 4 – 5 days, the floodwater will not get to the point where they temporarily stopped harvesting. If, however, the floodwater gets to the point where they

stopped harvesting, the cassava tubers will not be immersed in the floodwater for a long period of time. Thus, they will be able to harvest the inundated cassava tubers in order from preventing the tubers from rotting away.

In the context of social capital, some argued that it facilitated the accruement of financial capital. All, but one participant, argued that they have never been beneficiaries of any loan schemes made available by the government, even though it has been documented that the Delta State government have been allocating farm loans consistently to subsistence farmers for over a decade (see United Nations Development Program (UNDP), 2014). Due to their inability to secure government loans, they cushioned the financial drought by a strategy referred to as *osusu*. *Osusu* is based on some community members forming a group based on trust where they make weekly monetary contributions to a trustworthy person who, after collecting the funds, deposits it in a bank or loans the money out with interest. At the end of each month, the cumulative sum is given to a member of the group, based on prior arrangement. *Osusu*, as 35% of the farmers argued, is a viable option in ensuring that they can purchase seeds and other related items in order to continue in food production on an annual basis.

It was asserted that not all community members have been able to partake in the *osusu* scheme. This is due to some farmer's financial commitments ranging from paying children's tuition, family upkeep and other social obligations. Thus, the only option they have is to secure farm loans from "financial poachers" because their requirements are less stringent in comparison to the necessary documentations that are required before a bank loan can be secured. While the loan from the poachers addresses the immediate needs of the farmers, it is deemed counterproductive over the long haul. This is because if a farmer borrows #10,000:00 ($32.80) for six months, for example, the farmer is expected to pay back the sum with a 40% interest. Since the farmers cannot afford to be food insecure, it is endorsed as the only option

they have to ensure they continue to produce food on a yearly basis. Unfortunately, this cycle continues to plough some of the farmers deeply within the global poverty index.

Objective II

The study also revealed that the farmers' rely predominantly on their IKS to determine the appropriate time, as well as the quantity of food to produce in a particular planting season. In particular, the croaking of frogs, ducks repeatedly flapping their wings, the appearance of red-like millipedes, cloud observation and flowering of rubber trees were some of the key indicators used by the farmers. However, they acknowledged that their IKS have not been effective in anticipating future weather events accurately in comparison to previous decades. A few of the farmers attributed oil exploration activities as the causal factor responsible for the decline and increased inconsistences of their IKS. Others, however, vehemently echoed that only God can determine the actual cause of the increased irregularities confronting their IKS occasionally. Furthermore, some participants emphasised that the continued reliance and use of IKS are hinged on tradition. In spite of the increased inconsistencies besetting their IKS in comparison to previous decades, the farmers still do not rely on SCFs. This is against the backdrop of the 2012 flood disaster predicted by the Nigerian Meteorological Agency (NIMET) with pinpoint accuracy.

Objectives III & IV

Findings from the study suggest that, the farmers have not been able to plug into and benefit from the accurate prediction of climatic risks. Prior to the 2012 flood that was predicted by NIMET, for example, only one participant claimed to receive the forecast. Consequently, this resulted to devastating consequences for household assets and livelihood as shown in Chapters 2 and 4 respectively. When probed about the reasons that prevented most of the participants from receiving the 2012 warning, it was discovered that there was a huge

contrast between the method of communication adopted by the NIMET in disseminating the warning and the channels of communication that the farmers are more familiar with in terms of receiving vital pieces of information. When communicating the 2012 flood warning, the NIMET relied predominantly on the mass media, which proved to be a total mismatch from the farmer's perspective. The farmers argued that the most effective means of conveying crucial information to them is via town-hall meetings, the use of the village town criers and meeting groups.

While the 2012 flood forecast was accurately predicted, it would be "an uphill task" to get subsistence farmers in Igbide, Uzere and Olomoro communities to rely more on scientific forecast rather than their IKS. This is primarily because the farmers were victims of a grossly erroneous forecast in 2013. Barely five months after the 2012 flood disaster, the NIMET predicted that another flood disaster of parallel wavelength in comparison to what was experienced in 2012 was bound to occur in 2013. This time around the forecast spread like wildfire, predominantly via interpersonal networks and the mass media, to virtually every community where the impact of the 2012 flood was decisive. The farmers ignored their IKS, which suggested that there will be adequate rainfall in the 2013, and adopted several precautionary measures including not cultivating cassava (a major staple cultivated by every farmer) on their low-lying farmlands. Unfortunately, the anticipated disaster never occurred. This event, unfortunately, concretised the standpoint of most participants who believed that scientists cannot predict future weather events with surgeon's precision. In fact, the majority were of the view that only God can determine future weather occurrences with pinpoint accuracy (see Chapter 5).

Objective V

Due to the fact that subsistence farmers in the rural Delta State rely overwhelmingly on IKS, despite acknowledging that it is no longer as effective as it used to be in previous decades, the need to rebuild the dilapidated trust the farmers have for SCF, in the wake of a rapidly changing climate, cannot be overemphasised. In this regard, I argue that a crucial step that can set in motion the process of rebuilding subsistence farmer's faith in SCF is when it compensates for the weaknesses of the farmers IKS. As revealed in Chapter six, the IKS of the farmers in the Delta State fails to provide a precise indication of the early Rainfall Onset Date (ROD), the total amount of early rainfall and the Rainfall Cessation Date (RCD) in any particular farming season.

It is important for these groups of farmers to know precisely when the early rains will commence and the total amount of early rainfall because groundnut production, as illustrated in Chapter two, relies predominantly on the early rains. Thus, cultivating groundnut in contrast to precise early ROD and anticipated total early rainfall can hamper optimal yield and productivity. Knowing the precise RCD, on the other hand, is equally important for some farmers that migrate out of their respective communities at the heart of the rainy season as part of their livelihood strategy. This will enable the farmers that usually embark on migration to determine the most appropriate time to relocate back to their respective communities in order to commence the cultivation of cassava, which is also a major staple produced annually, by relying on the moisture left in the soil as the floodwater recedes the low-lying farmland.

In light of the above, a strategy that builds on the Multiple Evidence Based (MEB) framework was proposed for the integration of IKS and SCF. One of the greatest strengths of the MEB approach is that it promotes self-evaluation within each knowledge system, instead

of using Western scientific knowledge as the benchmark to determine the validity and accuracy of different knowledge based systems.

7.3. Recommendations

Due to the fact that the livelihoods of participants in this study are highly dependent on food production, it is pivotal for development actors to create avenues whereby it would be relatively easy for the poor have easy access to assets that are essential to ensure food security. It is also important to create viable platforms whereby the poor can build long-term resilience to climate variability such as having easy access to high grounds to produce food annually. It is, however, noteworthy to mention that whatever strategies that will be put in place should be cautious not to reinforce patriarchy and implicitly facilitate the erosion of social capital. For example, the relocation of households from the flood prone region might erode the social ties between neighbours, which are pivotal in enabling the farmer's hold their own to some extent in the aftermath of an extreme weather condition as shown in this study. In light of this background, it is essential to ensure that the rural poor are actively and consistently involved in the discourses with development practitioners, and not trivialise their voice as inconsequential (see Chambers, 1994). In so doing, this will likely facilitate the building of social capital between the farmers and decision makers that have been comatose in the study areas for decades.

It would be ideal to get weather stations that are in proximity to communities in ISLGA that depend predominantly on subsistence farming for their primary source of livelihood. At the moment, the closest weather station to Igbide, Uzere and Olomoro communities is approximately 80 km away. In addition, indigenes should be trained alongside with the extension workers on the ways of collecting daily rainfall and temperature data. It is important to enlighten these groups of people via workshop seminars, for example, regarding

the ways in which scientific forecasts are generated. If this is done, in the eventuality of an anticipated extreme weather event, for example, it will be relatively easy for the farmers to embark on pro-active measures especially when the forecast is disseminated by locals. This is because the forecast will likely be perceived as coming from individuals facing similar livelihood challenges (see e.g., Padgham et al., 2013).

Also, due to the farmer's overwhelming religious beliefs and values, it can be argued that the injection of religious narratives into the communication of future extreme weather warnings can be an avenue that will easily persuade the farmer's to adopt pro-active decisions. The use of biblical stories such as Noah building his ark (Genesis 6: 14 -22), for example, to convey an anticipated flood warning using the local communication channels might be more effective in convincing the farmers in Igbide, Uzere and Olomoro. Of course, the incentives they will be entitled to, and from whom, if the anticipated extreme weather warning fails to materialise must be explicitly communicated to the farmers. This is essential because previous experiences with both arms of government and coupled with the "neglect of their community especially in the aftermath of the 2012 floods", among others, might have facilitated the erection of a mental brick wall by most participants in the aforementioned communities that any information coming from the government should be lightly esteemed.

Findings from this study reveal that the majority of the farmers in the aforementioned communities lack access or title to farmlands on high grounds. This is a clog in the wheel that hampers household food security in the aftermath of an extreme weather condition like what the farmer's had to endure in the aftermath of the 2012 flood, for example. It is, therefore, imperative for the Delta State government to come up with strategies and schemes that will make it relatively easy for women to have easy access to arable farmlands on high grounds. This will ensure that the subsistence farmers are able to engage in food production throughout the year, and thereby, obtain the livelihood they desperately pursue.

7.4. Future research needs

It is well documented that poor rural households in the developing South still rely on IKS (Kolawole, 2012; Mavhura et al., 2013; Nyong et al., 2007). However, there have been relatively few studies that have attempted to compare the IKS of the rural poor with SCF in order to ascertain which is more reliable in predicting short and long term future weather conditions. This is important in order to explicitly reveal the strengths and weaknesses of each strand of knowledge. This will enable the proponents of each strand of knowledge to know precisely when to advocate for the use of each knowledge strand in order to ensure that rural households can continue more meaningfully in food production in the face of climate variability.

It is also important to conduct a pilot study whereby one group of farmers will use the "unified" forecast (the resultant forecast that will emerge from integrating indigenous and scientific forecasts) to determine the appropriate time and quantity of food to produce in a specific growing season against another group that will rely predominantly on IKS. This is crucial to effectively highlight the benefits of utilising the forecast generated by integrating IKS with SCF as against relying solely on IKS. This will, arguably, shed light on most, if not all, of the challenges that the process is likely to encounter so that ways to improve the model can be swiftly implemented before proponents of the "unified" forecast can vehemently advocate for its use.

In an unrelated vein, it has been documented that oil exploration activities have resulted in land degradation and thus, have reduced the nutritional value of food produced by households in ISLGA (see Elum et al., 2016; Ite et al., 2013). However, no study has been conducted in ISLGA that has adequately captured the extent to which the nutritional value of the food produced by farmers have been compromised by oil exploration activities and its associated

health implications. It is important to ascertain the health implications of consuming food produced in proximity to oil exploration activity sites. This will aid to ascertain the necessary measures that need to be taken in order to minimise any health related issues that could erupt from consuming such farm produce.

Finally, since the defunct Bendel State was divided into Edo and Delta in 1991, a number of agricultural policies for the Delta State have been enacted, implemented and modified. Yet, for rural households to obtain and secure their livelihoods have continued to be an uphill task. Thus, understanding the ways in which agricultural policies, underpinned by neoliberalism (see Ekanade, 2014) has contributed or made the impacts of climate variability more agonising on food production is crucial to undo and modify existing agricultural policies.

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Pers. Comm, 2015c. Personal communication with a participant, in her 70's, who hails from Igbide in the Delta State of Nigeria (12/07/2015).

Pers. Comm, 2015d. Personal communication with a participant, in her 30's, who hails from Olomoro in the Delta State of Nigeria (19/06/2015).

Pers. Comm, 2015e. Personal communication with a participant, in his 60's, who hails from Olomoro in the Delta State of Nigeria (19/06/2015).

Pers. Comm, 2015f. Personal communication with a participant, in her 40's, who hails from Uzere in the Delta State of Nigeria (26/06/2015).

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Pers. Comm, 2015j. Personal communication with a participant, in her 50's, who hails from Igbide in the Delta State of Nigeria (12/07/2015).

Pers. Comm, 2015k. Personal communication with a participant, in his 50's, who hails from Olomoro in the Delta State of Nigeria (04/07/2015).

Pers. Comm, 2015l. Personal communication with a participant, in her 50's, who hails from Igbide in the Delta State of Nigeria (20/07/2015).

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APPENDIX 1: Ethics clearance certificate

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Ebhuoma

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H15/05/10**
PROJECT TITLE	Climate change risk communication and asset protection of small-scale farmers in the Delta state, Nigeria. Perceptive on the impact of extreme weather events on the livelihoods of small-scale farmers
INVESTIGATOR(S)	Mr E Ebhuoma
SCHOOL/DEPARTMENT	Geography and Environmental Studies/
DATE CONSIDERED	22 May 2015
DECISION OF THE COMMITTEE	Approved unconditionally
EXPIRY DATE	07 June 2017
DATE 08 June 2015	**CHAIRPERSON** (Professor T Milani)

cc: Supervisor : Dr D Simatele

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

_____ **Signature**

_____/_____/_____ **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX II: Guiding questions for focus group discussions and in-depth interviews for subsistence farmers in the Delta State, Nigeria

This questionnaire seeks to collect empirical data in partial fulfillment of the requirement for a Ph. D. degree in the School of Geography and Environmental Studies at the University of the Witwatersrand, South Africa. The study seeks to understand how subsistence farmers in Igbide, Uzere and Olomoro communities produce food and the steps taken to protect and adapt household assets in the face of extreme weather conditions. The study is also interested in understanding the various forms of indigenous knowledge systems used in anticipating future weather events and if farmers use scientific forecast to prepare for a planting season. Your cooperation will be greatly appreciated.

1. **Background Information**
    i. Kindly state the highest level of schooling or education you have received?
    ii. What is your religion?
    iii. How long have you been staying in this community?
    iv. Kindly state your marital status?
    v. Are you the 'bread winner' of the family and how many people live in the house where you stay?

2. **Perceptions of the impacts of heavy rainfalls, flooding, and rising temperatures on agricultural crop production and other livelihood activities**
    i. What have you heard about climate change in your honest opinion?
    ii. Has there been any major change or changes regarding the weather conditions (rainfall, temperature and windstorms) for as long as you can remember?
    iii. Do you think human activities are partly responsible for the current change and frequency in extreme weather conditions?
    iv. Kindly list out the weather conditions that has adversely affected agricultural crop productivity, other livelihood activities and assets in your home?

v. Which had the most severe impact on your crops, livelihood activities and assets?

vi. In times of extreme weather conditions, kindly explain how it affects your health and that of your households, your ability to produce food, household properties?

3. Asset adaptation to the impacts of extreme weather conditions

i. Can you list out all the necessary items that enable you to effectively continue in food production?

ii. What were the strategies you and members of your household used in order to protect the assets listed above long before a flooding occurs, during and immediately after the 2012 flood?

iii. Did you receive any grant or agricultural loans in order to help you cope with the 2012 floods and get back into food production?

iv. How did you manage to repair your damaged houses and get back into food production after the 2012 floods?

v. Do you think those who are members of a co-operative society or those registered with the farmer's association groups are able to bounce back faster from the situation as against those who are not?

vi. Which institutions have been of immense benefit in helping you cope and bounce get back into your usual way of life after the 2012 flood?

4. Indigenous Knowledge Systems and Climate Change Risk Communication

i. Do you have any local sign(s) that you rely on to know when the early rainfall or rainy season is about to start so that you can start preparing to produce food or the "most suitable time" to start planting?

ii. How accurate has the local signs been in predicting the weather?

iii. How do you receive daily, weekly or monthly information regarding the weather?

iv. Have you ever used the weather information from the Nigerian meteorological agency (NIMET) when planning for the agricultural season? Or have you ever incorporated weather information from the Nigerian meteorological agency into your farming practices?

v. How helpful will you say NIMET forecast has been in terms of protecting your household properties and food stuffs as against previous times when you had no access to such information?

vi. What were the challenges you came across in trying to access the data, and also, in trying to interpret the data?

vii. Which language or languages will you like to report to be broadcasted in?

viii. What channels or medium of communication is likely to be very effective in ensuring you utilise NIMET forecast when making decisions regarding your farming practices and, who would you recommend as a suitable or trustworthy candidate to communicate weather related information to you?

ix. If a forecast from NIMET says that a flood disaster like the one in 2012 is coming, and your IKS says there will be no flood, which will you go with and why?

Thank you for your time and honest opinions. *Dgewor*.

APPENDIX III: Semi-structured interview questions for the meteorological service workers in Nigeria

This questionnaire seeks to collect empirical data in partial fulfillment of the requirement for a Ph. D. degree in the School of Geography and Environmental Studies at the University of the Witwatersrand, South Africa. The study seeks to understand the extent at which seasonal climate forecast disseminated by the Nigerian meteorological agency (NIMET) plays a key role in enabling subsistence farmers in Igbide, Uzere and Olomoro communities engage in effective produce food practices and facilitate the protection and adaptation of household assets of farmers in the aforementioned communities in the face of extreme weather conditions. Your cooperation will be greatly appreciated.

1. How long have you been working in the meteorology department?
2. What are the main aims and objectives of the department?
3. What models are used in generating the seasonal climate forecast?
4. What are the challenges associated with generating forecast for the Delta State, with a particular emphasis on the rural farming communities?
5. Are the challenges peculiar to the Delta State alone or it is virtually the same throughout the country?
6. How is it passed on to the end-users including subsistence farmers in rural communities?
7. What are the challenges, in your view, that prevents rural subsistence farmers from using scientific forecast to determine the best time to start cultivating and the quantity of food they need to produce in any growing season?
8. How are these issues being addressed from your department's point of view?
9. Why did you think the predicted 2012 flood disaster never got to most of the people residing in rural communities even though it was forecasted a long time ago before the event occurred?

10. What measures have been put in place by the department to ensure such vital pieces of information reaches those that are expected to be vulnerable to such extreme weather event?
11. What do you think was responsible for the incorrect forecast in 2013?
12. What measures have been put in place to ensure that such events never re-occurs and whenever the department disseminates a forecast people will be able to trust the forecast totally?

Thank you very much for your time. God bless.

APPENDIX IV: Semi-structured interview questions for a senior official of the Nigerian Red Cross Society in the Delta State

This questionnaire seeks to collect empirical data in partial fulfillment of the requirement for a Ph. D. degree in the School of Geography and Environmental Studies at the University of the Witwatersrand, South Africa. The study seeks to understand the extent at which seasonal climate forecast disseminated by the Nigerian meteorological agency (NIMET) plays a key role in enabling subsistence farmers in Igbide, Uzere and Olomoro communities engage in effective produce food practices and facilitate the protection and adaptation of household assets of farmers in the aforementioned communities in the face of extreme weather conditions. Your cooperation will be greatly appreciated.

1. Kindly state the role played by the Red Cross Society in ensuring the protection and safeguarding of lives and properties in the Delta State during the 2012 flood disaster?
2. What were the major challenges your team faced during the search and rescue operation including ensuring people where safely placed in the Internally Displaced Person's (IDP) camp erected by the State Government?
3. Was the flood predicted by the NIMET?
4. How channels of communication were used to disseminate the flood warning and how effective were they?
5. With your experience in working with rural communities, what mediums of communication do you think are the most effective and efficient with regards to passing on vital pieces of information across to rural households?

APPENDIX V: Questionnaire for agricultural extension service officials

This questionnaire seeks to collect empirical data in partial fulfillment of the requirement for a Ph. D. degree in the School of Geography and Environmental Studies at the University of the Witwatersrand, South Africa. The study seeks to understand how subsistence farmers in Igbide, Uzere and Olomoro communities produce food and the steps taken to protect and adapt household assets in the face of extreme weather conditions. The study is also interested in understanding the various forms of indigenous knowledge systems used in anticipating future weather events and if farmers use scientific forecast to prepare for a planting season. Your cooperation will be greatly appreciated.

1. How long have you been working as an agricultural extension service officer?
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2. Which of the communities in Isoko South LGA do you normally carry out your duties?
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3. How long have you been delivering agricultural information to subsistence farmers in the community where you
work?.....

4. Kindly list out all your academic qualifications and other qualifications including training(s) you may have obtained.
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5. Kindly state all the challenges you have encountered in the past when trying to work with the subsistence farmers in the community where you carry out your duties?
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6. How have these challenges been resolved so far?

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7. Are the subsistence farmers required to be registered with your institution?

Yes ☐ No ☐

8. Are there are financial charges that subsistence farmers are meant to pay on a monthly or yearly basis as subscription charges? Kindly state the amount if any.

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9. What are the benefits that the registered farmers have over those who are not registered with your institution?

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10. Whenever the government wants to give out loans, fertilizers or seedlings, is it your duty (the institution where you work) to notify subsistence farmers? Or please state how the subsistence farmers are usually informed?

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11. As part of your job requirements, are you expected to deliver the predicted or forecasted rainfall and temperature information (weather forecast information) to the farmers which the Nigerian Meteorological Agency (NIMET) releases each year?

Yes ☐ No ☐

If 'yes', please answer question 12 and beyond. If 'no', kindly proceed to question 18.

12. With regards to the weather forecast, what exactly do you pass across to the farmers (e.g. predicted monthly and temperature information, or only when the rainfall is expected to be very heavy, etc.)?

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13. How often do you provide farmer's with weather forecast information, and what medium or channels are usually used to pass the information across to the farmers?

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14. Just before the weather forecast information from NIMET is passed across to the extension agent, are you aware if members of staff such as the director of extension services for the Delta State normally have a meeting with the NIMET officials in order for the NIMET

officials to explain to extension members the content of the report, so that the report is well understood?

Yes ☐ No ☐ Cannot say ☐

15. Kindly state the challenges you usually face when trying to interpret the weather forecast information?

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16. What are the challenges you normally encounter when trying to deliver the weather forecast information to the farmer's in the community where you work?

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17. Are there any meetings or discussions held with farmers via town hall meetings just before the weather forecast information is delivered to farmer's in the community? If yes, kindly explain what the meeting is all about and what it aims to achieve.

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18. Do you think the farmer's use the weather forecast information in their farming practices?

Yes ☐ No ☐ Cannot say ☐

19. What do you think are the reasons why some or most of the farmers do not incorporate weather forecast information into their farming practices?

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20. What trend or significant behavioural pattern have you observed between the educated and non-educated farmer's in relation to their perception and use of best agricultural practices and/or weather forecast information as provided by your institution?

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21. Which channels or means of communication have been very effective in getting information of all sorts across to the farmers in the community where you work? Kindly list all that applies.

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22. What characteristics or qualities do you think that an agricultural extension service worker must have, in order to be highly effective in carrying out their duties, particularly as it relates to ensuring that subsistence farmers adopt the best agricultural practices?

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23. Generally, what challenges usually prevents you from effectively carrying out your duties to subsistence farmers?

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24. Are there are any other contributions that you think will be useful to me? Kindly include them in the space provided below.

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Thank you very much for your time, candid response and co-operation. God bless.

APPENDIX VI: Some fieldwork pictures

A). Low-lying farmland inundated by floodwater. Photo by Eromose Ebhuoma (2015).

B). An example of platform constructed on a flooded farmland where farmers preserve their cassava stems in order to ensure they can effectively produce cassava in the next planting season without purchasing stems. Photo by John Ayiko (2015).