

# Towards Sustainable Adaptation to Climate Change: the Role of Indigenous Knowledge in Nigeria and Ghana

AKINBAMI, C.A.O., C. IFEANYI-OBI, D.O. APPIAH & A.T. KABO-BAH

## Abstract

Climate change has been identified as a threat to poverty reduction and economic growth, and it may erode many of the development gains made in recent decades. From the short to the long term, climate change and variability threaten human and social development by altering customary means of livelihood and restricting the fulfilment of human potential. In all these, indigenous people are the most affected, considering their high vulnerability level. In view of this, such people find it difficult to adapt to climate variability and change as well as other environmental changes. Not only is the viability of indigenous livelihoods threatened, due to food insecurity, lack of potable water and poor health, but also the cultural integrity is also undermined. This study assessed the various sustainable indigenous adaptation strategies being utilised in the respective countries to combat the adverse effects of climate variability and change; and also, examined how sustainable the adaptation strategies were. The study employed the use of quantitative and qualitative methods to elicit information from the respondents from Ghana and Nigeria. The results indicate that there are major international differences but that adaptation strategies taken among indigenous people in the respective countries are similar. Indigenous people are resorting to soil-water conservation, identification of resistant crops to prevailing climate, use of appropriate techniques and chemicals for improving soil fertility, improvised harvesting techniques, and strategic planting periods for their crops. In most cases also, local people also embark on alternative livelihood options to support income levels of their households. The authors strongly recommend extension services and introduction of scientific technologies to complement indigenous knowledge approaches.

**Keywords:** sustainable practices, adaptation strategies, indigenous knowledge, climate change

### Introduction

Climate change has been identified as a threat to poverty reduction and economic growth, and it may erode many of the development gains made in recent decades. Both now and in the long-run, climate change and variability threaten human and social development by altering customary means of livelihood and restricting the fulfilment of human potential. Climate adaptation has therefore become a more visible and pressing issue in recent years and this can be attributed to the recognition that the climate system has been undergoing changes and will continue to in the coming century regardless of reductions in greenhouse gas emissions, mainly due to thermal inertia of oceans and the long atmospheric lifetime of carbon dioxide and other greenhouse gases (Matthews and Caldeira, 2008).

However, it has also been reluctantly acknowledged that emission reductions are unlikely to decrease at the rate and magnitude necessary to prevent climate change that is dangerous to many (Parry et al., 2009; Schellnhuber, 2009). Adaptation is thus increasingly considered as essential to reducing vulnerability to dangerous climate change. Adaptation can potentially reduce the negative impacts of climate change, more importantly; such adaptation strategies, policies and practices must be sustainable. What therefore seems to be a successful adaptation strategy, policies and practice to climate change may in fact undermine the social, economic and environmental objectives associated with sustainable development. Strategies or policies that make sense from one perspective, or for one group, may at the same time reduce the livelihood viability or resource access of other groups. Likewise, an eagerness to reduce climate risk through specific technologies or infrastructural changes may sometimes lead to the neglect of other environmental concerns, such as biodiversity (Næss *et al.*, 2005; Eriksen and O'Brien, 2007; Eriksen and Lind, 2009). Hence, adaptation can have unintended negative effects both on people and on the environment. A recognition that not every adaptation to climate change is good and sustainable has drawn attention to the need for sustainable adaptation strategies and measures (Eriksen and O'Brien, 2007). For the adaptation strategy to be good enough, it must incorporate the indigenous knowledge of the rural dwellers. Since this will help to address some of the mistakes and shortcomings of conventional social and

economic development pathways that have contributed to social inequity, poverty and environmental problems (Ulsrud et al., 2008).

It therefore becomes pertinent to identify the synergies between adaptation and sustainable developments because urgent and overwhelming poverty problems in the world, especially in the rural areas, are far from being satisfactorily addressed, and environmental problems other than climate change also threaten people's livelihoods and quality of life. This is because the rural dwellers are part of the mostly affected since they depend on the natural resources which have been affected by the climate change. The increase in attention to and resources for adaptation suggest that it is critical to 'get adaptation right' in order to solve, rather than exacerbate, problems. Consequently, it is important to understand what it means to sustainably adapt to climate change. Sustainable adaptation is defined in this paper as adaptation that contributes to socially and environmentally sustainable development pathways, including both social justice and environmental integrity and more importantly, it involves the inputs of the rural dwellers for collective indigenous outcomes.

Adaptation is not just about how people survive, it is also about human rights. Rural dwellers, especially, the women often bear the brunt of climate change impacts, including lack of food, potable water and energy sources which have increased instances of illness and the resultant stress on the family. This often results in domestic violence and the lack of resources to deal with daily needs. However, these same people hold much of the knowledge about how to adapt. There is a huge need therefore to understand how local communities organize themselves and use the knowledge they have built over generations for coping with the impacts of climate change. Hence, this study assesses indigenous adaptation strategies in parts of Ghana and Nigeria and presents some key lessons from indigenous communities that could be used as guidepost at informing policy and decision makers about the vital role of such settings towards improved policy towards sustainable adaptation policy.

Adaptation to climate change has been defined in various perspectives. According to Smit et al., (2000); Debels et al., (2009) adaptation has been defined as the process or adjustments through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides thereby reducing vulnerability. Leary (1999) and Burton et al.

(2002) referred to climate adaptation as a wide range of behavioural adjustments that households and institutions make (including practices, processes, legislation, regulations and incentives) to mandate or facilitate changes in socio-economic systems, aimed at reducing vulnerability to climatic variability and change. Nelson et al. (2007) defined adaptation as the decision-making process and the set of actions undertaken to maintain the capacity to deal with current or future predicted change. These definitions are summarized in the Intergovernmental Panel on Climate Change (IPCC) definition of adaptation: as the adjustment to practices, processes and systems in order to ameliorate negative effects and take advantage of opportunities associated with climate change (IPCC, 2007).

Though, the issue of sustainability has been an underlying factor of most of the definitions and assessments by IPCC, there is the need to create synergies between the role of indigenous knowledge and sustainable development (Bizikova *et al.*, 2010; Yohe *et al.*, 2007). Cohen *et al.* (1998) pointed out that although climate change is one of the most important symptoms of an unsustainable economic system, the climate change and sustainable development fields have been separated by differences in discourse. For example, climate change has been largely constructed as an environmental problem that can be solved by reducing greenhouse gas emissions, with little attention to its social, cultural, political and ethical dimensions which involve the active participation of the rural dwellers (O'Brien *et al.*, 2010).

Many of your cited authors are not listed in the reference section. You need to reconcile to ensure that all cited authors are listed. Though, on paper, the concept of sustainable development focused on the close connection between environmental problems, poverty, inequity and basic human needs, but it has been criticized as a vague policy term rather than reality. Cohen et al (1998) stated that it has been accused of being flexible to suit any interest, or a linguistic cover for business as- usual politics, thereby distracting attention from any fundamental changes in the rural systems. This has led to many calls for 'strong sustainability', which involves changing current modes of development, questioning calls for continued economic growth and appealing for a less managerial approach (top-bottom approach) to human-environment relations (Adams, 2009). This is with the aim of having sustainable adaptation strategies.

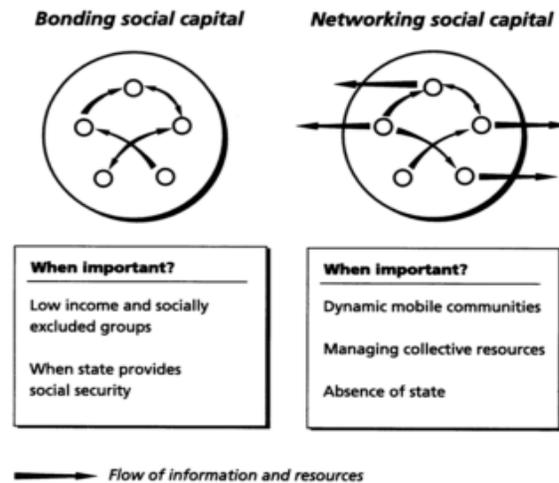
The underlying principle in sustainable adaptation is to acknowledge that responses of people to climate change will create social and environmental externalities, including trade-offs and negative consequences. Sustainable adaptation thus considers the wider effects of adaptive responses on other groups, places and socio-ecological systems, both in the present and in the future. Sustainable adaptation can be distinguished from adaptation in general in that it qualifies actions in terms of their effects on social justice and environmental integrity; that is, adaptation is sustainable only if it contributes (and at the very least does not seriously erode) these two features. Thus, making sustainable adaptation a solution to the problems of vulnerability since climate change is a global problem that affects both current and future generations, and responses must be sensitive to both spatial and temporal consequences which will influence resource access and the integrity of ecosystems that many people depend upon for their livelihoods (Eriksen et al., 2005). This will help to implement adaptation strategies that will actually assist the poor and vulnerable groups. It is not any and every adaptation intervention that reduces poverty and inequality (and some poverty reduction measures may aggravate vulnerability), sustainable adaptation measures therefore need to specifically target links between vulnerability and poverty (Eriksen and O'Brien, 2007; Eriksen et al., 2007).

#### *Process and agents of adaptation*

Adaptation process involves the interdependence of agents established through relationships between institutions and resources. For instance, the relationship between human ecology, geographic, and micro-economics; anthropological and political frameworks provide a bird-view of the essence of connectedness and networks and the exact role of institutions. Regardless of these interdependencies, some researchers have observed institutions are an outcome of individual social interaction and the provision of state's structures to provide an enabling environment for exchanges. Therefore, advocates have agreed that institutions are enshrined in the antecedent decisions and culture of the societies from which they emerge (Adger, 2003). This explains that phenomena such as resilience and stability of society, culture and economic performance react to the environment in different ways.

In order to understand the adaptation process, degree of social capital within the prevailing environment is important to foretell the level of adaptation that needs to be implemented in particular community. Social

capital is the sharing of knowledge, financial risk and market information during the times of crises. From figure 1, it can be summarised that social capital represents economic and other ties that are external to the group. For instance, in a farming community in Africa, the exact impact of the social capital would inform the degree to which the farmers can easily obtain technology transfer and obtain subsidies for farm-inputs for adapting to changing climate variability. A good social capital in a farming community would imply a more strategically positioned community towards climate change adaptation. Social capital relations such as the bonding and networking developed for non-economic purposes are necessary for coping with extreme weather and hazard events (Adger & N., 1999; Ribot, 1996).



**Figure 1: Bonding and Networking social capital importance for adaptive capacity**

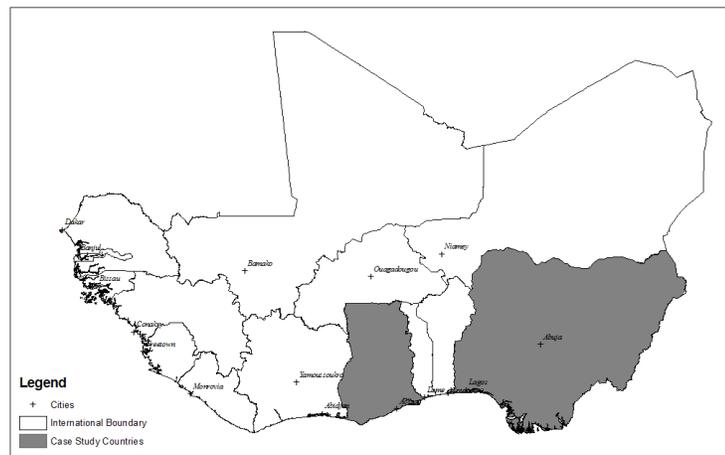
The social dynamics of adaptive capacity are defined by the ability to act collectively (Adger, 2003). Resource dependent communities have historically acted collectively to manage weather and seasonal resource changes such as water resources and livestock on which their livelihood depends. Social capital promotes the adaptive capacity of societies to manage and adapt to climate change. For instance, in the case of coping with weather related hazards such as droughts, social networks aid in adaptation and recovery. In cases where government intervention plans and forewarns communities in disaster planning and assisting a community during crises period, social capital takes over a substitute from the nation.

In indigenous communities, changing environmental and climatic conditions may result in the formation of “object-oriented communities”. Such communities come together to discuss and find out ways through which they can be able to resolve their local problems such as improving the yield of crops on their farms by jointly sharing knowledge and resources. For example, tomato growers association can come together to improve the soil fertility on their farms through joint efforts such as rotational group farm-care. Social capital therefore within indigenous communities especially in the wake of less organised institutional support proves to be vital for communities especially in West Africa e.g. Nigeria and Ghana

## Methodology

### *Study Area*

The research was conducted in Ghana and Nigeria. Selected case studies in each of the countries was examined and reported. Figure 2 shows Ghana and Nigeria within the West African region. Brief discussions about the climatic conditions are provided in the next sections.



**Figure 2: Selected study areas for the research**

### *Ghana*

Ghana has seven ecological zones namely coastal savannah, guinea savannah, rainforest, semi-deciduous forest, Sudan savannah, and the transitional zone (Oppong-Anane 2006). However these delineations can be re-categorized into two constituting the savannah zone and the forest zone based on similarity of characteristics (Figure 1). Sudan Savannah, Guinea Savannah and transitional zone have high temperature and low rainfall (Asante and Amuakwa-Mensah, 2015). The savannah ecological zones are particularly arid in nature and have harsh climate conditions.

The mean annual temperatures for two of the ecological zones (Sudan and Coastal Savannah) have increased greatly over the 40-year period with the Sudan Savannah experiencing an increase from 28.1°C in 1960 to 29.0°C in 2000 and the Coastal Savannah from 27.0°C in 1960 to 27.7°C in 2000 (Adaptation Fund, 2012). Extreme temperature conditions are experienced in some parts of the country. For instance, temperatures ranging between 18°C and 40°C or more are common in the southern and northern parts of Ghana, respectively (Adaptation Fund, 2012). Adaptation practices are therefore considered within the context of two broad categorizations *viz* the savannah ecological zones (coastal savannah, Sudan savannah, guinea savannah and the transitional zone) and the forest zones (semi-deciduous forest and the rainforest).

### *Nigeria*

The Federal Republic of Nigeria lies between Latitudes 4° to 14° North and between Longitudes 2°2' and 14° 30' East. To the north the country is bounded by the Niger Republic and Chad; in the west by the Benin Republic, in the East by the Cameroon Republic and to the south by the Atlantic Ocean, FAOSTATA???. Nigeria has a total land area of 92377(1000Ha) out of which 72000 (1000Ha) are Agricultural area, (FAO, 2010). Nigeria is a country of marked ecological diversity and climatic contrasts. The lowest point is the Atlantic Ocean at sea level while the highest point is the Chappal Waddi at 2 419 m, (Aregheore, 2005). Nigeria has diverse biophysical characteristics, ethnic nationalities, agro-ecological zones and socio-economic conditions.

Nigeria climate change review (NIMET, 2012) show an increasing trend in temperature from mid 20<sup>th</sup> century to date. Temperatures have

increased from 0.2 – 0.5°C in the high ground areas of Jos, Yelwa and Ilorin in the north and *Shaki, Iseyin* and *Ondo* in the southwest and by 0.9 - 1.9°C over the rest of the country. Also, increasingly vast portion of the country now experience late onset and early cessation of rainfall. The period of the rainy season in the country has been reduced from 1941 when the onset and cessation were generally normal to 1971 when signals of late onset and early cessation of the rainy season set in. Since then, the length of the rainy season has remained shrinking while annual total rainfall is about the same, thereby giving rise to high impact rainfall, resulting in flash floods, (NIMET, 2012). Example is the devastating floods of 2012 (August and October), Nigeria experienced torrential rains that led to devastating floods in several states, causing considerable human casualties and damage to crops, livestock and fisheries.

This resulted to high food prices and disruption of agricultural and market activities, increased burden to vulnerable households in both rural and urban areas, (FAO, 2012). Unfortunately, in the midst of all these changes in climate, Nigeria has neither a structured early warning system nor a food crises prevention and management mechanism at the federal and state levels (FAO, 2012). Though many studies are being done in climate change adaptation, there is a need for an effective co-ordinating body that can oversee these activities, assessing the various measures identified and carefully selecting the sustainable ones for the country's adoption

The vegetation zones of Nigeria are Mangrove swamp forest, Dry coastal vegetation, Fresh water swamp forest, Moist low land forest, Forest savanna mosaic, North guinea savannah, Sudan savannah, Sahel steppe and Mountain vegetation. These are broadly categorized into two namely: the savannah and forest zone. This study considers adaptation measures in the context of the two broad categorizations in the Southeast and southwest zone of Nigeria.

### ***Research design***

The paper adopted a qualitative research design, which utilized results from separate research surveys undertaken in the two countries respectively. The choice of this approach was adopted, *in tandem* with the assertion of Hancock et al. (2009), that qualitative research tends to broaden understanding of how our social sphere functions. The data were collected

from identified agro-ecological zones of the respective countries, using typical *case* non-probability sampling technique. To this, researchers decided on the characteristics of the target populations, i.e. smallholder farmers to fit the characteristics of typical case of selecting people for focus group discussion and in depth interviews.

From each of the zones, two farming communities were identified and selected for the study. Key informant interviews were conducted among some selected local smallholder farmers from our selected sites. This was to solicit the views of respondents on a rather indiscrete attributes as their innate and local innovative approaches embedded in their various indigenous knowledge (IK) schemes, guiding their adaptation to climate variability and change in their farming activities.

Further, some researcher observations were made, as part of the qualitative data collection methods. In addition to these approaches, a critical and thorough review of secondary data from relevant institutional documents was conducted. This was to place the paper within the current debate and paradigm of research regarding climate adaptation among smallholder farmers in sub-Saharan-Africa. The results were analysed thematically on the basis of the respective agro-ecological zones identified for Ghana and Nigeria. These enabled the teasing out of the discussion and write-up of this paper.

## **Results and Discussion**

### *Ghana*

#### *Experiences of climate change mitigation and adaptation*

Climate change is made manifest in Ghana through rising temperatures, declining rainfall with deleterious consequences on food crop production (Codjoe, et al., 2013). Historical data for Ghana from the year 1961 to 2000 clearly shows a progressive rise in temperature and decrease in mean annual rainfall in agro-ecological zones in the country (Tellam, et al., 2008). The changing climate in Ghana for the different ecological zones has implications for the nature of agriculture and income earnings (Yaro, 2013).

Values and interests of communities play an important role in climate change responses, and they influence the adaptation strategies

adopted (O'Brien, 2009). Recognizing potential value conflicts can help to identify how adaptation responses taken by one group may affect the vulnerability context of other groups. Strong vested interests within particular adaptation strategies may act as a barrier to sustainable types of adaptation. For example, the adaptive responses that distribute risk across market and subsistence production in Ghana may in fact prioritize the maintenance of the status quo for men, at the cost of women's self determination (Carr, 2008). Sustainable adaptation may thus involve a more transparent political process that creates enabling conditions and access to information that supports decision-making for adaptation. Indigenous communities have long been recognised as being particularly vulnerable to the impacts of climate change due to the close connection between their livelihoods, culture, spirituality and social systems and their environment. At the same time, however, this deep and long-established relationship with the natural environment affords many indigenous peoples with knowledge that they have long used to adapt to environmental change, and are now using to respond to the impacts of climate change.

This brings out with it important concerns about power, rights, and ethics in engaging with these kinds of partnerships. Different groups and actors therefore produce different knowledge on adaptation, and which source of knowledge is recognized and used in decision making is crucial in determining which interests or development paths are prioritized. Different approaches to adaptation often reflect varying approaches to knowledge and understandings of the local context, resulting in different diagnoses of both problems and solutions. Integrating local knowledge based on the experience of living in a risky place and of observing the natural environment is essential for sustainable adaptation to climate change (Olsson and Folke, 2001; Berkes, 2007). Community-based adaptation initiatives are increasing in response to the top-down, technical approaches promoted by the scientific discourse on climate change (Huq and Reid, 2007).

Indigenous knowledge can be defined as the wisdom, knowledge and practices of indigenous people gained over time through experience and orally passed on from generation to generation. This knowledge gained has over the years played a significant part in solving problems, including problems related to climate change and variability. Indigenous people that live close to natural resources often observe the activities around them and are the first to identify and adapt to any changes. In coping with risk due to

excessive or low rainfall, drought and crop failure, some traditional people grow many different crops and varieties with different susceptibility to drought and floods and supplement these by hunting, fishing and gathering wild food plants. The diversity of crops and food resources is often matched by a similar diversity in location of fields, as a safety measure to ensure that in the face of extreme weather some fields will survive to produce harvestable crops.

Adaptation to climate change includes all adjustments in behaviour or economic structure that reduce the vulnerability of society to changes in the climate system (Smith et al., 1996). Whether people can adapt, and for how long, depends on the resources available. Africa is the region most vulnerable to the negative impacts of climate change and at the same time has low adaptive capacity. But the people, particularly at the local level, are making efforts to adjust to the changes they observe. In Ghana, recorded temperatures rose about 1°C over the last 40 years of the twentieth century, while rainfall and runoff decreased by approximately 20 and 30 percent, respectively (Ghana Environmental Protection Agency, 2000). As a country that depends mainly on rain-fed agriculture, Ghana is extremely vulnerable to climate variability and change. But over the years, farmers and other natural resource dependent communities in the country have found varied ways of coping with these changes, based on traditional knowledge and practices.

#### *Adaptation strategies to climate change*

Adaptation strategies to climate change across the various ecological zones in Ghana are a function of the geographical location. This also dictates the relative amount and intensity of rainfall and temperature distribution in these areas respectively. The people living in these locations employ their local and indigenous knowledge (IK) and experience developed over the years to adapt to their changing natural as well as their social environments. The coastal and interior savannahs are characterized by dry climate, increasing rainfall variability and hotter temperatures that result in decreased food output and incomes (Yaro, 2013). The vegetation in the coastal savannah zone is mainly grass and scrub with rather poor soils. Staple crops such as maize, cassava and vegetables are widely produced in this zone, which also supports livestock, including cattle (IEA, 2013).

In this regard, the effect of climate change in the form of sea erosion and tidal flooding, shoreline recession, increased flooding and salinization of surface and groundwater are experienced in the coastal savannah ecological zones (Linham and Nicholls, 2010). This has informed particular adaptation practices that serve to ameliorate the challenge posed to crop production in this regard. Proper management systems such as weeding, mulching, irrigation with fresh water, and thinning applied by the farmers are key adaptation strategies that help overcome salinity and drought (Uddin et al., 2014).

Furthermore, within the interior savannah zone there is only one rainy season, which starts in late April or early May, reaches a peak in late August or early September and truncates in October, followed by a long dry period and crops can only be grown under irrigation during the dry long season (Olesen et al., 2013). Food crops such as cereals, root and tubers, legumes and some tree crops such as mango, tick tree, shea tree, and cashew are cultivated (Mabe et al., 2014). In view of these, farmers in Northern Ghana have developed intricate strategies to adapt (Nyantakyi-Frimpong, 2013 cited in Nkegbe and Kuunibe, 2014).

To adapt to the extremities of climatic variables, key on-farm adaptation practices that have prevailed include creating or improving drainage system, early planting, irrigation or dry season farming, planting more trees and cover crops, planting drought resistant and early yielding crops, early planting, improved farm management practice, diversification into livestock rearing and increasing fertilizer (Antwi-Agyei et al., 2013; Mohammed et al., 2014; Asante and Amuakwa-Mensah, 2015).

Planting of drought resistant crops has been one key traditional indigenous adaptive strategy in the zones. Sorghum for example, has for generations proven to be drought resistant and tolerant of harsh condition. In the absence of truly drought tolerant maize varieties, farmers in drier areas prefer to plant more sorghum than maize, as the former is perceived to have better tolerance to drought. Farmers generally planted landraces suited to the existing rainfall pattern in their localities (Buah, et al., 2010).

Change in sowing dates and the use of medium heat-tolerant maize variety are very useful approaches in dealing with climate change in these dry and drought prone areas (Tachie-Obeng et al., 2013; Gyampoh and Asante, 2011). This ensures that even if the time of planting is earlier than

the rains for a particular season, the seeds still germinate at the on-set of the rains; A practice which is predominant across all the ecological zones

Irrigation is a key adaptation practice alternative to rain-fed agriculture. This is due to challenges associated with water deficits in the transition to the savannah zones. Tellam et al., (2008), found that groundwater recharge in Ghana would likely be reduced by 5% to 22% by the year 2020, and further reduce by 30% to 40% by the year 2050. This is a particularly noteworthy finding for the Upper East Region given that this region has the highest number of dams and dugouts in the country. Gardeners within the irrigation schemes are able to successfully prepare compost to boost the soil fertility in the event of incessant land use. The food security situation is fairly stable now in some areas due to the introduction of irrigation scheme as noted by Bagson and Kuuder (2013). Farmers engage in the cultivation of major staple food crops in the rainy season but now cultivate vegetables in the dry season (Bagson and Kuuder, 2013).

A number of technologies have been developed, tested and adopted by smallholder farmers across Sub-Saharan Africa, yet not all technologies are appropriate or productive under all conditions. Decision to adopt one or more of these strategies is influenced by such factors as access to and ownership of land, gender, location of households, source of farm inputs, household income and the impact of drought on households; also measured as a function of literacy level of household head, size of household, farm size, and access to credit (Egyir et al, 2014, Etwire et al., 2013).

#### *Soil and water conservation methods*

Soil and water conservation as adaptation practices to climate variability dates back into antiquity. Colonial efforts to conserve soil and water became paramount after the deleterious impact of over-cultivation and its attendant soil erosion of cultivable lands were detected. The forest-savannah transitional ecological Zone is an expanding zone along forest fringes where grassland is gradually replacing forest. The area extends from the northern part of Ashanti to the Brong-Ahafo region and the parts of the Northern regions of Ghana. In the northern part of Ghana, vulnerability assessment of irrigation farming communities in Kokoligu and Karni in the Upper West Region; and Veve in the Upper East Region of the Northern Ghana was conducted by the Green WaterHut of Ghana together with the Department of Environmental Studies of the University of

Development Studies. Other similar studies conducted included villages such as Sekyere-Odumase, Ejura, Kintampo, Takyiman and Attebubu. The results are discussed below.

Sequencing the cultivation of different crops throughout a field's cultivation history helps to response the soil fertility decline caused by continuous crop production. The sequence usually starts with the most demanding crop and ends with the crops requiring the least amount of soil fertility. Crop sequencing is usually combined with crop rotation. In doing this, certain crops that facilitate soil nutrient recovery as the legumes are used in the cultural processes. This practice limits soil nutrient depletion.

Crop rotation is combined with this method. Different crops follow periods in which a particular combination of crops is rotated. For example, a sequence may start with three years of sorghum, which may be followed with a period in which sorghum and millet are rotated on a yearly basis, to be replaced later by a groundnut, millet and vegetables rotation. This practice limits soil nutrient depletion and reduces the risk of plant disease and weeds. It also has the tendency to maintain the soil textural and structure considerably.

After a certain number of years a field is abandoned so that soil fertility can be regenerated through natural composting processes. Used extensively for bush fields but not for compound fields which instead receive organic matter inputs, the practice is more practiced in the forest-dominant areas in this *ecotone* than the savannah.

Selective clearing of the farmland whereby, an old fallow is taken into production again, serves as the basis of this method. During land preparation, a number of trees and shrubs are left on the field because of their edible fruits, medicinal properties or other qualities (Mazzucato and Niemeije, 2000b). In addition, when removed, shrubs and trees are usually cut about half a metre above the soil surface to facilitate regeneration once the field is put to fallow. This practice retains some soil cover, creates micro-climatic differences within the field and speeds up fallow regeneration.

Intercropping is one of the common practices used in the transition zone. In this wise, multiple crops are grown together on the same field, such as millet, sorghum, cowpeas and groundnuts. This practice reduces

soil nutrient depletion when leguminous crops such as cowpeas or groundnuts are included and improves the soil cover thereby reducing susceptibility to erosion. It also reduces the risk of total crop failure as some crops require more rainfall than others.

Rainfall is in one peak in some years and two peaks in other years, although the double maximum is more common. This variation in the distribution of rainfall shows the transition nature of the zone: between the Guinea Savannah to the north and the Forest to the south. The vegetation is a degraded forest with a wide range of tall grasses. Among the surviving forest relicts are *Antiaris*, *Phyllanthus* and *Elaeis*, while *Borassus*, *Lophira*, *Daniellia*, *Lonchocarpus*, *Pterocarpus*, *Burkea* and *Parkia* represent the Savannah intrusions. Similarly, among the grasses, the humid zone representatives include *Pennisetum purpureum* and *Panicum maximum* (Fianu et al. 2001).

The forest-savannah transitional zone of Ghana is characterised by fragile ecosystems that are critical for the livelihood of the local communities. The area is susceptible and vulnerable to climate variability and change that affect water and other natural resources in the ecosystems. Water conservation is required to reduce water usage while maintaining the continued viability of current water sources, particularly for agricultural purposes.

Again, in situations where precipitation is equal to crop requirements, the strategy is local conservation of precipitation, maximizing storage within the soil profile, and storage of excess run-off for subsequent use. For crops whose precipitation requirement is less than what is supplied, the strategies are to reduce rainfall-generated erosion, to drain surplus run-off and store it for subsequent use. As supplementary to rainfall, irrigation schemes are also developed to forestall water supply for crop cultivation. This is done especially during dry, seasons. Furthermore, control of run-off to reduce shortages of water availability have been practiced as mitigation and adaptation strategies to climate variability. They have also introduced supplementary irrigation technologies for inland valley water management through dams, stream channelling and dug-outs.

Adaptation measures and options vary according to sector, and may be constrained or enhanced by national or local conditions (Olmos, 2001). Some of these strategies are often deeply rooted in local cultures and

knowledge, as well as the focus of research, support and application by key international agencies and non-governmental organizations (Tubiello, 2012). In agriculture, for example, adaptation options could include adjustments to planting dates or changes in fertilization rates, irrigation applications, cultivar traits and selection of animal species (Olmos 2001).

This resonates well with Nzuma (2010), who found off-farm adaptation practices to climate change to include reducing consumption levels, rationing the amount of food consumed by each household member during droughts, collecting wild foods to supplement other foods, using inter-house transfers and loans, increasing petty commodity production, migration, selling assets such as agricultural tools and livestock, mortgaging land and obtaining credit from merchants and money lenders, using early-warning systems and appealing for food aid.

## **Nigeria**

### *Experiences from climate change*

Climate change is already having its toll on the citizenry of Nigeria particularly the southeast and southwest inhabitants where the study was conducted. Some of the respondents reported that climate change is not a new phenomenon as they noticed the change in climate as far back as fifteen years ago. According to them, the weather is no longer the same as it used to be, you cannot differentiate between rainy season and dry season as it were in the 60's and 70's. Even the harmattan season is now too harsh. Burning of trash during harmattan is now very risky as the fire could easily spread.

Generally, weather events are very irregular. However, majority of the households interviewed have farming as their major source of livelihood, hence depend on weather signal for the farming activities. They discussed their experiences of climate change as it affects their farming and the other enterprises they engage in. According to the respondents, climate change has numerous effects on their livelihood patterns. They complained of excessive sunlight and rainfall. According to them, for the past three years, they have been experiencing excessive rainfall which destroys their crops. A smallholder in Southeast zone of Nigeria reported that:

*“The duration of rainy season is shortened while the intensity of the rainfall is increased. Most of our crops are destroyed by thunderous rainfall, the remaining ones are swept away by the flood resulting from the rainfall”.*

This may not be surprising as the Nigeria meteorological agency (NIMET), (2010) report indicated experiences of extreme weather events in the country which includes significant rise in the intensity of rainfall (rainfall amounts exceeding normal means). The respondents also complained that excessive sunlight destroys their crops especially after planting. They further explained that in most cases, rain cease to fall after they have planted their crops causing all the seedlings planted to decay. This constitutes a major source of loss to their farming enterprise. Most of the vegetable farmers complained of sudden change of colour (colouration) of the vegetables planted. According to them, the vegetables after some time suddenly turn yellow, which normally happens after rainfall. They believe there are some chemicals in the rains that cause this to happen. Pests and unfamiliar diseases sometimes invade our vegetable farms. The rains do not only disrupt our planting, it sometimes constitute problem during harvesting. Harvesting periods are usually not periods of heavy rainfall, as surprisingly, they experience sudden heavy rainfall during harvest period. The decay and discolouration of vegetables affects their income as most of the vegetables are lost to those weather events, leaving them with barely enough quantity to feed their family with and a little to sell in few occasions. Other respondents in different enterprises shared their experiences as follows:

Constant rainfall evenly spread results in abundance of palm kernel as well as juicy and ruddy nuts but due to the erratic nature of rainfall, palm kernels are not very ruddy again even the yield is not very encouraging. The quantity of palm oil produced from the kernels has drastically reduced. Respondents also complained of drying up of kolanuts during excessive harmattan. According to them, harvested kolanuts last over a long period of time under normal temperature range, but during excessive harmattan, their shelf life is shortened leaving many of them dried up. Cassava seems to be relatively resistant to extreme weather events as the respondents reported that the production is not so affected by the change in rainfall. Only those into processing cassava into *gari* (cassava chips) complained that the rain affects their work. Those into cocoyam production also complained that excessive harmattan affects cocoa production as it normally dries up cocoa before maturity. They further

explained that it is not only harmattan that affects cocoa production, general irregularity in weather has had severe effect on cocoa production. According to them, they use to produce cocoa in very large quantities in the area but unfortunately the reverse is the case now as a result of weather irregularities.

Respondents that are involved in petty trading especially those that deal on foodstuffs complained that change in climate also affects them in the sense that they find it difficult to see robust and healthy products to buy. Even the unhealthy products they buy are expensive and difficult to sell, affecting their rate of sales and consequently their profit margin. Some complained of persistent diseases like malaria which was not so in the olden days. They explained that diseases like malaria, diarrhoea, headache cough were easily taken care of with local herbs in the 60's and even early 70's, but this is not so as those diseases seem to be resistant to those herbs. They believe that the change in climate has affected the potency of drugs. The herbs sometimes are not seen again in the bushes. They also complained that many medicinal herbs that were formally part of their menu are no longer consumed. According to them, the younger generation do not accept the consumption of these leaves thereby making them vulnerable to many diseases as their immune system is low.

#### *Adaptation strategies to climate change*

The major effects of climate change on the respondents in this study results from variations in rainfall, sunshine and temperature. Several strategies are employed by respondents to adapt to climate change. Though some of these methods are crude technologies invented by the farmers, it seems to be relieving the effects of climate change on the respondents. The respondents reported that they dig wells round the '*akuro*' (flat plains for dry season farming) to get water for their vegetables during cessation of rainfall. They also apply fertilizers to improve their crop yield, apply herbicides and pesticides on crops to reduce pests, practice fallowing to improve fertility of the soil (though this does not seem to help much). Some of them also resorted to petty trading and other businesses like production of local stoves, frying of *puff-puff* and *akara* (local beans cake) in order to make ends meet. Diseases are no longer treated with one herb as done in the olden days, they now combine various herbs to have better result. Also, there is increasing emphasis on consumption of herbs as was done in the olden days to help improve immune system of the villagers.

Similarly, Ifeanyi-obi (2014) identified numerous climate change adaptation measures used by farmers in southern Nigeria to include planting of different varieties of crops, early harvesting of crops, use of different planting dates for crops, use of pest and disease resistant species of crops, undertaking of non-farming income generating activities, increase reliance on family labour to reduce cost of production, more frequent weeding, increase planting of cover crops to reduce heat stress on crops, use of indigenous knowledge to combat climate change effects, increase in farm size, treating seeds with fungicides before sowing, use of herbicides to reduce high rate of weed infestation, use of more drought tolerant species of crops, harvesting early when adverse dry weather is expected, increase use of fallowing to enable farm land replenish, increase planting by the river side, combination of crop production and livestock management to increase income, use of farm yard manure to improve soil fertility, application of pesticides, moving to a better farmland and use of information from agricultural extension agents.

#### *Role of indigenous knowledge in climate change adaptation*

Most of the adaptation strategies used by the respondents in this study are indigenously invented. This is indicative of the important role indigenous knowledge play in climate change adaptation. Indigenous peoples are the major occupants and users of world land surface thus making them knowledgeable in environmental issues. With most of their livelihood activities dependant on agriculture, they are known to be excellent observers and interpreters of change in the environment. Indigenous knowledge offers valuable insights as well as compliments scientific data that is critical for developing effective climate change adaptation measures. The IPCC (2007) assessment noted that indigenous knowledge is an invaluable basis for developing adaptation and natural resource management strategies in response to environmental and other forms of change.

In addition, while climate change poses a growing threat to the global community, the indigenous people are known to be more vulnerable. Excluding them from global processes of decision and policymaking on climate change adaptation not only deny policy makers the insight from their local experiences, it also contributes to their non-challant attitude towards effective adaptation measures proffered by these scientists and policy makers. Farmers are known to be more committed to

programmes to which they are involved in the planning, it is therefore important to recognise their indigenous knowledge in planning climate change adaptation.

Furthermore, some of the globally proffered climate change adaptation measures instead of alleviating the impacts of climate change on the indigenous people increases the impacts of climate change on them, thus undermining their livelihoods even more. Some of these measures contradict their traditional beliefs and in some cases weaken their customary rights (e.g. land ownership) thereby impairing their resilience. What about result on soil and water conservation as we have for Ghana?

### *Practical lessons*

#### *Prospects*

As identified in the above discussions in Nigeria and Ghana, it is clear that indigenous communities are more than willing to innovate new ideas based on indigenous experiences as a way of supporting themselves towards climate change adaptation. Most indigenous communities are generally inhabited by farmers and hence the biggest impact of climate change is the rainfall variability and as a result, emphasis by indigenous communities is towards strategies and solutions at improving soil fertility and water retention. Efforts however by small scale farmers using soil and water conservation have proven as reliable solutions towards improving crop yield. High crop yield is an indicator for good harvest and subsequently, more returns on investment. As long as there are returns from farming, farmers can make use of the economic gains at supporting their daily needs such as education of their wards, improving housing conditions, access to safe sanitation and to potable water. In a whole, farmers become better economically empowered over time to have in-built capacities towards climate change effects such as droughts or floods or extreme temperatures.

The availability of mobile phones for farmers have proven as a laudable way through which farming associations within a country can share knowledge and experiences towards improving their crop yield and further preparing themselves towards climate adaptation. There are a number of useful case studies where farmers have used this communication technology to have improved knowledge on forecast of weather conditions

and value for farming – through market information. It is believed with the provision of more support with farmer-based applications on the mobile phone, small scale farmers can over time develop virtual associations through which experiences and vital indigenous skills can be shared towards a holistic long-term impact on climate change adaptation in both Nigeria and Ghana.

Also, engaging indigenous people in international discourse on climate change is very necessary as this will help to better understand their level of vulnerability and the effects of climate change on them thereby proffering climate change adaptation strategies that close the gap between indigenous knowledge and climate science.

### *Challenges*

Though farmers may be engaging in indigenous knowledge, the up-scaling of such skills and experiences from the government has been inadequate. Efforts may have been made by Non-Governmental Organisations and private organisations to identify which indigenous practices are scalable and replicative for other communities but, the lack of full national support does not sustain such initiatives. It is imperative to combine indigenous knowledge with expertise skills and support from government or relevant institutions to be able to upscale the work being done by such farmers. From Ghanaian perspective, the recent support from International Monetary Fund and similar organisations have often restricted the support for farmer initiatives and hence to a long term, dampened the spirit of farmers to adapt or put in efforts to mitigate disasters related to climate change.

### **Conclusion**

The study assessed the indigenous adaptation strategies in parts of Ghana and Nigeria amid varying impacts of climate change. The results show that there is a general concern among farmers in both countries that weather patterns have significantly changed over time. This change in weather has also significantly affected their cropping patterns, crop yield and hence, their income levels.

Notwithstanding, these challenging experiences by farmers, they are adapting using simple techniques such as soil-water conservation,

selection of suitable varieties of crop, early harvesting of crops, use of different planting dates for crops, use of pest and disease resistant species of crops, increase reliance on family labour to reduce cost of production, more frequent weeding, increase planting of cover crops to reduce heat stress on crops, use of indigenous knowledge to combat climate change effects, increase in farm size, treating seeds with fungicides before sowing and use of herbicides to reduce high rate of weed infestation.

Farmers have also decided to engage in alternative livelihood options such as trading to support their daily subsistence. In Ghana and Nigeria, the results confirm that farmers in both study areas show similar trends in adapting to issues of climate change. The authors believed strongly that, if farmers could be supported financially and through extension services and introduction of scientific technologies to complement indigenous knowledge approaches, this could leverage the current efforts been used for adapting towards climate change.

### **Acknowledgments**

We wish to thank the CIRCLE and our supervisors Prof. J. Olawoye, Prof. A. Togun, Dr I.O. Azeez and Dr Chuks. J. Diji for their support on this paper. We also thank Dr E. Owoaje for her commitment to the CIRCLE Visiting Fellowship programme in the University of Ibadan.

### **References**

- Adger, & N., W. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. *World Development*, (27), 249–6.
- Adger, W. (2003). Social capital, collective action, and adaptation to climate change. *Economic Geography*, 79(4), 387–404. Retrieved from [http://link.springer.com/chapter/10.1007/978-3-531-92258-4\\_19](http://link.springer.com/chapter/10.1007/978-3-531-92258-4_19)  
Include date assessed for the online references
- Asante, F., & F. Amuakwa-Mensah (2014). Climate Change and Variability in Ghana: Stocktaking. *Climate*, 3(1), 78–99. doi:10.3390/cli3010078
- Dampney, P.T.M. (2011). By Patience T. M. Dampney Paris, January 27-28, 2011.
- Ribot, J.C. (1996). Climate variability, climate change and vulnerability: Moving forward by looking back. In *Climate variability, climate change and social vulnerability in the semi- arid tropics*, ed. J.C. Ribot,

- A.R. Magalhães, and S.S. Panagides, 1-10.1996. Cambridge, .  
*Cambridge University Press*.
- Sarah, N.W. and D.A. (2005). Technical paper linkages between poverty and climate change: adaptation for general introduction□:
- Tellam, I., Agyemang-bonsu, W.K., & Kemp-benedict, E. (2008). Netherlands Climate Assistance Programme Ghana Country Report, (July), 1-24.
- Yaro, J.A. (2013). Building Resilience and Reducing Vulnerability to Climate Change: Implications for Food Security in Ghana, (August 2013), 14.
- Akoh, B. (2012). Supporting Multi-stakeholder Internet Public Policy Dialogue in a Least Developed Country: The Togo Experience. *International Institute for Sustainable Development*. Retrieved from [http://www.iisd.org/pdf/2012/internet\\_policy\\_dialogue\\_togo.pdf](http://www.iisd.org/pdf/2012/internet_policy_dialogue_togo.pdf)
- Antwi-Agyei, P., A.J. Dougill and L.C. Stringer (2013). Barriers to climate change adaptation in sub-Saharan Africa□: evidence from northeast Ghana & systematic literature review. Centre for Climate Change Economics and Policy Working Paper No. 154 Sustainability Research Institute Paper No. 52, pp.1-30. <http://doi.org/10.1/17565529.2014.951013>
- Asante, F.A and F. Amuakwa-Mensah (2015). Climate Change and Variability in Ghana: Stocktaking. *Climate*, 3, 78-99.
- Bagson, E. and C.J.W. Kuuder (2013). Assessment of a Smallscale Irrigation Scheme on Household Food Security and Leisure in Kokoligu; Ghana. *Research on Humanities and Social Sciences*, Vol.3 (1):
- Buah, J.N., G.C. Van der Puije, E.A. Bediako, E.A. Abole and F. Showemimo (2010). The Growth and Yield Performance of Oyster Mushroom (*Pleurotus ostreatus*) on Different Substrates. *Biotechnology*, 9: 338-342.
- Codjoe, F.N.Y., C.K. Ocansey, D.O. Boateng and J. Ofori (2013). Climate Change Awareness and Coping Strategies of Cocoa Farmers in Rural Ghana. *Journal of Biology, Agriculture and Healthcare*, 3(11), 19-30.
- Etwire, M. P., R.M. Al-Hassan, J.K.M. Kuwornu and Y.O. Owusu (2013). Smallholder farmers' adoption of technologies for adaptation to climate change in Northern Ghana, *Journal of Agricultural Extension and Rural Development*, 5(6): 121-129.
- Fianu, F.K., S.C. Fialor, S. Asante Mensah (2001). *Commercialisation channels of distribution of forage seeds in Ghana*. Consultancy Report. UK Department for International Development/Ministry of Food and Agriculture, Accra, Ghana.

- Kwame Oppong-Anane (2006). Ghana Country Pasture/Forage Resource Profiles Research and Extension, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy, 20p.
- Linham, M.M. and R.J. Nicholls (2010). Technologies for Climate Change Adaptation: Coastal Erosion and Flooding. Roskilde, Denmark, UNEP Ris Centre on Energy, Climate and Sustainable Development, 150p.
- Linham M., C. Green and R. Nicholls (2010). *Costs of adaptation to the effects of climate change in the world's large port cities*. Work stream 2, Report 14 of the AVOID programme (AV/WS2/D1/R14). Available online at [www.avoid.uk.net](http://www.avoid.uk.net)
- Mabe F. N., G. Sienso and S. Donkoh (2014). Determinants of Choice of Climate Change Adaptation Strategies in Northern Ghana. *Research in Applied Economics*, Vol. 6, (4): 75-94.
- Mazzucato and Niemeijer (2000). Rethinking Soil and Water Conservation in a Changing Society: A Case Study in Eastern Burkina Faso, Wageningen, Wageningen University.
- Mazzucato V. and D. Niemeije (2000). The Cultural Economy of Soil and Water Conservation: Market Principles and Social Networks in Eastern Burkina Faso. *Development and Change*, Vol. 31 (2000), 831-855.
- Narayana, D. and R. Babu (1985). Closure to "Estimation of Soil Erosion in India" by Dhruva V.V. Narayana and Ram Babu (December, 1983). *Journal of Irrigation and Drainage Engineering* 111(4): 408-410.
- Nkegbe P.K. and N. Kuunibe (2014). *Climate variability and household welfare in northern Ghana*. WIDER Working Paper 2014/027. World Institute for Development Economics Research, 17pp.
- Nyantakyi-Frimpong, H. (2013), 'Indigenous Knowledge and Climate Adaptation Policy in Northern Ghana', Africa Portal Backgrounder No 48, Available at: [www.africaportal.org](http://www.africaportal.org) (Accessed 20 July 2015).
- Nzuma, J.M. (2010). Strategies for Adapting to Climate Change in Rural Sub-Saharan Africa A Review of Data Sources, Poverty Reduction Strategy Programs (PRSPs) and National Adaptation Plans for Agriculture (NAPAs ) in ASARECA Member Countries. *Food Policy*, 1013(July), 64. Retrieved from [http://www.eis-africa.org/EIS-Africa/2ifpri\\_review.pdf](http://www.eis-africa.org/EIS-Africa/2ifpri_review.pdf)
- Olesen, J.E., N. Chirinda and S.G. Adiku (2013). Climate Change Impacts on Crop Productivity and Possible Adaptations in Ghana. In (Asafo-Adjaye, J. ed.); *Climate change in Ghana: impacts on agriculture and the policy implications*. *Ghana Policy Journal Special Edition on Climate Change*, pp40-57.

- Olmos, S. (2001). Vulnerability and adaptation to climate change: concepts, issue, assessment methods. *Climate Change Knowledge Network Foundation Paper*, (July), 20.
- Tachie-Obeng, E. P.B.I. Akponikpe and S. Adiku (2013). Considering effective adaptation options to impacts of climate change for maize production in Ghana. *Environmental Development* 5 (2013): 131-145.
- Tellam, I., W.K. Agyemang-Bonsu and E. Kemp-Benedict (2008). Netherlands Climate Assistance Programme Ghana Country Report, (July), 1-24.
- Tellam, I., W.K. Agyemang-bonsu and E. Kemp-benedict (2008). Netherlands Climate Assistance Programme Ghana. Country Report, (July), pp.1-24.
- Tubiello, F. (2012). Climate Change Adaptation and Mitigation: Challenges and Opportunities in the Food Sector; Natural Resources Management and Environment Department, FAO: Rome, Italy. Retrieved from [http://www.cifor.org/publications/pdf\\_files/articles/APham1401.pdf](http://www.cifor.org/publications/pdf_files/articles/APham1401.pdf)
- Uddin, M., W. Bokelmann and J. Entsminger (2014). Factors Affecting Farmers' Adaptation Strategies to Environmental Degradation and Climate Change Effects: A Farm Level Study in Bangladesh. *Climate*, 2(4): 223-241. <http://doi.org/10.3390/cli2040223>.
- Yaro, J.A. (2013). Building Resilience and Reducing Vulnerability to Climate Change: Implications for Food Security in Ghana, (August 2013), 14. Retrieved from [http://www.fesghana.org/uploads/PDF/FES\\_ResilienceVulnerability\\_CC\\_Ghana\\_2013\\_FINAL.pdf](http://www.fesghana.org/uploads/PDF/FES_ResilienceVulnerability_CC_Ghana_2013_FINAL.pdf).