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## The Effects of Climate Change on Livelihoods of Smallholder Farmers in the Upper East Region of Ghana

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### Abstract

Smallholder households obtain livelihoods through the rural labour market, self-employment in rural non-farm economy, migration and rain-fed agriculture. Agriculture is the major source of rural livelihoods and employs more than 60% of the population in Sub-Saharan Africa (SSA). Climate change presents severe threats and erodes essential livelihoods of the poor and marginalized. Guided by the Sustainable Livelihood Framework (SLF), the study combined qualitative methods, participatory rural appraisal (PRA) techniques such as Focus Group Discussion's and interviews with a quantitative method (traditional survey) to gather the data. The results revealed that households have been under considerable stress of livelihood insecurity since key livelihood activities such as crop and animal farming, fishing, trading, basket weaving and shea butter processing were severely threatened by climate change through rippling effects such as droughts, floods, pest and diseases, post harvest losses and consequently declining crop yields and animal production.

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Non- farm/off-farm livelihood activities are vital to supplement the incomes gained from agricultural activities. Therefore, policy makers need to formulate more specific and targeted climate change adaptation policies and robustly pursue livelihood diversification strategies in order to reduce the vulnerabilities of smallholder households whose livelihoods depend largely on rain-fed agriculture.

**Keywords:** climate change effects; livelihoods; smallholder households; Upper East Region; Ghana.

## **1. Introduction**

Rural households obtain livelihoods through agriculture, rural labor market and self-employment in rural non-farm economy and others through migrating to towns, cities and other countries [13, 27]. Agriculture is the major source of livelihood in many African countries. Large numbers of rural population are dependent on agriculture for their livelihoods. In Sub-Saharan Africa, more than 60% of the economically active population and their dependents rely on agriculture for their livelihoods. Although the share of agriculture in GDP is decreasing, the share of agriculture in employment is still high [27]. In the Bongo district and the Upper East Region (UE/R) as a whole, the livelihoods of rural people are limited to a fairly narrow range of activities, but these activities may be combined in complex ways and are sometimes short lived [5].

Climate change and extreme weather events present severe threats and erode essential needs, capabilities and rights more especially for the poor and marginalized thereby redesigning their livelihoods [35, 2, 25]. A number of livelihoods are directly climate sensitive, such as rain fed agriculture, seasonal employment in agriculture (for example fishing and pastoralism) and tourism [25]. Reference [13] indicated that rainfall is the primary driver of change, altering crop production from year to year and causing massive longer-term fluctuations in production. Households are unable to raise sufficient grain for their subsistence needs in one out of three years [13].

Many studies have confirmed that food and livelihood security in the Upper East Region and the Bongo district to be specific is severely threatened by climate change [7]. Other studies also revealed that, aside climate change, there are other elements such as rising population growth, consumption patterns and increasing urbanization also threatens livelihood security [10].

Climate change has been labeled as a new security threat to Africa [11]. More recent researches predict increases in civil wars as a result of climate change [12]. Climate change will harmfully influence all the components of food and livelihood security [26]. The livelihood portfolios of households disrupted by climate change in the Upper East Region include (but not limited to) cropping, livestock, fishing, agriculture, labour, business and hawking/vending, non-agricultural labour, weaving, industry, and construction [5]. These damaging effects of climate change on livelihoods call for the urgent need for policy makers to implement strategies to mitigate these negative impacts.

## **2. The sustainable livelihood framework (SLF)**

The SLF focuses on how people use livelihood assets (human, natural, financial, social, and physical) in a

context of shocks, trends and seasonality. The choice of strategies is mediated by structures (e.g. Government, NGO's) and processes (e.g., Laws, policies, culture, institutions) and results in livelihood outcomes, such as income, well-being, or food and livelihood security [14, 17].

Reference [3] indicated that, the unique feature of the sustainable livelihood perspective is the appreciation that the root of development is livelihoods. It is a people-centered paradigm which recognizes people's inherent capacities and knowledge. Again, it signifies a multi-sectoral character in real life, integrating environmental, social and economic issues into a holistic framework. It highlights the development of short- and long-term adaptive capacities that enhance the abilities of individuals and communities to deal with changing circumstances [31].

The sustainable livelihood framework conceptualizes and enables better understanding of the livelihood processes in the study area (Figure 1). Vulnerability is seen not simply as the result of an event or stress, but as a function of the socio-economic characteristics of a population which determine the degree to which their life and livelihoods are put at risk by a distinct and identifiable event in nature or in society.

The SLF contends that households reliant on agriculture could be capable of lessening their complete susceptibility to climate change through diversification of strategies within the range of their livelihood and specializing to gain advantage of a niche [17, 20].

The SLA has been criticized for failing to recognize resource allocation and distributional issues [7]. For example, although it emphasizes the significance of raising the prospect obtainable and accessible for the poor to accomplish their livelihoods, it fails to recognize and advance issues of equity [38] which are vital to coping and adapting to climate change.

This research overcomes this weakness by employing a multi-scale climate change susceptibility appraisal by mapping vulnerability at the district, community and household levels. Concerns relating to temporal dimensions were taken into consideration in the choice of research methods. For instance, participatory methods are used to explore the temporal dimensions of livelihood susceptibility to climate change.

This study builds on this by combining livelihood theory with a temporal element through local level participatory approaches [7]. The SLF offers a people-centered approach to the understanding of livelihood susceptibility and inequalities faced by various households hence helps to shape development objectives.

The SLF permits a better understanding of the sources of vulnerability and how smallholder households usually respond to the negative effects of climate change.

This study adopted the SLF because it permits the assessment of livelihoods which allows the identification of the vulnerability context of households/individuals which highlights how such households are susceptible to the negative effects of climate change.

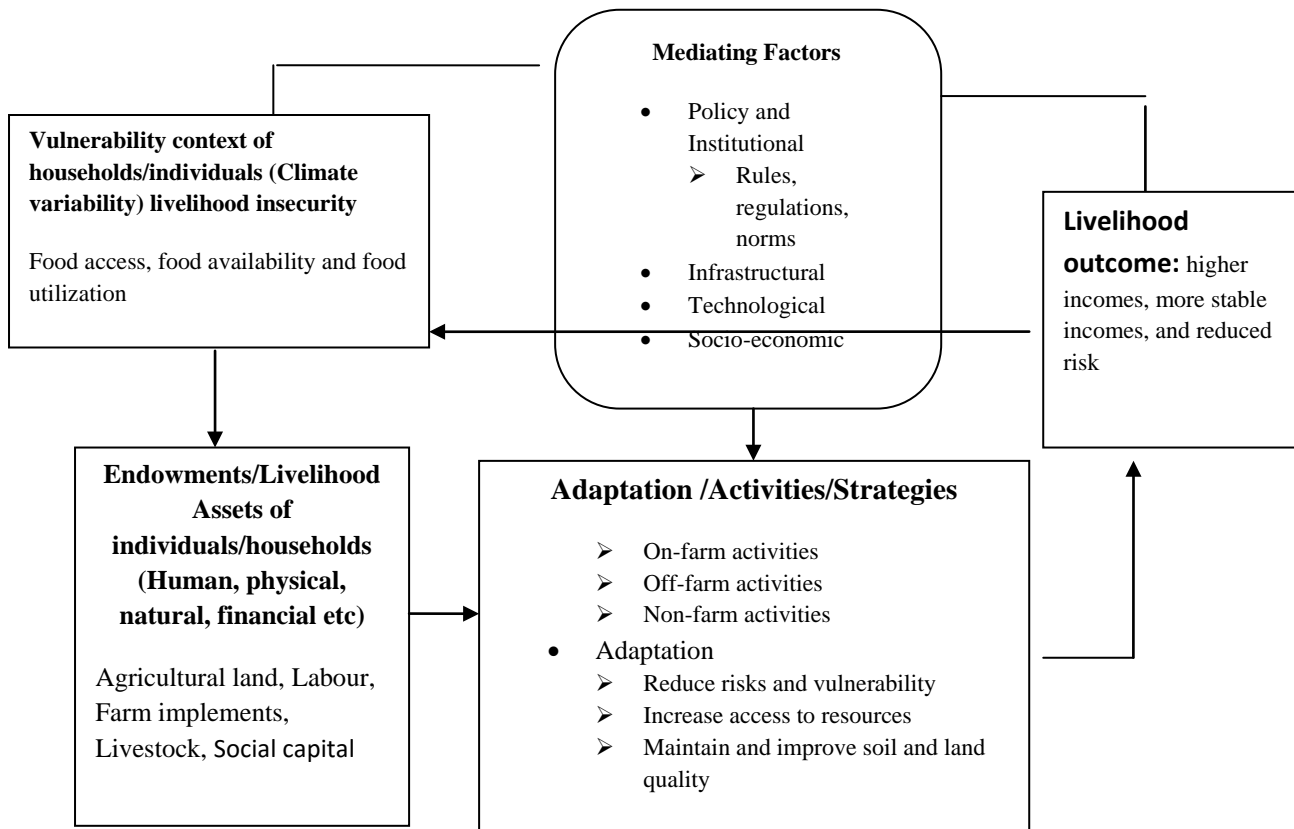


Figure 1: SFL

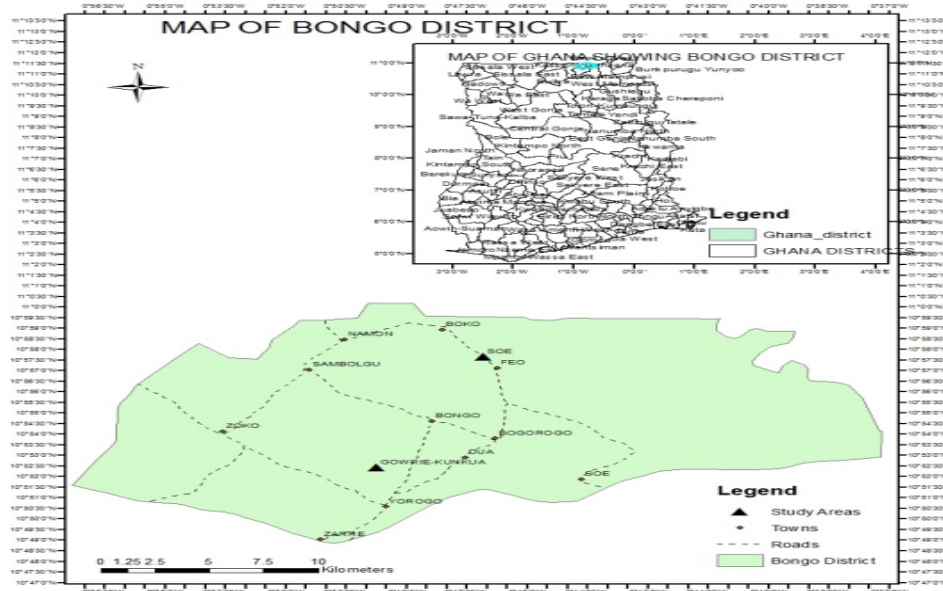
Source: Adopted from [34] and modified

### 3. Methodology

#### 3.1 Profile of Study Area

The natural vegetation of the Bongo district is the savannah woodland, characterized by short scattered drought-resistant trees and grass that gets burnt by bushfire or scorched by the sun during the long dry season. Human interference with ecology is significant, resulting in near semi-arid conditions [4, 6]. The most common economic fruit trees are the shea nut, dawadawa, baobab and acacia [21]. The climate is characterized by one rainy season from May/June to September/October. The mean annual rainfall during this period is between 800 mm and 1,100 mm. The rainfall is erratic spatially and in duration. There is a long spell of dry season from November to mid-February, characterized by cold, dry and dusty harmattan winds. Temperatures during this period can be as low as 14 degrees centigrade at night, but can go to more than 35 degrees centigrade during the daytime [21]. Humidity is, however, very low, making the daytime high temperature less comfortable. According to the [21], agriculture, hunting and forestry are the main economic activities in the Bongo district of the UE/R. About eighty percent (80%) of the economically active population are engaged in agriculture. The main produce is millet, guinea-corn, maize, groundnut, beans, sorghum and dry season tomatoes and onions.

Livestock and poultry production are also important sources of livelihood for the people. Industrial activity in the region is generally low, with only one industry in operation at the moment [6]. This is the cotton ginnery at Pusu-Namongo (near Bolgatanga). Other industrial establishments are the Tomato Canning Factory (GIHOC) at Pwalugu, the Meat Processing Factory (GIHOC) at Zuarungu and the Rice Mills at Bolgatanga, which are not operational and have been earmarked for divestiture [21].



**Figure 2:** Map showing the study communities in the Bongo district

Source: This study

### 3.2 Methods of Data Collection

The selection of the study district began with an appraisal of production/yields data obtained from MoFA (from 2000 to 2014), to establish the most susceptible district in the UE/R to climate change and related extremes. The Bongo district was tinted as the most vulnerable district in the UE/R based on the scrutiny of crop yield data from MoFA hence its selection [5]. Two farming communities Gowrie Kunkua (vulnerable community) and Soe Kabre (resilient community) were selected through stakeholder interviews. This research combined qualitative methods (participatory rural appraisal (PRA) techniques such as Focus Group Discussion's and interviews) with a quantitative method (traditional survey) to gather the data. 150 semi-structured questionnaires were administered in the two selected communities (75 each). Six (6) Focus Group Discussions (FGDs) were conducted, three (3) at Gowrie Kunkua and three (3) at Soe Kabre. A total of fifteen (15) key informant interviews was conducted. Community leaders such as the Tindaana (earth priest), chiefs, elders, assembly members, model farmers and institutional heads such as MoFA director, EPA and GMA were interviewed. This study used the sustainable livelihood approach [32], where assets/endowments (financial, human, natural, physical, and social) were evaluated using the household survey questionnaire. Households were inquired to point out particular factors that compel them to be vulnerable to climate change. These

evidences were used to discuss the household livelihood assets and their vulnerability to climate change. The nature of farming and the variety of crops as well as land tenure matters were examined.

### ***3.3 Data Analysis***

During the fieldwork, interviews and focus group discussions were audio-recorded and notes were also taken with the help of field assistants. After each field visit, the reports were written based on the field notes and all the audio recordings were transcribed in the exact words of the respondents. These were then classified into themes under the different case categories and synthesized using descriptive narratives to reflect the collective worldview of communities as the basis for evaluating the negative effects of climate change on smallholder livelihoods.

## **4. Results and discussion**

### ***4.1 Livelihood Assets of Smallholder Households in the Bongo District***

Household livelihood assets signify the essential foundation upon which households embark on production, engage in labor markets and participate in mutual trade with other households [17]. These include skills and experiences of household members (human capital), their relations within the wider communities (social capital), their natural environment (natural capital), and physical and financial resources [9]. The ownership and control of these assets vary among households in the study communities. This variation indicates the fact that households are confronted with different challenges and engage in different livelihood strategies to achieve livelihood outcomes [8].

#### ***Human capital:***

In this study, the main human resources that can enhance improved livelihoods include technical/vocational training, education, health status, farming experiences and household size. [29], indicated that skills, good health, knowledge and physical capability jointly facilitate households to pursue livelihoods. Skilled labour power is regarded as the most important human resource to generate meaningful development. In this study, the resilient community had about 17.3% of sampled households having access to formal education (primary to tertiary level) while the vulnerable community had 52% of the sampled households are being educated (primary to tertiary level). This low educational attainment in the resilient community suggests the fact that, the community (Soe Kabre) is endowed with vast agricultural land for crop farming and animal rearing, hence majority of the people are engaged in farming. The high education level in the vulnerable community explains the fact that, the vulnerable community has an inadequate agricultural land and hence the majority of the households are willing to send their children to school as a means to diversify their livelihoods to non-farms jobs. An evaluation to determine the effect of education on households' vulnerability to livelihood insecurity was conducted. The findings showed that 80% of the illiterate households were not vulnerable to livelihood insecurity. It was discovered that, some educated households who were not engaged in farming were vulnerable. The explanation by a key informant noted that, there are high prices of food stuff due to declining yields and households who do not farm spend a significant amount of their income in purchasing food stuff. On

the other hand, some of the illiterate households through the use of indigenous knowledge in adapting to climate change are able to feed their families from their farm produce throughout the lean season to the next harvest. This supports the fact that, adaptation to climate change can reduce the vulnerability of households. This finding is contrary to [29], [9], who observed that educated households are less vulnerable to climate change than illiterate or uneducated households.

### ***Social capital***

Social capital comprises connections to technical support and social resources such as networks and associations were evaluated by counting the number of associations or groups to which the members of the household belonged to [37]. Local informal institutions/neighborhood associations, religious groups, self-help groups, kinship structures, small credit schemes and cooperatives were found to be important social capital assets in the study area. Social capital consists of both formal and informal associations such as Community Based Organizations (CBOs), Farmer Based Organizations (FBOs) and Faith-Based Associations (FBAs) [32]. Another association found in the study area was communal labor groups. This comprised a group of individuals who come together to form an association for the purpose of sowing, weeding and harvesting for each member. The study revealed that, 78% of households farming activities such as sowing, weeding and harvesting were carried out by communal assistance from family, groups and friends. It was anticipated that households that are affiliated with more social groups and associations are better prepared to cope with the negative effects of climate change on their livelihoods activities since this embody social safety nets and a form of informal grassroots insurance available to the household during climate-related crisis [19, 1]. Belonging to such networks, reflects the economic well-being of the household as it was discovered during FGDs that, members of the existing groups are required to pay dues. These associations' presents means for the members to assist each other in times of need to reduce powerlessness and mitigate adverse effects of immediate social problems. In this study, 40% and 36% of households in Gowrie Kunkua and Soe Kabre communities respectively belonged to associations such as FBO, CBO and *Susu* savings groups as can be seen in Figure 2.



**Figure 2:** meeting of social group (*Susu* Association) in Gowrie Kunkua

Source: Field Survey, July 2015.

### ***Physical capital***

In FGDs and Key informant interviews held through the communities, discussants identified roads, markets, schools, health centers, shelter, access to information, water harvesting and soil conservation structures as critical physical assets. The existence of irrigation facilities and ownership of radios, donkey cart, television or mobile phones by a household were also identified as key physical assets for strengthening household resilience. Irrigation facilities are vital for rain-fed agriculture-dependent communities, as these facilities help farmers to engage in dry season farming. The Gowrie Kunkua community (vulnerable community) had an irrigation facility viz the Vea dam. However, it was discovered that, the cannels where water passes through to the farms were badly damaged, hence farmers were/are not able to farm in the dry season for the past three years. However, animals have access to water for drinking from the dam and household access water from the dam for household consumption (building and construction). On the other, the Soe Kabre community (the resilient community) does not have a dam. Discussants in an FGD lamented that, their animals do not have access to water for drinking in the dry season. Households cannot also cultivate crops in the dry season. It is hypothesized that households with irrigation facilities will be less vulnerable to changing rainfall patterns [7]. Contrary to this assertion, the Gowrie Kunkua community is still vulnerable despite the presence of an irrigation facility in the community. The presence of radios, television or mobile phone in a rural household can be an effective tool for communication and accessing information on changing weather patterns [30]. Physical assets in the form of road network and the availability of markets and health facilities can improve the adaptive capacity of a household [39]. The Gowrie Kunkua community has a road linking to the district capital (Bongo - 8 km) and Bolgatanga (the regional capital - 15 km) though not in good shape. The Soe Kabre community did not have a road from the community to the main town but the main town has a road linking to Burkina Faso market (9 km) and Bongo market or district (10 km). Other studies have tinted that, the development of rural infrastructure could encourage the development of non-farm enterprises [22] and that, good road networks will mean that farm produce are transported to the market on time and sold in order to obtain financial resources that can be used to purchase food items to reduce the vulnerability of households to drought-related food insecurity [39]. These assets did not significantly vary among various households either in the resilient or vulnerable communities.



**Figure 3:** Donkey cart (for carting goods, fetching water for dry season gardening)

Source: Field Survey, July 2015.

### ***Natural capital***

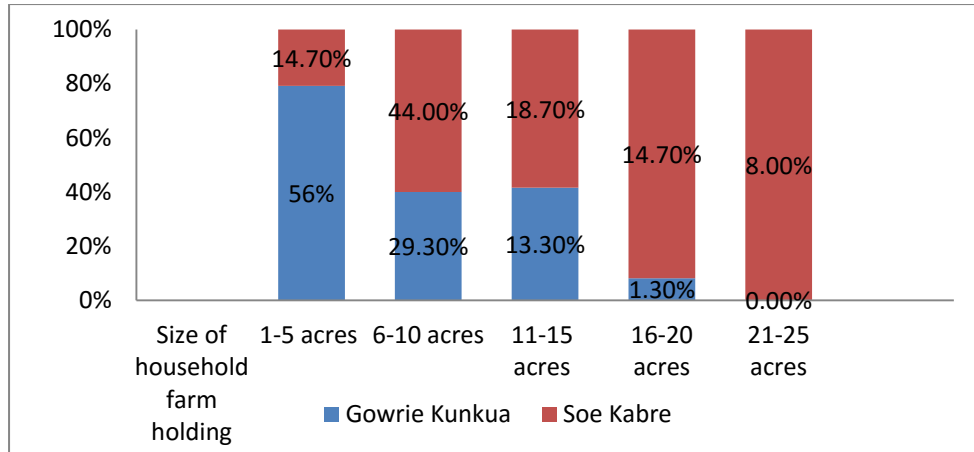


Natural capital assets comprise of natural flow and stocks, land, and biological resources such as trees and biodiversity [32]. In the study area, the rural households considered farmland as the most important natural capital. Households also indicated that, availability of water, grazing land, soil conditions and fuel wood are important natural assets. In general, land holdings were small and varied between households and communities in this study. The One-Way ANOVA confirmed that these differences are statistically significant (at  $p < 0.001$ ).

The first was the size of the farm holding under cultivation, which was estimated as the average area of cultivated land. The study revealed that (as shown in figure 3), 56% of households in the vulnerable community (Gowrie Kunkua) cultivates between 1-5 acres of land while 14.7% of households in the resilient community (Soe Kabre) cultivates between 1-5 acres. It further revealed that, 44% of households in the vulnerable community cultivates between 6-20 acres while 85.3% of households in the resilient community cultivates between 6-30 acres. The One-Way ANOVA confirmed that these differences are statistically significant (at  $p < 0.001$ ). This perhaps explains the vulnerability of the Gowrie Kunkua community, despite the presence of a dam and an irrigation facility (not function any more). It is assumed that the larger the farm holding, the greater the opportunity for the household to have more crops and yields, and hence the lower the vulnerability to climate change. On the contrary, it is worth stressing that a household with a larger farm holding may be more dependent on agriculture and therefore more vulnerable than someone with a small area of land under cultivation, but who works as a teacher or mason/carpenter [7]. The resilient community due to its closeness to the forest belt between Ghana and Burkina Faso, is endowed with a vast pasture or grazing land for animal production. The vulnerable community on the other hand lacks adequate land for farming and no land is left for animals to graze. The resilient community is also endowed with a lot of economic and fruit trees such as shea, dawadawa among others while the vulnerable community has very few trees.

The second indicator of natural capital was the type of land ownership system under which the household is operating. The type of land ownership and level of security it provides may have serious implications for the management of agricultural soils, and could indirectly affect crop productivity and environmental sustainability, consequently influencing household vulnerability [15]. Three different ownership types were identified in the study communities. These were "land inherited", "land purchased" and "land rented" by the households. The study discovered that, 5.3% of households in the vulnerable community purchased land, 90.7% inherited the land from their ancestors and 1.3% of households rented the lands. In the resilient community, 1.3% of households purchased land for their farming activities, 98.7% of the households inherited the land from their ancestors and 0% (no household) rented land in the resilient community. This indicates an abundance of land in the resilient community than the vulnerable community.

The Pearson correlation is 0.447 (\*\* Correlation is significant at the 0.01 level (2-tailed). There is a moderate positive relationship between household land holdings in the Gowrie Kunkua and Soe Kabre community statistically significant (at  $p < 0.01$ ).



**Figure 4:** Size of household farm holding

Source: Field Survey, July 2015.

**Financial capital**

[24] are of the view that, financial capital assets viz cash, savings and availability of credit, wages, liquid assets (livestock, poultry, jewelry), pension and remittances play an essential responsibility in cushioning households against drought-related livelihood insecurity. Livestock was considered to offer readily available cash in times of crop failure due to erratic rainfall patterns in the study communities. In this study, 89.3% of household in the vulnerable community owned livestock and poultry while 94.7% of households in the resilient community owned livestock and poultry (Figure 5 a and b). The major sources of finance include agricultural products (crop and livestock production, economic trees), engagement in food-for-work/cash-for-work activities, remittances and non-farm and off-farm activities. Livestock, as a financial asset, contributes to household livelihoods in many ways in the study area. It begets income through sale of animals and/or animal products, which enables households to purchase food and agricultural inputs. [9] noted that livestock can be considered as a liquid asset that can be turned into other forms of financial capital relatively quickly. This means agricultural products are considered the leading source of income in the study communities and grain production is the major activity of the sample households.



**Figure 5:** (a) household poultry and (b) livestock

Source: Field Survey, July 2015.

#### 4.2 Household livelihood strategies

As it is shown in (Figure 6), 97% of households in the vulnerable community and 99% of households in the resilient community were engaged in *on-farm* livelihood strategies (crop and livestock production). 51% of the households in Gowrie Kunkua and 46% in Soe Kabre were engaged in *off-farm* livelihood strategies (petty trading) besides the major livelihood activity (crop farming and livestock production). 12% and 9% of households in Gowrie Kunkua and Soe Kabre communities respectively, were engaged in *non-farm* livelihood strategies such as civil service, temporary migration and gifts/remittances.

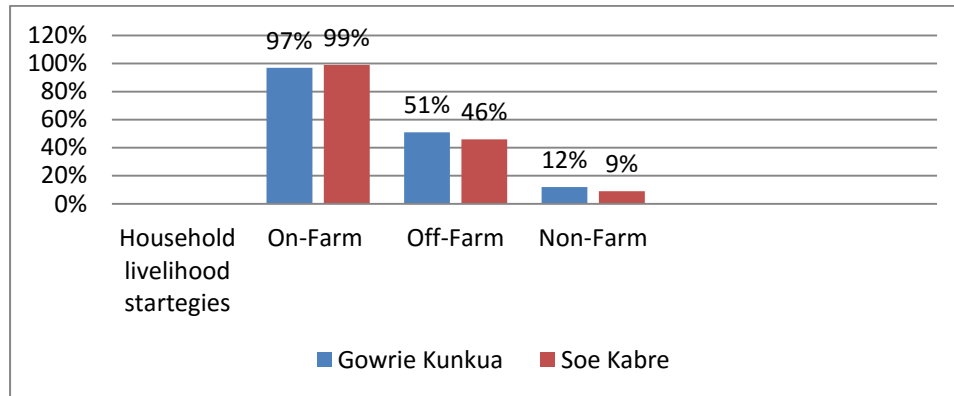


Figure 6: Household livelihood strategies

Source: Field Survey, July 2015.

[12] reported that the inherent seasonality and year-to-year variability of agricultural enforced the rural poor to engage in livelihood diversification which is consistent with this present study. This research is also in tandem with [27] who observed that, rural households obtain livelihoods from agriculture, rural labour market and self employment in rural non-farm economy, and others through migrating to towns, cities and other countries.

#### 4.3 Livelihood activities of smallholder households

The major livelihood activities across the study communities were crop farming, animal production, pito brewing and malt processing, labour on non-farm jobs (masonry, pottery, pealing of hoes, civil service) as well as shea butter processing. These livelihood activities were being engaged in both studied communities. Other livelihood activities were peculiar to the locality or community due to differences in the agro-ecology. For instance, smock weaving was not engaged by any household in the Gowrie Kunkua community whiles 2.6% ( $r = 7$ ) of households in the Soe Kabre community were engaged in smock weaving. Basket and hats weaving was engaged by 14.6% ( $r = 3$ ) of households in the Gowrie Kunkua community whiles none (0%) of households in the Soe Kabre community was engaged in basket and hats weaving (Table1). Also, fishing was a significant livelihood activity for the Gowrie Kunkua community with 11.5% ( $r = 5$ ) of households engaged in fishing whiles in the Soe Kabre community; fishing was not a livelihood option. Charcoal production was a livelihood option for Soe Kabre with 2.2% ( $r = 8$ ) of sampled households engaged in charcoal production whiles Gowrie Kunkua did not have charcoal producers. This is attributed to the fact that, the Gowrie Kunkua community is

not close to any forest. Stone quarrying (8.2%) was engaged by households in the Soe Kabre community whiles in the Gowrie Kunkua community, no household was engaged in stone quarrying. There was, however sand winning in nearby communities (Vea and Bulungu).

**Table 1:** Livelihood activities of households

Livelihood Activities	Gowrie Kunkua				Soe Kabre			
	% within community, n=75	Rank	% within livelihood	% of total	% within community, n=75	Rank	% within livelihood	% of total
Crop Farming	23.4%	1	50.0%	13.6%	32.3%	1	50.0%	13.6%
Animal Rearing	20.6%	2	49.3%	11.9%	29.3%	2	50.7%	12.3%
Petty Trading	13.7%	4	73.3%	8%	6.9%	5	29.7%	2.9%
Basket weaving	14.6%	3	100.0%	8.5%	0.0%		0.0%	0.0%
Smock weaving	0.0%		0.0%	0.0%	2.6%	7	100%	1.1%
Fishing	11.5%	5	100%	6.7%	0.0%		0.0%	0.0%
Stone Quarrying	0.0%		0.0%	0.0%	8.2%	4	100%	3.4%
Shea nut picking and butter processing	3.1%	8	27%	1.8%	11.6%	3	73%	4.9%
Pito stock processing and brewing	3.7%	7	50%	2.2%	5.2%	6	50%	2.2%
Charcoal production	0.0%		0.0%	0.0%	2.2%	8	100%	0.9%
Others (masonry, pottery, peeling of hoes, civil service)	9.3%	6	88.2%	5.4%	1.7%	9	11.8%	0.7%
Totals	100%			58%	100%			42%

Source: Field Survey, July 2015.

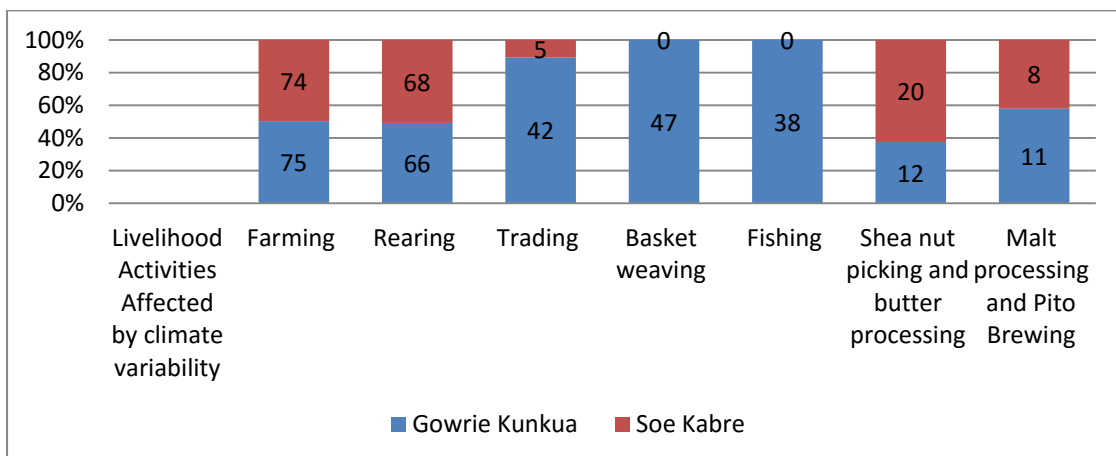


**Figure 7:** (a) A fisherman with fish ready for sale    Figure 4 (b) pito stock/malt processing

Source: Field survey, July 2015

**4.4 Livelihood activities negatively affected or disrupted by climate change**

As shown in figure 8, all 75 (100%) of sampled households in the Gowrie Kunkua community and 74 (98.7%) of sampled households in the Soe Kabre community indicated that farming (crop farming) as a livelihood activity was disrupted or severely affected by climate change. Crop farming through perennial droughts, erratic and delayed rainfall pattern is severely disrupted by climate change and this consequently has led to declining crop production [7]. Similarly, 66 (44%) and 68 (45.3%) of sampled households in the Gowrie Kunkua and Soe Kabre community respectively, revealed that livestock production (including poultry) is severely affected by climate change. A study by [18] indicated that, about 83.1% of households noted livestock farming was most disrupted by climate change which supports the current study. Livestock production is particularly hampered by the unavailability of pasture/grass for animals to graze, inadequate water for animals to drink and more importantly diseases have been killing animals in recent times.



**Figure 8:** Livelihood activities affected by climate variability

Source: Field survey, June 2015

As shown in figure 8, 42 and 37 households in the vulnerable and resilient communities respectively, said that, petty trading is disrupted or affected by climate change in the form of high and unstable food prices and supply among others. Basket weaving and fishing as livelihood alternatives in the vulnerable community were disrupted by climate change as indicated by 47 and 38 sampled households respectively. Fish stock, according to a FGD has reduced heavily as compared to the periods before 1980s and this reduction in fish stock is caused by the reduced amount of rainfall. Key informant noted that, “basket weaving is also hampered since the grass (vertiver grass) whose straw is used for the weaving of baskets and hats is gradually disappearing”. Basket/hats producers are compelled to buy the straw from markets in the Brong Ahafo and Volta region at a high cost. The gradual disappearance of sheanut trees and the inability of the existing trees to bear enough fruits due to high temperature, severe wind storms and poor rainfall have hampered the local shea industry. Shea nut picking (or butter processing) is severely disrupted by climate change as indicated by 12 and 26 sampled households in the Gowrie Kunkua and Soe Kabre communities respectively. Pito brewing (or malt processing) is also disrupted by climate change as hinted by 11 and 8 sampled households in the Gowrie Kunkua and Soe Kabre communities respectively. Low crop yields, particularly sorghum or guinea corn is the key factor affecting pito brewing since this culminates in high prices of sorghum. Discussant at a FGD also noted that, due to the high temperature, there is usually poor germination of the pito stock during the malt processing and this consequently leads to bad pito (poor taste and quality).

A one-way ANOVA was used to test the null hypothesis that livelihood activities are not affected by climate change.  $H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ . The One-Way ANOVA showed that livelihood activities (farming, animal rearing, trading, basket weaving, fishing, shea nut picking and butter processing, pito malt processing and brewing) were indeed severely affected by climate change statistically significant (at  $p < 0.005$ ). Since the  $F$  cal (4.554753)  $>$   $F$  crit (3.554557), we conclude that livelihoods activities are severely affected by climate change.

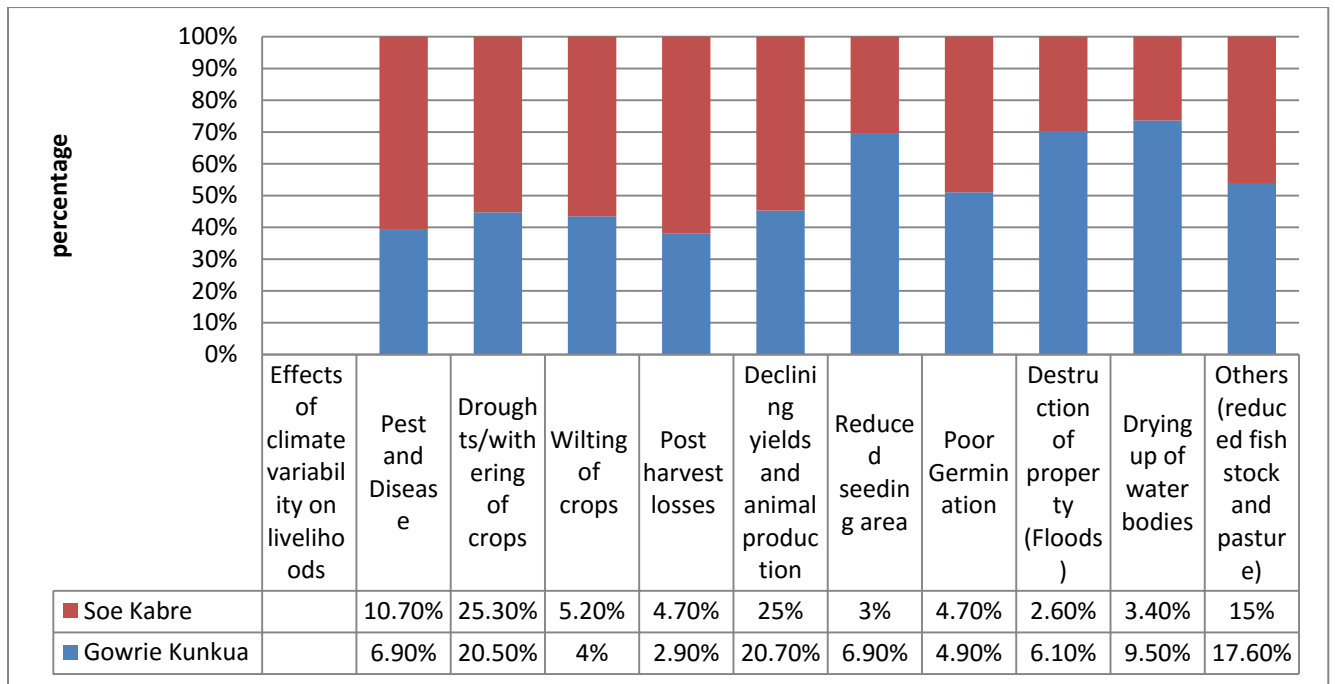
#### ***4.5 Negative effects of climate change on livelihoods of smallholder households***

As shown in figure 9, 20.5% and 25.3% of households in Gowrie Kunkua and Soe Kabre respectively, reported droughts which results in withering of crops as a major negative effect of climate change on their livelihoods. As indicated by [36] and supported by this study, droughts affect household livelihood more than other circumstances (floods) since wet years are normally good years and hence there are less extreme cases in which excess rainfall results in yield declines. The particular types of drought reported by sampled household include meteorological, agricultural and socio-economic droughts. Households noted that rainfall was deficient and mostly shortage. The rains fall below the regular or expected amounts in a season. This confirms [28] definition of meteorological droughts as deficient by two times below the standard deviation of the mean. Households also noted that, crops had inadequate water (thus withers) to grow and yield unsatisfactorily which confirms [28,36] illustration of agricultural droughts. Although it is difficult to monitor agricultural droughts since moisture needs of different crops vary considerably, households and KIs noted that, in drought years, there is always inadequate supply of food or farm produce in the markets which results in high prices of food. This assertion in the description of [28] is referred to as socio-economic droughts. Discussants in FGDs held across the study communities and KIs noted that, when droughts occur, food availability reduces, feed/grass and water

for animals also reduces and the land degrades. This consequently results in high prices of food which reduces income and hence livelihood insecurity. They also noted that, when grass availability for grazing reduces, households are compelled to sell their livestock at a very low price (supply exceeds demand) and this consequently reduces household livelihood assets. These findings are consistent with [23] earlier observation. A key informant also noted that “soil erosion caused by loss of vegetative cover due to overgrazing and over cultivation in the midst of droughts increase the vulnerability of households”. Reference [23] confirmed that, land degradation reduces the value of assets and the productive capital hence livelihood insecurity. Rainfall variability, which has triggered many drought events in the UE/R have led to negative effects on farming activities resulting in decreasing trend for crop and animal production and subsequently food shortfalls hence food and livelihood insecurity, lower incomes and malnutrition. The effects of droughts range from inadequate water for crop and livestock production, which resulted in crop failure and the death of livestock hence severe hunger and malnutrition. Reference [16] identified hydrological imbalances, declining crop and animal production, lower germination rates, premature flowering and low quality grain as the problems droughts presents to farmers. Reference [16] observation is in tandem with the present study.

Another effect of climate change reported in this study, though not significant is wilting of crops by excessive rainfall. 4% and 5.2% of households in Gowrie Kunkua and Soe Kabre respectively, reported wilting of crops as effects of climate change on their livelihoods. Excess rainfall (as happens in some few months –August) is harmful to crops like millet and sorghum. Discussant noted that, the rains sometimes concentrate and fall heavily in a particular month (August) causing loss of grains stored and unavailability of sunlight to dry the harvested crops at that particular period (millet). Other devastating effects of climate change include post harvest losses as indicated by 4.7% of households in the Soe Kabre community and 2.9% of household in the Gowrie Kunkua community. About 6.9% of households in Gowrie Kunkua and 10.7% of households in Soe Kabre communities respectively indicated that, climate change affects their livelihood through pest and disease. This assertion is supported by [33], that, climate change and extreme weather conditions are eroding households/farmers livelihoods through decreases in crop yield periodically complicated by the proliferation of insect infection, pathogens, parasitic weeds, diseases, reduced availability of and access to medicinal plants and biodiversity loss. Approximately, 3% and 6.9% of households in Soe Kabre and Gowrie Kunkua communities respectively labeled reduced seeding area due to late onset of the rainfall season as an effect of climate change currently hampering their livelihoods and increasing their vulnerability.

About 4.7% of households in the Soe Kabre community and 4.9% of households in Gowrie Kunkua mentioned poor germination of crops due to high/hot temperature and less rainfall as an effect of climate change on their livelihoods. The destruction to physical property, loss of life and livestock as a result of floods was indicated by 2.6% and 6.1% of households in Soe Kabre and Gowrie Kunkua community respectively as a critical menace of climate change on their livelihoods. Some households reported having lost their animals to floods, but there was no mention of loss of human life in both studied communities. 3.4% and 9.5% of household stressed on drying up of water bodies as effects climate change presents on their livelihoods. Focus Group discussant noted that, “streams, ponds, lakes, rivers, dams and even ground water are drying up due to droughts (poor rainfall)”. Reference [28] classify this explanation or assertion as hydrological droughts.



**Figure 9:** Climate change effects on livelihoods of smallholder households

Source: Field Survey, July 2015.

Reference [25] suggested that, natural assets such as rivers, lakes and fish stock are disrupted by climate change and extreme weather conditions. Around 16% and 17.6% of households in Soe Kabre and Gowrie Kunkua communities respectively mentioned other effects of climate change such as reduced fish stock and pasture, killing of micro-organism in the soil, inadequate termites and erosion of cultural and social assets through interruption of familiar social linkages of the poor, women, elderly and women-headed households as negative effects of climate change on household livelihoods. Reference [25], projected that the effects of climate change in fishing will exceed that of overfishing by humans and other human impacts. Reference [16] confirms these research findings by indicating that, local fish supplies are negatively affected by climate change due to increasing temperature and less rainfall. He further indicated increased contaminants and reduced quality of water, low yields and animal production, reduced liquidity and hunger as the human livelihood effects of climate change [16]. A single factor or one-way ANOVA was used to test the null hypothesis that the effect of climate change on livelihoods is due to chance.  $H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8 = \mu_9 = \mu_{10}$ . The one-way ANOVA showed that the effects of climate change (pest and disease, droughts, wilting of crops, post harvest losses, declining yields, reduced seeding area, poor germination, destruction of property by floods, drying up of water bodies and others) present severe negative effects on livelihoods of households which is statistically significant (at  $p < 0.001$ ). Since the ( $F_{cal}$ ) 6.374873 > ( $F_{crit}$ ) 3.354131, we conclude that, climate change presents severe effects on livelihoods of smallholder households.

**5. Conclusion**

Smallholder households are under considerable stress of livelihood insecurity since key livelihood activities are



severely threatened by climate change. Livestock plays a crucial role in supporting households in times of food shortfalls; however, the number of livestock owned per household dramatically declined, which has contributed to destitution and marginalization of the smallholder households. The resource base such as farmland, grazing land and forests has reached their critical stage of degradation, and this is the main cause for the decline of agricultural production and productivity. Non-farm/off-farm livelihood activities are vital to supplement the income gained from agricultural activities, but few sampled households were engaged in off-farm/non-farm livelihood activities which are indications that the livelihood strategies pursued by smallholder households in the UE/R are entirely dependent on rain-fed agriculture which is extremely vulnerable to natural and human induced factors. Therefore, policy makers need to formulate more specific and targeted climate change adaptation policies and robustly pursue livelihood diversification strategies in order to reduce the vulnerabilities of smallholder households whose livelihoods depend largely on rain-fed agriculture.

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