Local Knowledge and Community–Based Assessment of Environmental Change in Ghana

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Abstract

Although much scientific knowledge exists about global environmental change, two kinds of limitations arise: limited scientific understanding about first, localized geographic specificities and second, the perspectives of the affected populations, the communities. This paper contributes to an understanding of local knowledge on environmental change through Community Risk Assessment (CRA) in Ghana. Qualitative methods of data collection, particularly Participatory Rural Appraisal (PRA) methods were employed for data collection and complemented with a survey of 200 farmers. The paper highlights three key findings. First, it underscores the potential role of local knowledge in CRA and in contributing to an understanding that environmental change has been primarily negative, as in a deteriorating climate and the natural environment. Secondly, that local knowledge on vulnerability to climate change revealed multiple exposures to climatic extremes such as drought, heavy rainfall, floods and rainstorms. However, drought and rainstorms were identified as the highest risk stressors with disruptive or damaging consequences on livelihoods of local populations. Communities also had their knowledge of change in the natural environment. The primary stressors of environmental change were identified as deforestation and land degradation and anthropogenic factors as the primary drivers of such changes. Thirdly, that there is great potential for a role of local knowledge in environmental change research and adaptation in Africa and wherever such knowledge exists. This is because the outcomes are both scientific and relevant for Environmental Change Mitigation and Adaptation Planning (ECMAP).

Key words: Local Knowledge, Community Risk Assessment, Environmental Change, Planning, Ghana

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Introduction

One of the greatest challenges of development in Africa in the 21stCentury is how to deal with climate change in all facets of life. The major concerns for development policy at the local level should be twofold: first, what are the dimensions and extent of climate variability, and second, what mitigation and adaptation measures can achieve sustainable development? Both aspects are important for informing policy, particularly in the context of the post Millennium Development Goals (MDG) and Sustainable Development Goals (SDGs) that came into force in September 2015. The nature of climate change and extent of climate variability at local levels, particularly from community based perspectives and or perceptions from indigenous knowledge systems, is the subject of interrogation in this paper. There are several concerns of the dimensions and potential impacts of climate change in Ghana. The Ghana Climate Change Policy Framework has outlined the impacts of climate change as including increased temperatures; rainfall variability, including unpredictable extreme events; sea-level rise; and increasing greenhouse gas emissions and loss of carbon sinks (MEST, 2012). A study of rainfall patterns in Ghana by Owusu and Waylen (2008) shows that mean annual rainfall totals declined between 1951 and 1970, and also between 1981 and 2000across all four agro-ecological zones in the country. According to Owusu and Waylans (2008), large-scale rainfall deficits have the potential to destroy plant cover, reduce evapotranspiration, increase surface albedo, and affect other aspects of water and energy balance, which can set in motion a long period of below-normal rainfall. Changes in the onset of rainfall alter the normal rainfall pattern and may seriously affect crop yields even in instances of slow changes (Ofori-Sarpong, 1998). Climate variability, particularly rainfall variability, is one of the major factors affecting livelihoods. The predicted changes in climate will have adverse social and environmental impacts on human well-being, food security and water availability (Cameron, 2011). Based on observed historical rainfall patterns in Ghana (Oguntunde et al., 2006), it is predicted that the northern half of the country will bear the brunt of climate change effects (Minia, 2004; EPA 2000; Dietz et al., 2004;Yaro, 2010). The north suffers highly unpredictable rainfall patterns which impose drought and flooding conditions, with consequences on crop yield variability and food insecurity (Dietz et al., 2004; Van de Giesen et al., 2010). The northern part of Ghana has suffered from several droughts and floods. In 2007, floods wiped out the entire infrastructure and livelihoods of many farm households in the Upper East, Northern and Upper West regions (NADMO, 2007). Thus, such extreme climatic events are likely to have significant impacts on rain-fed agriculture in Ghana in the future.

In the past and up to date, traditional communities have and continue to rely heavily on their own indigenous knowledge systems for observing the environment and dealing with natural hazards. These communities, particularly those in hazard prone areas, have collectively generated a vast body of knowledge on disaster prevention and mitigation, early warning, preparedness and response. This knowledge is obtained through observation and is often based on cumulative experience handed down from generation to generation (Pareek and Trivedi, 2011). Indigenous peoples are vital and active parts of many ecosystems and have the potential to enhance the resilience of these ecosystems. Their livelihoods depend on natural resources that are directly affected by climate change and variability, and they often inhabit economically and politically marginal areas in diverse, but fragile ecosystems. In addition, they interpret and react to climate change impacts in creative ways, drawing on traditional knowledge as well as new technologies to find solutions, which may help society to cope with the impending changes (Jan and Anja, 2007).

The perspectives of the indigenous people, the way they think and behave in relation to climate change and variability, as well as their values and aspirations have a significant role to play in addressing and managing climate change and its impacts (Doss and Morris, 2001). Despite this potential, indigenous and other traditional peoples are rarely considered in academic and policy discourses on climate change, although they are greatly impacted by changes in climate (Berkes and Jolly, 2001). Further, although the Intergovernmental Panel on Climate Change (Parry et al, 2007) underscores the importance of indigenous knowledge for dealing with climate change, governments throughout Africa continue to undervalue the role of indigenous knowledge in national climate change adaptation policies (Nyantakyi-Frimpong, 2013). To this end, while incorporating indigenous knowledge into project design has yielded some sustainable outcomes in the work of some non-governmental organizations, little attention has been given to the role of indigenous knowledge systems in climate change adaptation policy frameworks and strategies for implementation. This is basically due to overconcentration on scientific and conventional approaches (Gyampoh et al., 2011).

Invariably, these scientific approaches, including the application of climate models, have been used in various ways to predict future climate scenarios in most countries. However, these models paint the bigger picture of climate change and provide estimates for the likely consequences of different future scenarios of human development; they are not very good at providing information about changes at the local level. In recent years, there has been an increasing realization that indigenous groups are a valuable source of this information. Indigenous peoples are not only keen observers of climate change, but are also actively trying to adapt to the changing conditions. In some instances, people can draw on existing mechanisms for coping with short term adverse climatic conditions. Some of these responses may be part of their normal traditional subsistence activities, while others may be acute responses, used only in case of critical weather conditions (Stott and Kettleborough, 2002).

In Ghana, the majority of the population are still dependent on traditional approaches to sustenance and livelihoods. Efforts to enhance productivity in sectors such as agriculture using conventional and technological approaches have been hugely inadequate, leaving most farmers and rural dwellers to continually utilize and devise their own indigenous and traditional modes of sustenance. Despite the fact that efforts have been made towards dealing with climate change from the perspective of western scientific logic, research and policies directed towards indigenous knowledge and perceptions are needed for appropriate policy responses that reduce the vulnerability of local populations and enhance their cultural resilience and adaptive capacity. In the light of this, it is important to understand indigenous perceptions of climate change (Gyampoh et al., 2011), and thus in the context of this paper, to examine and analyze how local communities assess environmental change using their local knowledge.

To address this research agenda, this paper is structured in six sections. In the next section (section two), the conceptual framings on Community Risk Assessment (CRA) and local knowledge systems are presented as the theoretical bases for the paper. This is followed by a description of the study area and context in section three. Section four entails a description of the methods of data collection and analysis. The empirical analysis and discussions are done in section five. This discussion is expanded in section six to highlight the connection between local knowledge, environmental change research and adaptation. Section six is devoted to the conclusion and some policy recommendations for Environmental Change Mitigation and Adaptation Planning.

Community Risk Assessment: Potential Role of Local Knowledge

Community Risk Assessment

In general, Risk Assessment (RA) is a process to determine the nature and extent of risk, by analyzing hazards and evaluating existing conditions of vulnerability that could potentially harm exposed people, property, services, livelihoods and the environment on which they depend (UNDP, 2010).Risk assessment is basically the identification of potential and likely risks within a particular community, and the process of prioritizing those risks (Stuoffer, n.d). A comprehensive risk assessment does not only evaluate the magnitude and likelihood of potential losses but also provides full understanding of the causes and impact of those losses. Risk assessment is therefore an integral part of decision and policy-making processes and requires close collaboration among various parts of society (UNDP, 2010).It is the critical initial step in emergency preparedness, which enables organizations to eventually mitigate (if possible), plan, prepare and deploy appropriate resources to attain a desired outcome (Stuoffer, n.d).In the context of climate change, risk assessment refers to any impact assessment that considers the uncertainty associated with the consequences of climate change in a specific area of interest. In most cases, a climate risk assessment should analyze climate risks resulting from current climate conditions and trends, as well as future, long-term climate projections (World Bank, n.d).

In general, Community Risk Assessment (CRA) is a generic term adopted by the ProVention Consortium to cover the many methods used by non-governmental organizations (NGOs) and other organizations to assess local and community vulnerability and adaptive capacity. Thus, CRA refers to participatory methods for assessing hazards, vulnerabilities and capacities in support of community-based disaster risk reduction (van Aalst et al., 2007). According to the UNDP (2010), there are two levels of risk assessments: national and local. A national risk assessment is a strategic risk assessment that supports the design of national disaster risk reduction strategies, policy and regulations, disaster risk management programming, and budget allocation. However, a local risk assessment is an operational risk assessment for disaster risk reduction action planning, contingency planning, pre-disaster recovery planning, and proper community planning. The latter represents Community Risk Assessment (CRA).From the review, we note that CRA is essentially about mapping and analyzing vulnerability arising from exposure to 'environmental' hazards, as in the generic understanding of environment and adaptive capacity through Participatory Rural Appraisal Methods (PRA) at local and community levels.

Risk assessment guides the optimal allocation of scarce resources available to the phases of disaster risk management (DRM). By identifying and assessing the likelihood and consequences of potentially disastrous events, risk assessment provides the basis for the prioritization of investments in disaster risk reduction, the improvement of emergency management capabilities and the design of financial protection strategies in a manner tailored to local conditions, needs and preferences. The results may be used to inform and educate all relevant stakeholders about the most important threats society faces and thereby contribute to a culture of risk consciousness and management amongst communities and individuals. Risk assessment is thus an essential prerequisite for the full array of DRM plans and policies that contribute to overarching governmental objectives of reducing society's vulnerability and enhancing its resilience. Communities need to identify the broad range of natural and man-made hazardous events and assess those that could cause significant damage and disruption to their vital interests (G20 and OCED, 2012).

Conceptualizing Local Knowledge

Local knowledge, indigenous knowledge and traditional knowledge are terms used interchangeably to mean knowledge held by local people, outside the formal scientific domain (Ogallo, 2011).In the view of Nakashima et al. (2012), local knowledge refers to know-how accumulated across generations which guide human societies in their innumerable interactions with their environment. Berkes (2012: 7) defines such traditional ecological knowledge as: 'a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment'.

Traditional knowledge is the knowledge, innovations and practices of indigenous and local communities around the World. It is developed from experience gained over the centuries, adapted to the local culture and environment and transmitted orally from generation to generation. It tends to be collectively owned and takes the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language and agricultural practices, including the development of plant species and animal breeds. Sometimes it is referred to as an oral tradition, for it is practiced, sung, danced, painted, carved, chanted and performed over millennia. Traditional knowledge is mainly of a practical nature, particularly in agriculture, fisheries, health, horticulture, forestry and environmental management (United Nations Convention to Combat Desertification, 2012).

According to Kirkland (2012), indigenous knowledge means the understanding of the local environment developed by communities over the last several millennia. It also refers to the practices, techniques, and technologies used by these communities to ensure food security in the face of climate variability. Local or indigenous knowledge refers to the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For rural and indigenous peoples, local knowledge informs decision-making about fundamental aspects of day-to-day life. This knowledge is integral to a cultural complex that also encompasses language, systems of classification, resource use practices, social interactions, ritual and spirituality. These unique ways of knowing are important facets of the world's cultural diversity and provide a foundation for locally-appropriate sustainable development (United Nations Educational, Scientific and Cultural Organization, 2013). Thus, indigenous knowledge (IK) refers to the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area. The development of IK systems covering all aspects of life, including the management of the natural environment, has been a matter of survival to the people who generated these systems. Such knowledge systems are cumulative, representing generations of experiences and careful observations, and generated through trial-and-error experiments (Grenier, 1998).

The pattern of flows of such indigenous and/or local knowledge is geographically localized and primarily diffused through kinship and social ties, particularly in the case of the *Atankwidi* basin in northeastern Ghana (Derbile and Laube, 2014). IK systems are also dynamic: new knowledge is continuously added. Such systems do innovate from within and also will internalize, use, and adapt external knowledge to suit the local situation (Grenier, 1998).

The Case for Local Knowledge in Community Risk Assessment

In this paper, we adapt CRA as an appropriate conceptual framework for analyzing the role and/or potential role and relevance of local knowledge in conducting CRA of environmental change at the local level in Ghana, and in the Wa Municipality in particular. Thus, we assume that CRA involves mapping and analyzing community vulnerability to environmental hazards by drawing on the local knowledge of local populations through Participatory Rural Appraisal (PRA) at the community level. Environment is applied in a holistic sense as comprising the physical, social, cultural and economic environments.

Local knowledge is relevant to CRA because it allows for and facilitates genuine community participation, application of PRA tools and development. Local knowledge on environmental change is built through the experiences and observation of the local people over a long period of time (at least a decade). The knowledge built shapes the understanding of the people with respect to environmental change. This understanding is important for informing policies targeted at building adaptive capacities. An underlying appeal of indigenous knowledge in the area of assessing climate change and its consequences is that, knowledge gained through the tested experiences and observations of local communities may offer useful insights about changing trends and patterns of the seasons and weather. It has also been argued that indigenous knowledge focuses on the local timing and impacts of weather and climatic events and it is communicated in a local language – all of which foster local acceptance and use (Lefale, 2009; Green and Raygorodetsky, 2009). There is also agreement that complementing indigenous knowledge with that of scientific knowledge improves adaptive capacity.

The Study Area and Context

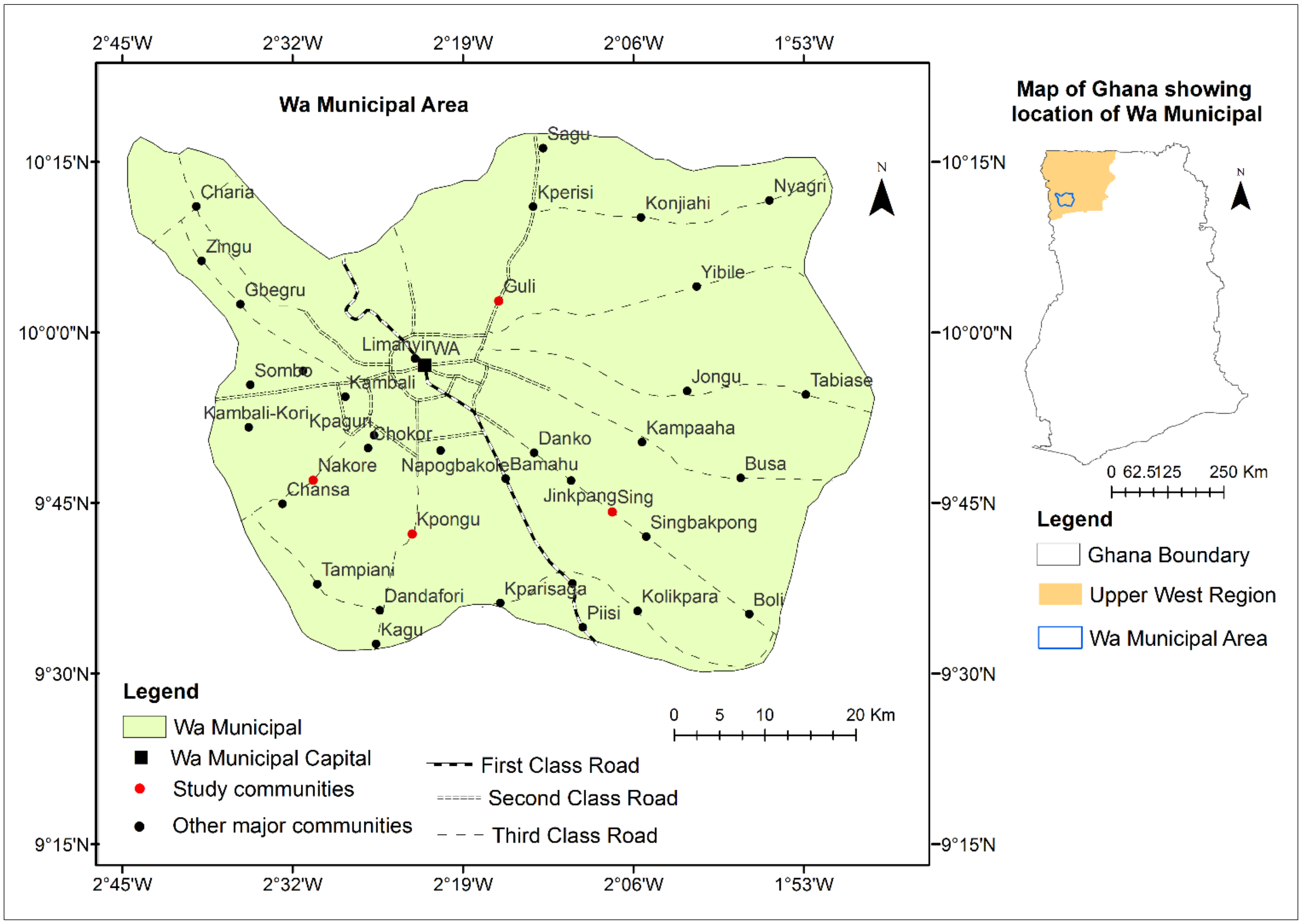
This study was conducted in four rural communities in the Wa Municipality of the Upper West Region, Ghana (Figure 1). The Wa Municipality is predominantly an agriculture area and has a landmass of approximately 234.74 square kilometers, 6.4% of the region's land mass. The Municipality is part of the Savannah high plains, gently undulating with an average height between 160m and 300m above sea level. The gentle rolling nature of the landscape or topography supports agriculture (Wa Municipal Assembly, 2010). The main drainage systems are the *Sing-Bakpong* river and its tributaries to the south and *Billi* and its tributaries to the north. The streams dry up during the long dry season, thereby reducing the availability of water for agriculture and industrial activities (Wa Municipal Assembly, 2010).

The types of rocks which underlie the Municipality are predominantly Pre-Cambrian, granite and metamorphic, with low weathering due to low rainfall, high evapo-transpiration and less vegetation. These rocks have given rise to two main types of soil in the Municipality, laterite and the savannah ochrosols. The laterite is predominant in the Municipality and is excavated for roads and housing construction. Similarly, sand is abundant in the municipality. Sand winning is done along roads and in river beds, but much of the activity is done at Nakore. The savannah ochrosols are shallow but support the growth of a variety of crops including millet, sorghum, soya beans, groundnuts, rice and yams (Wa Municipal Assembly, 2010).There isalso evidence of clay in Charia, a community famous for pottery. The rocks also have mineral deposits and this has led to gold mining and stone quarrying, but also positive and negative socio-economic and environmental impacts (Wa Municipal Assembly, 2010).

The vegetation is the Guinea Savannah grassland, made up of short trees with little or no canopy and shrubs of varying heights and luxuriance, with grass ground cover in the wet season. Common indigenous trees are shea trees, *dawadawa*, Kapok and *Baobab*. Cashew and mango are exotic species that also grow well in the area. Part of the natural tree vegetation is disappearing due mainly to human activities such as cultivation, construction, overgrazing, bush fires and charcoal-burning. The people have also relied on the plant species for the extraction and preparation of herbal medicine, particularly in the days predating scientific medicine. The neem tree in particular is useful for the preservation of seeds and also for the treatment of malaria. The vegetation, in combination with the climatic condition, supports livestock rearing, including large and small ruminants (See Wa Municipal Assembly, 2010).

Generally, the Municipality has two marked climatic seasons, namely the wet and dry seasons. The South-Western Monsoon winds from the Atlantic Ocean bring rains between April and October, whilst the North-Eastern Trade winds from the Sahara Desert bring the long dry season between November and March. The mean annual rainfall varies between 840mm and 1400mm. Most of the rainfall occurs between June and September, and is generally low and unreliable both in its timing and duration.

Figure 1: Map of Wa Municipality and the study Communities



Source**:** Adapted from Wa Municipal Assembly, 2014.

However, it is not unusual to have very high rainfall figures concentrated in a few rainy days. One feature of the rainfall pattern is that it tends to occur in heavy downpours, thus encouraging run-off rather than soil moisture retention. An erratic rainfall regime is clearly shown in the water balance, which is a reflection of the poor soil moisture condition in the area. It is estimated that there are only four humid months, in terms of soil moisture conditions suitable for the cultivation of crops such as millet, guinea corn, yam, groundnuts and beans. Even during the rainy season, it is not unusual for drought to adversely affect yields. The long dry season and the erratic rainfall pattern hinder all-year-round farming and facilitate bush-burning (Wa Municipal Assembly, 2010).

Methods of Data Collection and Analysis

The CRA was conducted in two phases in the Wa Municipality of the Upper West Region of Ghana (Figure 1). In the first phase, the assessment drew primarily on qualitative methods of data collection and analysis. The qualitative data was collected through PRA methods, particularly key informant interviews (KIIs) and focus group discussions (FGDs) in 2 randomly sampled in-depth study communities, *Nakore* and *Kpongu.* These communities were randomly sampled from a list of 20 largest communities (excluding Wa) in the municipality (See Ghana Statistical Service, 2010). However, Wa was excluded because the assessment had a rural focus in a project context and by design. In-depth interviews were conducted among key informants with the aid of a checklist. The sampled respondents included chiefs, earth priests, opinion leaders and women's leaders, including leaders of women's groups. A total of 14 key informant interviews (KIIs) were conducted in the two in-depth study communities. FGDs were conducted among carefully sampled categories of discussants with the aid of an FGD guide. These included male farmers, female farmers, female traders and/or agro-processors. A total of 6 FGDs were conducted, 3 in each community, and the number of discussants ranged from 9 to 12 per session. This phase of the assessment provided in-depth insights into the risks to environmental change, perspectives on the causes of change and the implications on livelihoods. A three generational framework provided guidance for analysis of environmental change and risks. This framework comprised the present generation of respondents (as the son's generation), the fathers' generation (the parents of respondents) and the grandfathers' generation (the grandparents of respondents).

The qualitative data was analyzed through transcription, detailed description, paraphrasing and use of boxes.

In the second phase, a survey was conducted among 200 randomly sampled farmers in four communities. The communities included the two in-depth study communities and two additional communities, *Sing* and *Guli*which were randomly sampled from a list of farming communities. Findings from the qualitative assessment informed the design of the questionnaire that was used for conducting the survey. Systematic random sampling was used for sampling households while simple random sampling was applied for sampling respondents at the household level. The total study population comprised 1567 adult farmers aged 30-64 years who had at least a decade of experience in farming or any other agro-related livelihood (Table 1).

Table 1: Population and sample distribution

Name of Community	Population aged 30 to 64 years	Sample	
		Number	Percentage
Kpongu	709	80	40
Nakore	386	60	30
Sing	294	40	20
Guli	178	20	10
Total	1,567	200	100

Source: Derived from Ghana Statistical Service (2010:27, 66)

Targeting the population of such age groups was deemed appropriate. This is because such life time experience was important for respondents' understanding and analysis of environmental change over time and the associated risk. The sample size of 200 farmers was distributed among the communities using proportionate quota sampling in order to minimize biases (Table 1). This sample size was adequate for the study because according to Peretomde (1992) and Owojori (2002), cited by Abdulsalam and Mawoli (2012), a sample size that is not less than 10% the sample population is a good representation of the population. In this study, the sample size is 13% of the study population, three percentage points higher than suggested by Peretomde (1992) and Owojori (2002). Another view expressed by Cohen *et al.* (2007) is that a sample size of thirty is the minimum number of cases if researchers plan to do some form of statistical analysis of their data. With the exception of Guli, all the other study communities have sample sizes above 30, and on average the sample size is 50 per community. The quantitative data was analyzed using the basic statistical analysis package, excel for generating percentages, tables and graphs.

Analysis and Discussion

The study set out to examine the role and/or potential role of local knowledge for conducting an assessment of vulnerability to environmental change, including extreme climatic events. The results from CRA reveal local knowledge and perspectives on environmental change that has occurred or continues to occur in the communities. These perspectives are broadly categorized into climate variability and land degradation.

Local Knowledge on Climate Variability

The prime concern of climate change is rainfall variability and this is because it directly affects agriculture, the primary livelihood of the people. From the CRA, rainfall variability is one of the main environmental changes affecting agriculture and other livelihoods in the community. Rainfall variability manifests in extreme climatic events such as drought, heavy rainfall, rainstorms and flash floods. The results show that the rainfall pattern was much more stable and predictable in the era of grandparents than in the sons' generation, that is, the present generation. Results from KIIs and FGDs revealed that in the grandparents' generation, multiple early rains were recorded in December and this facilitated decomposition of plant stalks and made easier land preparation for the next production season. This was often followed by a second batch of rains from March to April, which often made the soils moist. These rains were known to facilitate the raising of mounds for planting yam. This is then followed by a further batch of rains from May to June. These rains signaled the start of the planting season and were associated with the planting of crops. Thereafter, torrential and high intensity rains were recorded every two to four days between July and September, and these rains signaled the peak of the rainy season. This was followed by a decline in rainfall intensity in October and further decline in November. These rains were associated with flash rains and harvesting of early maturing crops. Respondents reported that food crop yields were relatively high in the era of grandparents because the rainfall pattern was good, stable and predictable. This facilitated appropriate timing of planting activities, leading to good harvests. In the era of sons, yields are far lower and many households have to contend with the risk of food insecurity. Respondents largely attribute this situation to an unpredictable rainfall pattern that makes it difficult for farmers to plan their farming activities, often resulting in inappropriate timing of farming activities. They also attribute the situation to a decline in rainfall intensity and the occurrence of droughts that deprive crops of the relevant moisture requirement for plant growth.

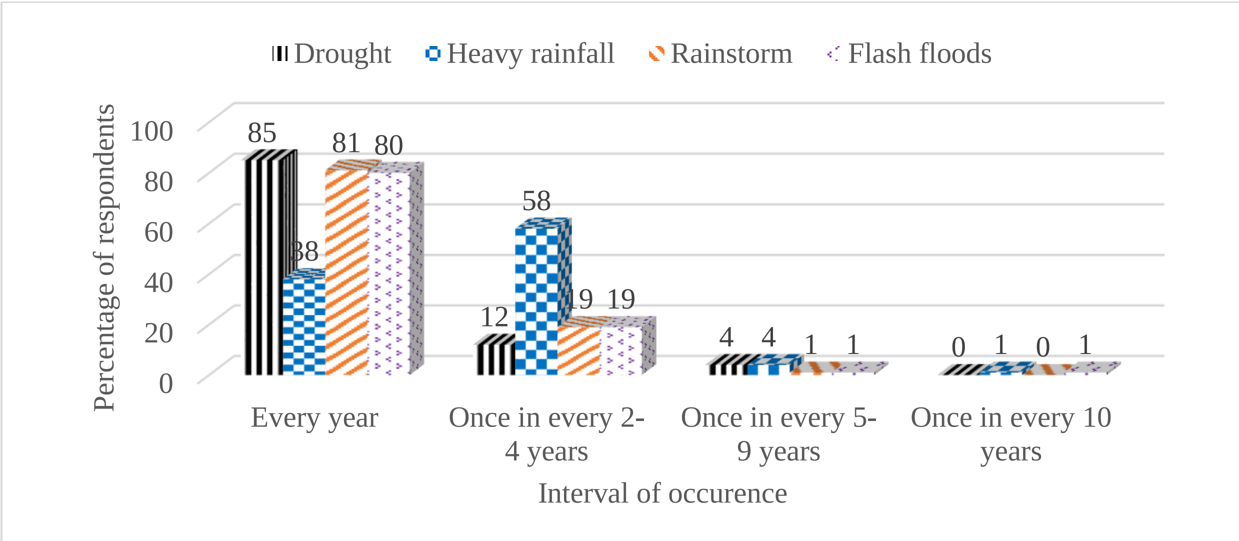
Further and more detailed descriptions of extremes in rainfall patterns and the negative consequences on livelihoods were revealed in the CRA. Farmers lament that they no more maintain a regular farming calendar because of uncertain rainfall patterns. For instance, an opinion leader from Nakore laments the irregular and unpredictable rainfall pattern in Nakore:

We are in the seventh month (July) of the year, but we cannot tell whether we are in the rainy season or the dry season… (Male Respondent, Nakore, July 27, 2014).

Such irregular rainfall patterns were reported to adversely affect fertilizer application necessary in the cultivation of early maturing crop varieties farmers have adopted for climate change adaptation. Farmers identified a double exposure to risks associated with extreme rainfall events in respect of fertilizer application. On the one hand, farmers have to contend with the risk of torrential rains or flash floods washing off fertilizer from farms; on the other hand, farmers are exposed to the risk of drought and the consequence of not having the requisite moisture for dissolution of fertilizer applied on farms. Farmers shared unpleasant experiences of prolonged droughts following fertilizer applications on farms during which plants wilt and die. They lament the double economic losses associated with either floods or droughts – that is, losing both fertilizer and crops.

Further results from CRA show that farmers are exposed to both drought and heavy rainfall in the same production season. From the survey, drought is reported by the majority (84%) of respondents as one of the environmental stressors that occur every year and every production season in study communities (Figure 2).

Figure 2: Frequency of occurrence of environmental stressors[1]



Source: Field Survey, 2015.

In-depth community level analysis revealed that in general, the climate was becoming dryer and that the dry season was extending in length in place of a shrinking rainy season. In addition, the results reveal that these droughts affected the growth of crops and led to low crop yields and consequently, food insecurity. Excerpts from interviews and FGDs in Nakore and Kpongo illuminate the experiences, understandings and knowledge of drought:

In the past, that is our grandparents' era, we did not experience droughts. The rainy season used to start with Binkoglisaa (dry season) and followed by Saagesaa (February).These rains were the first rains that facilitated ploughing of farm lands. They were also known to support flowering and pollination of certain economic trees such as the dawadawa and shea tree. However, these rains are rarely experienced in recent timesand if they occur, they occur with much lower frequencies and intensities (Male Respondent in Nakore, Interview, July 28, 2014)

We should have been harvesting groundnuts and beans by now but that is not the case. Farmers should be applying fertilizers on their farms and others should have been sowing their crops, but all these activities are not happening. This is because we are currently experiencing a drought (Male Respondent in Nakore, Interview, July 28, 2014).

At the moment, we don't know whether we are in the rainy season or dry season. We are all confused by the irregularity and confusing rainfall patterns (Female Discussant in Nakore, FGD, July 28, 2014)

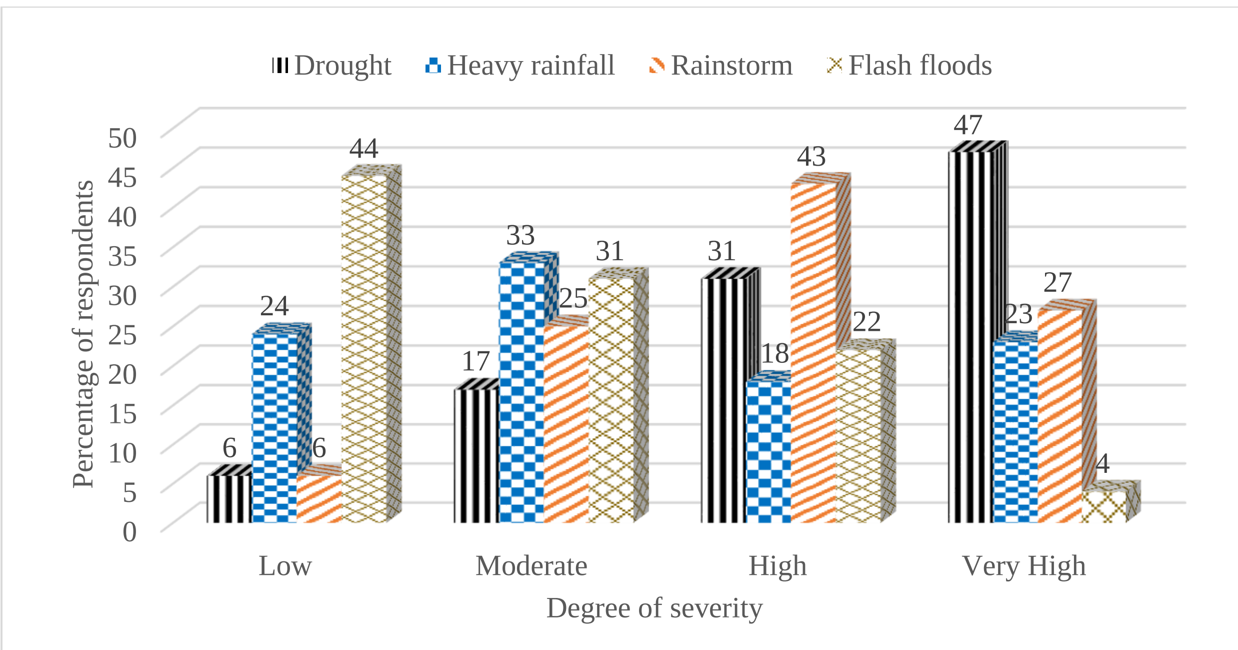
[1] For the purpose of clarity, the bars as presented in the group bar graph represent from left to right drought, heavy rainfall, rainstorm and flash floods. This pattern runs through two other graphs in the ensuing sections.

Three years ago, we sowed groundnuts and for the next one month, there was no rain. When it finally rained, only a few of the groundnut seed germinated. So the germination was very poor (Female Discussant in Kpongo, FGD, August 2, 2014).

We planted crops three months ago but we are still waiting for rainfall that will provide the required moisture for germination. Last year, I cultivated half an acre of groundnuts. I hired labour for the planting. However, the harvest was poor because the crops were adversely affected by drought. I harvested only a 25 kg bag of groundnuts, but even then, some were empty shells (Female Discussant in Kpongo, FGD, August 2, 2014).

These excerpts from interviews and discussions underscore the severity of droughts and the negative consequences they have on livelihoods at community levels. Results from the survey corroborate the severity of droughts. From the analysis, the majority of respondents (78%) rated the severity of droughts over the past decade as either being high or very high (Figure 3).

Figure 3: Severity of stressors related to rainfall variability over the past decade



Source: Field Survey, 2015.

The assessment shows a low to moderate severity of most heavy precipitation related stressors over the past decade. Cumulatively, most respondents (57%) have rated the severity of rainfall as either low or moderate while the remaining respondents (41%) rated its severity as either high or very high. Similarly, most respondents (75%) have rated the severity of flash floods as either low or moderate. In contrast, most respondents (70%) have rated the severity of rainstorms as either high or very high (Figure 3). In-depth analysis reveals knowledge of the effect of such rainstorms – as adversely affecting the fruiting of economic trees like the *Dawadawa* and *Shea*, particularly during flowering and pollination. This leads to low yields and impact on the availability of raw materials for women engaged in agro-processing livelihoods. The analysis further reveals that some rainstorms rip off roofs of houses and render some people homeless. In such cases, residents have to accommodate relatives and friends as a relief mechanism. Even school buildings are sometimes ripped off. For example, in 2012 about four classrooms in *Kpongo* community were ripped off and for several weeks, pupils had to sit under trees for lessons. Although most respondents agree that heavy rainfall and floods have become more frequent over the past decade (Figure 2), they are less severe if compared to drought and rainstorms (Figure 3).

From the local knowledge of the local populations on vulnerability to climate change, communities are exposed to multiple climatic extremes. These include drought, heavy or torrential rainfall, floods and rainstorms. However, drought and rainstorms are the highest risk environmental stressors affecting livelihoods in the communities. These extreme climatic events can be expected to occur every year or at least every two years. Nonetheless, a drying trend is predominant and droughts have been assessed as regular annual events with disruptive or damaging consequences on agriculture and livelihoods. This finding corroborates results from similar studies. For instance, Codjoe et al (2013) identified floods, drought and wind storms as the major extreme climatic events that affected the livelihoods of residents in Accra Metropolis. They concluded that indigenous weather monitoring systems and indicators that have been transmitted from one generation to the next are still in use by residents in the metropolitan communities. These indigenous monitoring systems help residents anticipate the onset of wet and dry seasons, flood and drought events, and fisheries production. According to the World Bank (2011), rainfall over Ghana was particularly high in the 1960s, and decreased in the late1970s and early 1980s. This produced an overall decreasing trend in the period 1960 to 2006, with an average precipitation of 2.3 mm per month (2.4%) per decade. Similar studies that draw on the participation and knowledge of local populations have yielded relevant scientific findings on climate change. For instance, in the *Atankwidi* basin in northeastern Ghana, farmers identified drought, heavy rainfall, rainstorms and floods as environmental stressors that adversely affect agriculture and the totality of their way of life(Derbile, 2010). In a study conducted by Islam et al (2014) in Koyraupazila in the Khulna District of southwestern Bangladesh, the results showed that respondents had noticed changes in the weather pattern in the coastal area over the past years. They believed that irregular rainfall, occurrence of storm surges, flooding and disasters had increased in the study area. Other noticeable changes included increased uncertainty in predicting the weather. According to Nyong et al. (2007), in the African Sahel region rural communities are already accustomed to climate change adaptation because of a long history of severe and frequent droughts. Therefore, they demonstrated the benefits of integrating indigenous knowledge into locally relevant and sustainable climate change mitigation and adaptation strategies for agriculture. This CRA revealed that although communities were exposed to multiple climatic stressors and risks, drought and rainstorms were rated the highest risk stressors because of their high frequency of occurrence and frequent disruption of livelihood activities, particularly agriculture and agro-processing activities.

Local knowledge on Land Degradation

The results also revealed knowledge of land degradation as manifest in deforestation and desert-like conditions, land pits and soil degradation. The results from KIIs (14/14) and FGDs (6/6) revealed an overwhelming state of land degradation largely driven by human activities including bush burning, tree felling, charcoal burning, farming and sand winning. Drawing on a comparative analysis of the situation between the era of grandparents and the present generation, the assessment revealed widespread incidence of desertification in both Nakore and Kpongo. The case of Nakore (reflecting also experiences in Kpongo) is presented. Male discussants in Nakore highlighted the incidence of desertification in the community (Box 1).

Box 1. Focus group discussion highlighting desertification in *Nakore* community

Discussants were unanimous that in the past, three generations back (era of grandparents of discussants), the vegetative cover was thick and comprised a mix of trees, thick shrubs and sacred groves and grasses. Trees varied in size, and included big and tall trees, including shea and dawadawa trees, medium size trees and smaller trees. There were also many medium and small size wild fruit trees. In addition, there were multiple thick shrubs and multiple sacred groves. There was also a thick grass cover landscape, comprising very tall and medium height grasses, and a short and carpet like grass cover. They said that the vegetation was a continuum comprising trees, shrubs and sacred groves interspersed with a thick grass cover. It was not possible to see through the entire length of two farms because of the thick vegetative cover. The vegetation was a good habitat for wildlife and one could find daily traces of wildlife activities on farms and around homes.

In the present generation, the thick vegetative cover has given way to a thin vegetative cover comprising a mix of sparsely dotted trees, a few thin shrubs and sacred groves and grasses. The big and tall trees are no longer available. There are no more big and tall shea and dawadawa trees, very important economic trees to us. The trees still vary in size, but most trees are small, with a few sparsely distributed medium size trees. Most medium and small size wild fruit trees are no longer available and our children have not had the opportunity of knowing them. The thick grass cover has given way to a thin grass cover. Tall grasses are no more common. The vegetative cover is no more a continuum and comprises short trees, a few thin shrubs and sacred groves interspersed with patches of grass cover in general, but particularly in the dry season. It is now possible to see through the entire lengths of multiple farms because of the thin vegetative cover. One can no more find daily traces of wildlife activities on farms and around homes.

Further analysis and discussions revealed that deforestation and land degradation were primarily caused by human activities. These included felling trees, charcoal burning, bush fires, sand winning and stone quarrying. From interviews, respondents noted that although trees played an important role in rain formation, people felled trees as lumber or for burning charcoal. A respondent from Nakore expressed his view on this subject during an interview session as follows:

All the important trees are now being felled for charcoal. They are now felling the shea tree and the dawadawa trees as well. Now we do not talk of the shea tree again. All the charcoal you see them carrying are gotten from the shea tree. In the past we used to have big shea trees in the community but now you cannot see even one. Shea nuts are now rare and you can only pick from your farm because others will not permit you to pick from theirs (Female Respondent, Nakore, July 28, 2014).

The assessments revealed that human activities are leading to loss of soil fertility. Respondents noted that currently farmers can no longer cultivate maize without applying fertilizer due to soil degradation and loss of soil fertility. Farmers from Kpongo and Nakore made the following observations on the subject during interviews and FGD sessions:

Currently, our soils are degraded. Soils which were fertile in the past have lost fertility for supporting meaningful plant growth. We can no longer farm without fertilizer. However, that is not all to it. Even if you apply fertilizer, the rains may also disappoint you. I applied fertilizer to my crops (maize and guinea corn) a month ago and we have since not had rainfall. So you see, you can apply fertilizer to your crops but droughts can deny you of the moisture required for fertilizer to make a difference in yields (Female Discussant, Kpongo, July 28, 2014)

In the past, when you cultivated an acre of crops, the yield was very good and you were happy at harvest. This is because soils were fertile. Today (currently), if youeven cultivate three acres of crop land, you can expect poor yield. You may not even harvest a bag (Male Discussant, Kpongo, July 28, 2014)

In this community you cannot grow crops such as maize without applying fertilizer (Male Respondent, Interview, Kpongo, July 28, 2014)

We say we want development, so how can there be development without sand winning for building houses? There cannot be development without sand winning and this is the reason the land is being degraded (Male Discussant, Nakore, July 28, 2014)

We are losing our farmlands because of sand winning and stone quarrying. You can't imagine that you go to your farm and they have turned it into a sand winning pit. How can you do any meaningful farming under such situations (Male Discussant, Nakore, July 28, 2014)

As part of the CRA, the survey was designed to explore the understanding of the research participants of the extent to which various human activities impacted negatively on the natural environment. Three human activities which emerged strongly from focus group discussions interviews as causing environmental degradation were considered. The frequency of occurrence of these causal agents, bush fires, sand winning and charcoal burning, are analyzed (Table 2).

Table 2: Frequency of factors causing land degradation

Factor	**Every Year**		**Once Every 2-4 years**		**Once Every 5-9 years**		**Once Every 10years**		**Total**	
	No	%	No	%	No	%	No	%	No	%
Bush fires	189	94.5	8	4.0	1	0.5	2	1.0	200	100
Sand winning	192	96.0	6	3.0	2	1.0	0	0.0	200	100
Charcoal burning	194	79.0	3	1.5	3	1.5	0	0.0	200	100

Source: Field Survey, 2015.

From the analysis, the factors causing land degradation were reported to occur every year as either an annual seasonal event (in the case of bush fires) or a continuous process throughout the year (in the cases of sand winning and charcoal burning). The majority of respondents, ranging from 79% to 96%, asserted that these causal factors were annual events (Table 2). Further analysis explores the perceptions of respondents concerning the extent to which these factors contribute to land degradation in communities. From the analysis, the majority of respondents (78%) rated the degree to which bush fires contribute to land degradation as either high or very high (Table 3).

Table 3. Factors and their contribution to land degradation

Factor	Low		Moderate		High		Very High		Total	
	No	%	No	%	No	%	No	%	No	%
Bush fires	7	3.5	38	19.0	63	31.5	92	46.0	200	100.0
Sand winning	43	21.5	62	31.5	69	34.5	26	13.0	200	100.0
Charcoal burning	46	23.0	59	29.5	66	33.0	29	14.5	200	100.0

Source: Field Survey, 2015.

Contrastingly, the majority of respondents (52%) rated the contribution of sand wining and charcoal burning toland degradation as either low or moderate, with higher rates for the latter category. However, 48% of respondents rated the contribution of sand winning and charcoal burning as high or very high. Comparatively, although the majority rated their contributions as either low or moderate, the percentage that rated their contribution as high or very high is significant, and thus brings to the limelight the need to pay sufficient attention to these factors. Nonetheless, from the knowledge of the local population, bush fires have emerged as more a cause of environmental degradation than sand wining and charcoal burning.

Results from the CRA show that the communities have their local knowledge of land degradation. They have working knowledge of the incidence of land degradation and deforestation, the extent of change of the natural environment from a three generational perspective and the factors that are contributing to such change. In general, this knowledge corroborates findings from conventional research. Itis cited that in Africa, development is a main cause of these land-use changes. People cut down trees for economic purposes: to expand cities, build houses, and create large-scale farming (AMCEN, 2011). According to FAO (2009), between 2000 and 2005Ghana lost an average of 115,000 hectares of forest per year, which amounted to 2.0 percent of the country's land. Over the last 15 years, West Africa has lost almost 12 million hectares (two times the size of Togo) of tropical forest. In northeastern Ghana, particularly the *Atankwidi* basin, farmers identified land degradation and soil fertility loss as key environmental stressors affecting agriculture and the totality of their way of life (Derbile, 2010). According to Glasdottir and Stocking(2005, cited in Nkonya et al. 2006, AMCEN, 2011), land-use changes such as deforestation, desertification, and urbanization remove the vegetative cover and contribute to increased atmospheric temperature and global warming.

Another key finding is the knowledge that environmental change is primarily driven by human activities such as bush fires, tree felling, charcoal burning, and sand wining. This corroborates the anthropogenic view on environmental change. This view suggests that environmental change is largely a human induced phenomenon. Similarly, according to the German Center for Climatic Computerizations, the warming of the last 20 years can be attributed at 95% certainty to anthropogenic causes as opposed to natural climatic variability (Bronstert, 2003). Furthermore, IFAD asserts that anthropogenic factors such as uncontrolled deforestation and over-tapped natural resources are disrupting the functioning of ecosystems and the traditional relationships between communities and these ecosystems in Mali's inner Niger Delta. As a result, the capacity to sustain the management of the environmentally fragile ecosystems in the Niger Delta is fast eroding (IFAD, 2011).

Local Knowledge, Environmental Change Research and Adaptation

The discussion here highlights the importance of local knowledge in environmental change research and adaptation in Africa. The results from this CRA essentially underscored the importance of local knowledge in research and development. The results provided insights into the local knowledge of the people in respect of the following: the incidence and nature of environmental change, the causes of and exposure to the associated risk, and implications for livelihoods. This knowledge provides the basis for further research, policy formulation and appropriate design and implementation of development interventions. Local level studies that focus on local knowledge fill a critical research and knowledge gap. For instance, Tschakert et al. (2009) have noted that there is a lack of climate information at the local level, and where it is available, the people do not use it because it is too general and unreliable. Communities therefore depend on the indigenous knowledge handed over to them by their ancestors to counter natural perils. A study by Gyampoh (2011) in Ghana showed that famers depended on forecasting indicators including fruiting of certain local trees, appearance of certain types of frogs and birds, and insect behaviour. Risiro et al. (2012) found that traditional methods of weather forecasting ranged from biological, to atmospheric, relief and astronomic features.

Studies abound on the use of indigenous knowledge to deal with challenges in the areas of agriculture and food security (Derbile, 2010; Ellis, 2000), weather and climate change adaptation (Gyampoh, 2011;Tschakert, 2009). In the African Sahel region, for example, Nyong et al. (2007) concluded that rural communities are already accustomed to climate change adaptation because of a long history of severe and frequent droughts. They demonstrate the benefits of integrating indigenous knowledge into locally relevant and sustainable climate change mitigation and adaptation strategies for agriculture. Many studies have also demonstrated that rural communities respond actively to the challenges posed by climactic variability. In Tanzania, for instance, farmers faced with drought switch crops, expand cultivation and seek alternative employment (Paavola, 2012). In the southern Arctic, Inuit peoples have made adjustments in hunting patterns as the climate warms (Berkes and Jolly, 2001).

These responses are, in a certain sense, unsurprising; indigenous communities have lived in the same environment for thousands of years, and have developed a wealth of knowledge about their surroundings. When their livelihoods are under threat, it seems only natural that they would draw on this knowledge as much as possible to adapt (Kirkland, 2012).Accordingly, indigenous knowledge is the resource that is most readily available to smallholder farmers, pastoralists, fishing communities and forest dwellers in Kenya (Odero, 2011).The Intergovernmental Panel on Climate Change (IPCC, 2007) has highlighted the role of indigenous knowledge in its report and has concluded that "indigenous knowledge is the basis for local-level decision making in many rural communities. It has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities".

Understanding and building upon indigenous knowledge and tools may enhance the design, acceptance, and implementation of climate change and/or environmental change adaptation strategies for Ghana and other developing nations. However, a precautionary note is in order: there is evidence that some indigenous knowledge systems are becoming extinct because they are considered unreliable and are therefore, not being applied (Gyampoh, 2011), and that the capacity of local knowledge for enabling adaptation and resilience to environmental change is overstretched and reflects the limits of local knowledge systems(Derbile et al,2016).

Conclusion and Recommendations

This paper set out to explore the role and/or potential role of local knowledge in the application of CRA as a tool for community level assessment of vulnerability to environmental change in selected rural communities of the Wa Municipality in Ghana. From the evidence, the paper makes three interrelated conclusions. First, that there is a potential role for local knowledge in CRA and that environmental change is negative, as manifested in a deteriorating natural environment. The results reflect the local knowledge of the local populations on the nature of environmental change, its causes and the associated risks and implications for livelihoods. Second, that the primary stressors of environmental change are drought, deforestation and land degradation, and that anthropogenic factors are the primary drivers of such changes. Third, that there is great potential for a role of local knowledge in environmental change research and adaptation in Africa and wherever such knowledge exists, and that the outcomes are scientifically and policy relevant.

Further to the findings, the paper recommends an Endogenous Development (ED) approach to Environmental Change Mitigation and Adaptation Planning (ECMAP) within the context of local governance in Ghana in particular and in Africa in general. An ED approach to ECMAP should target attaining Sustainable Development (SD) through the primary reliance on local resources, institutions and local knowledge systems at community levels that have a great potential for contributing to SD (See Derbile, 2014).

An ED approach as advocated does not necessarily preclude utilization of external knowledge and resources, but rather a certain proportional blend that engenders sustainability (Haverkort et al, 2003; Derbile, 2014). External knowledge and resources can be incorporated into the strategy to complement local knowledge, subject to two key precautions: first, caution to avoid the risk of external dependency, given the problems of irregular flows of resources, particularly financial resources to local governments in Africa, and second, appropriate ‘localization’ of external knowledge and resources, that is, the adaptation of external knowledge and resources to local conditions for addressing development needs and engendering sustainability.

To engender better prospects for sustainability, the implementation of an ED approach to ECMAP would require paying close attention to community mobilization and education for engendering behavioral change and response, natural resource management and support for livelihood sustainability.

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