An Assessment of Institutional Importance of Climate Change Adaptation in the Volta River Basin of Northern Ghana

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Abstract

Climate change affects a lot of sectors including agriculture. Several measures are being adopted to avert the impacts associated with it. Water resources in semi-arid areas are not excluded. The study, conducted in Lawra District of Upper West region of Ghana was undertaken to identify and assess the adaptation strategies adopted by settlers along and in the Volta River Basin as well as to analyse the level of agreements among the institutions that are helping farmers to adapt to climate change impacts. This study used a mixed method including focus group discussion and a semi-structured questionnaire to obtain information from 160 farming households in 8 randomly selected communities in the Lawra district. Results revealed three classes of adaptation strategies which include environmental, cultural/agronomic and economic strategies. Majority (65%) of the settlers adopted the environmental practices, whiles 52% of the respondents also adopted the cultural/agronomic practices and less than half of the respondents (31%) adopted the economic practices. We viewed that adoption levels, though more than half of the respondents adopted the environmental and cultural strategies, are still not encouraging given the magnitude of interventions related to water management. The results also reveal that community watchdogs, climate change, agriculture and food security platforms and non-governmental organisations are the three most important institutions working to improve farmer resilience to climate change. Therefore the results could re-stimulate policy implementation with the overall aim of increasing adoption levels of the strategies. Only when this is done, will a significant step have been taken towards saving our water resources from climate change impacts.

Introduction

The fundamental importance of freshwater to the economic growth and social activities in Sub-Saharan Africa cannot be overemphasized. Water is used in many sectors of the Ghanaian economy including sanitation and hygiene, crop production, livestock raising, industry, urban development, generation of hydropower, inland fisheries, transportation and eco-tourism (Kankam-Yeboah *et al*., 2013; McCartney *et al*., 2012). Improvements in these sectors are being challenged due to the global issue of climate variability and change (IPCC, 2007; Thornton *et al*., 2014) and partly due to non-climatic factors (EPC, 1991). Over decades, the adverse effects of climate change and variability on physical and biological systems across the world have been pervasive (Rosenzweig *et al*., 2007), and the impacts are highly felt in Sub-Saharan Africa (Niang *et al*., 2014; Osei, 2017). The impacts arise as a result of seasonal changes of key climatic stressors such as drought, high temperature, floods and erratic rainfall (Antwi-Agyei *et al*.,2017; Lambert, 2014), thereby affecting the volume of water in most river basins in Ghana including the Volta River Basin. The negative effects would affect agriculture, the environment and human livelihoods (Ndamani and Watanabe, 2015).

The Volta River and its tributaries serve as a good source of water for the inhabitants of six riparian states namely; Ghana, Benin, Burkina Faso, Cote d'lvoire, Mali and Togo (McCartney *et al*, 2012). It is hypothesized that, the stress on the basin is likely to rise due to increase water demand and climate change in the near future (McCartney *et al*,

2012). Agriculture in Ghana, which greatly depends on available water sources employs the majority of the basin's inhabitants and generates about 40% of the basin's economic output (Biney, 2010). With the recognition of significant reuse of water, the river basin is increasingly acknowledged as the appropriate unit for the analysis and management of water resources, especially as water availability at the basin level becomes the primary constraint to agriculture (Bandaragoda, 2000). In recent years, the pressure on the Volta river basin has increased, partly due to increase in population growth in two countries (Ghana and Burkina Faso). The greater part of the basin lies within these two countries where their high human populations depend on water to meet their growing demands (van de Giesen *et al*. 2001). The growing scarcity of good quality water in most river basins results in intense inter-sectoral competition for water (Bandaragoda, 2000).

Although seasonal shortages are quite common, such shortages are due primarily to poor management and inadequate use of available technologies. Other factors related to the problems of water availability in the basin include regulatory; administrative and institutional conditions; flooding; water pollution and improper land use; high fluoride concentrations in groundwater; high salinity of groundwater; socio-cultural conditions and economic and financial aspects (EPC, 1991).

An integrated approach to water resources management in a river basin would enhance both productivity and sustainability of natural resource use (Bandaragoda, 2000). This would involve the collective efforts of both formal and informal institutions. Institutions are a composition of formal and informal organisations that serve as a conduit for decision-making among societal structures (McGray and Sokona, 2012). The roles played by rural-local institutions contribute significantly to sustainable livelihoods in various ways and are important precursor for dealing with elements of insecurity and vulnerability (Uphoff and Buck, 2006). The rules and norms in any society through which individuals share ideas are also institutions. Organizations, rules and norms are all necessary foundation for both short- and long-term action on climate change. These institutions may need to adapt substantially as the climate problem worsens (McGray and Sokona, 2012).

Agrawal *et al*. (2009) in their publication of "the role of local institutions in adaptation to climate change" classified institutions into three types namely: public, private and civic institutions. The public institutions include local agencies and local government, while the private institutions are the service organisations and private businesses. The civic institutions include the membership organisations and cooperatives.

Institutions are also classified as formal-local and external institutions. The formal-local institutions are composed of village council/ chiefs and subjects, forest local management committee, family meetings and local NGO's. The external institutions are local government agency, international organisations and international research centers (Brown and Sonwa, 2015). Similarly this research has broadly classified these institutions into two types: formal and informal institutions given the level of national interest in contributing to the adaptive capacities of rural farmers in the Volta Basin.

In sub-Saharan Africa, farmers who practice smallholding agriculture have adopted a

number of adaptation measures to cope with the changing climate (Osei, 2017). In view of the afore-mentioned, several measures are being adopted, by inhabitants along the Volta River to reduce, if not completely eradicate, the impacts that climate variability and change comes with, especially its impact on agriculture. This research therefore revealed the current adaptation practices in relation to river water management and the institutions that are helping the course to adopt better measures as far as climate change is concern.

To better understand climate change, it is imperative to know the role played by institutions that are working to improve farmers' resilience against climate change impacts. Previous researches focused on adaptation strategies (Akinnagbe and Irohibe, 2014; Amusa *et al*., 2015; Ndamani and Watanabe, 2015) without considering institutions that will help farmers to take-up adaptation strategies. This is what this study has considered. By using the mixed method, this study identified adaptation strategies and further measured the rate of adoption of each strategy, having classified them into three major groups. The study further identified the institutions which are needed to work together to enforce the adoption of the adaptation strategies. In light of the foregoing discussions, the specific objectives of the study are to; (i) identify the adaptation strategies used by farmers to increase their resilience against climate change impacts and (ii) analyse the level of agreements among the institutions that are helping farmers to adapt to climate change impacts.

The findings from this study will help policy makers to address the adaptation needs of farmers as well as provide a conduit through which effective and efficient linkages can be built among formal and informal institutions in the fight against climate change in the area. The paper has been organised into five sections. Section one looks at the introduction where a brief literature has been reviewed and problem and justification of the study stated. While section two deals with the methodology, section three presents the results of the study. Finally, section four and five presents the discussion of the results and conclusion and recommendations respectively.

Methodology

Study Area

The Lawra District is one of the eleven districts that make up the Upper West Region. It lies in the north-western corner of the Upper West Region of Ghana. It is bounded to the north by Nandom District, to the east by Lambussie-Karni District, to the south-west and west by the Republic of Burkina Faso and to the south by Jirapa District. It lies within longitude 10°30′ N and latitude 2°35′ W. The total area of the district is 527.37 square kilometres. This constitutes about 2.8 percent of the Region's total land area, which is estimated at 18,476 square kilometres. Lawra District has over 80.0 percent of the inhabitants living in the rural areas. According to 2010 population and housing census, the district's population was 54,889, representing 7.8% of the region's total population (GSS 2014). The population density of the district was 104.1 per square kilometre (GSS, 2010).

The district lies within the Guinea Savannah Zone which is characterized by short grasses and few woody plants. The greatest influence on the vegetation is prolonged dry season. During this period, grasses become dry and subsequent bush burning leaves the area patchy and mostly bare of vegetation.

Consequently, torrential early rains cause excessive soil erosion. The climate of the district is the tropical continental type with mean annual temperature ranging between 27°C and 36°C. Annual rainfall ranging from 900 – 1200mm usually starts in May/June and ends in September (GSS 2014). The rest of the months are left to the dry spell. Four main sources of water in the district are borehole, pipe borne water, protected well and river. About two-thirds of the households (66.4%) drink water from bore holes.

The rock formation in the District is essentially Birimian with dotted outcrops of granite. As a result of a well- developed fracture pattern in the rocks, the potential for obtaining ground water in the district is very high which makes it suitable for all year-round farming (GSS 2014). The soils in the district consist mostly of laterite soils. There are also strips of alluvial soils along the flood plains of the Black Volta as well as sandy loamy along some of its tributaries (GSS 2014). Agriculture is the major economic activity in the district, employing about 78.0 percent of the working population (GSS 2014). About 80.0 percent of the farmers are into subsistence agriculture, producing mainly maize, millet, groundnuts, soya bean and cowpea. Animal production is a major agricultural activity undertaken by the people to supplement incomes from crop farming (GSS 2014).

The study was conducted in eight (8) farming communities in the Lawra district of the Upper West Region of Ghana. The communities include Orbilli, Bagri, Metor, Dikpe, Brifochaa, Yikpe, Yarpele and Naburnye.

Research Methods and Sampling Procedure

The research employed both quantitative and qualitative methods to obtain data for the study. Pre-tested questionnaire were designed and used to collect quantitative information. The major quantitative information obtained was the percentage of farmers adopting a particular adaptation strategy. Qualitative data was obtained through focus group discussions with community members and some selected key institutions working to improve livelihoods in the area. A desktop review of information

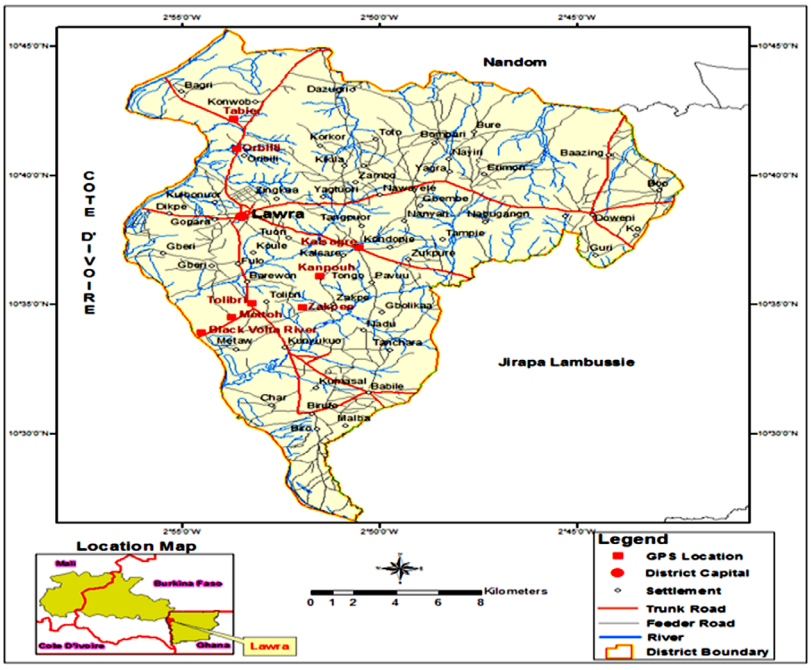


Figure 1: District Map of Lawra, Upper West Region of Ghana
Source: Lawra District Assembly

on institutions working on climate change in the area was also conducted. A multistage procedure of sampling was used for the study. The first stage involved purposive sampling of Lawra district. This is due to the prevalence of the effect of climate change on food security in the area and the fact that there have been interventions on climate change vis-a-vis water management projects in the area. Stage two involved a random selection of seven communities close to the Black Volta River and one community involved in water usage and management for livelihood change. The third stage involved a random selection of 160 farm households in these communities.

Data Analysis

The data was analysed using Statistical Package for Social Sciences (SPSS) version 21. Farmers were made to score the types of strategies they adopt towards water management. The strategies include resettlement of some communities away from the river, avoiding crop farming close to the river, prevention of bush burning and discouraging deforestation near the river. Others are safe methods of fishing without having to use chemicals, ridging across the slope, the use of animal manure to fertilise arable lands, planting of economic trees near the river and taking advantage of some tributaries of the river to construct micro-dams.

Following Adams and Ohene-Yankyera (2015), each of the strategies were scored by attributing percentage of adoption by the farmers. A strategy receives zero percentage if no farmer adopts it. The strategies were then categorized into three broad strategies and the percentage means were calculated to determine the level of adoption of each broad classification. For example, if a farmer adopts seven out of the nine strategies and the score is 50, 30, 65, 0, 45, 70, 0, 60 and 80, then such farmer's percentage mean score is 44.4%. This is calculated as (50 + 30 + 65 + 0 + 45 + 70 + 0 + 60 + 80)/9. Depending on the number of strategies under each broad classification, the percentage mean scores were determined for each broad strategy. The broad strategies/ classification includes environmental, cultural/agronomic and economic adaptation strategies.

On the second objective of this paper, a set of formal and informal institutions was identified through literature search and farmer Focus Group Discussions were used to ascertain which institutions were more important in terms of role played to minimize, prevent or build farmers resilience to climate change hazards. The institutions are Financial Institutions (FIs), Forestry Commission (FC), Farmer Based Organisations (FBOs), Non-Governmental Organisations (NGOs), Community watch Dogs (CwD), Climate Change, Agriculture and Food Security Platforms (CCAFS-Ps), District Assemblies (DAs), Traditional Authorities (TAs) and Ghana National Fire Service (GNFS).

Description of Institutions Identified

Financial Institutions: The main financial institutions that support farmers are the Lawra Rural Bank, Group Ndoum (GN) Bank and other Village Savings and Loan Associations (VSLA). The support is mainly in the form of loans to groups and individuals.

Forestry Commission: The forestry commission is responsible for the management of forest and forest products within the district. They are the formal organisation with the mandate of preserving forest species, by making sure that inhabitants do not indiscriminately cut down

trees at reserved places within the district.

Farmer Based Organisations: The Farmer Based Organisations are like the Climate Change, Agriculture and Food Security Platforms (CCAFS-P) but the difference is that, the FBOs were in existence long before the creation of the CCAFS-P. Also the CCAFS-Ps usually composes of other organisations that matter, to increasing the resilience of vulnerable people to climate change.

Non-Governmental Organisations: The NGO's have for many years been operating in the area to improve food and livelihood security. Their impact has been phenomenal. Through their activities, most communities that hitherto did not have good drinking water, have good sources of water now. Boreholes and dams have been developed by these NGO's.

Community Watchdogs: This is a body of carefully selected individuals within the community or village with the sole aim of clamping down illegal activities. The work of these individuals is purely on volunteerism, and they do not receive any form of pay for discharging their duties.

Climate Change, Agriculture and Food Security Platforms: The CCAFS-P is a body of people in selected communities of Lawra district that sees to the effective adoption of climate-smart agricultural practices. This body of people were organised as a result of effective implementation of CCAFS projects in the district, including other parts of northern Ghana.

District Assembly: The DA is the government representative in Lawra district, indeed in all districts of Ghana, which are responsible for local governance of the district. The National Disaster Management Organisation (NADMO) is a unit under the DA that is solely in-charge of the management of disasters. As annual floods do occur and destroy farms and other property, the DA comes in with management plans to control annual floods. In line with this study, Ripiye (2016) indicated that the government is mandated to assess the flooding potential of watersheds as well as to determine, design, develop and authorize the development of appropriate flood mitigation measures in the watersheds.

Traditional Authorities: The traditional authorities are usually the chiefs. They work with their subjects including the land owner, commonly referred to as the Tindana, to protect the interest of the community including the protection of water bodies in the village. To enforce by-laws, they work in tandem with other community leaders such as assembly members and other youth groups.

Ghana National Fire Service: The Ghana National Fire Service is another institution that were identified. Among other duties, their main duty is to prevent and control fire accidents in the district.

The research therefore sought to know which institutions are key in helping to make sure that the society does not negatively exploit the water bodies. Management of water bodies involves stakeholders known in this study as institutions. On this basis, a set of institutions, identified from literature and Focus Group Discussion, were presented to farmers to rank the order of importance of such institutions. The farmers believe that to avert the challenges of climate change, these institutions are key, but it is important to know which ones are more important than the other.

Farmers at individual questionnaire level were made to rank the institutions based on their importance in reducing the effects of climate change. The highest ranked (most important)

institution was assigned a value of one, and in that order up to the last ranked institution.

There exist several ranking methods for institutional analysis. These include Kendall's coefficient of concordance, Pearson's correlation coefficient, the Spearman rank correlation, Garrett's ranking technique and Freidman's two way analysis of variance. However the Kendall's coefficient of concordance and the Garrett's ranking technique are the two most widely used methods, especially in constraint analysis. Moreover, except the statement of hypothesis, the Kendalls' coefficient of concordance and the Freidman's two way analysis of variance are the same (Osei, 2017).

The Garrett method of ranking involves the ranking of factors according to order of importance. The rank scores are then converted into percent positions. The Garrett and Woodworth (1981) tables are then used to convert the percent positions of each rank into scores. The scores of an individual are summed up and divided by the total number of respondents who ranked that particular factor. By ranking the mean scores, the most important factor would be the one with the highest mean score.

This technique has its own shortcomings, thus it does not test for any hypothesis and level of agreement among rankings by rankers. This study therefore adopted the Kendall's coefficient of concordance. The Kendall's coefficient of concordance (W) is the measure of the degree of agreement among 'm' (number of rankers) of 'n' (number of constraints) ranks.

Kendall's coefficient of concordance (W) was used to measure the level of agreement among the rankings of the institutions by the respondents using their rank scores. Kendall's W has positive value ranging between zero (0) and one (1).

Given that T = the sum of ranks of each institution being ranked, the variance of the sum is given by;

$$Var_T = \frac{\sum T^2 - (\sum T^2)/n}{n} \quad (1)$$

And the maximum variance of T is then given by

$$\frac{m^2(n^2-1)}{12} \quad (2)$$

Where, m = Number of sets of ranking by the farmers and n = the number of specific institutions being ranked.

The coefficient of concordance (W) is therefore given as,

$$W = \frac{[\sum T^2 - (\sum T^2)/n]/n}{m^2(n^2-1)/12} \quad (3)$$

Equation (3) is further simplified to the computational formula as;

$$W = \frac{12[\sum T^2 - (\sum T^2)/n]/n}{nm^2(n^2-1)} \quad (4)$$

The hypothesis and the significance of the rankings are further assessed using the F-test as follows:

The null(H_o) and the alternative (H_a) hypothesis are stated as follows;

H_o: There is no difference in farmers' ranking of importance of formal and informal institutions.

H_aa: There is difference in farmers' ranking of importance of formal and informal institutions.

The coefficient of concordance (W) may be tested for significance using the F-statistic. This is given by,

$$F = \frac{[(m-1)w_c]}{(1-w_c)} \quad (5)$$

If the $F_{calculated}$ is greater than the critical F^* from Fisher's F-statistics distribution table, the null hypothesis is rejected; otherwise, it is

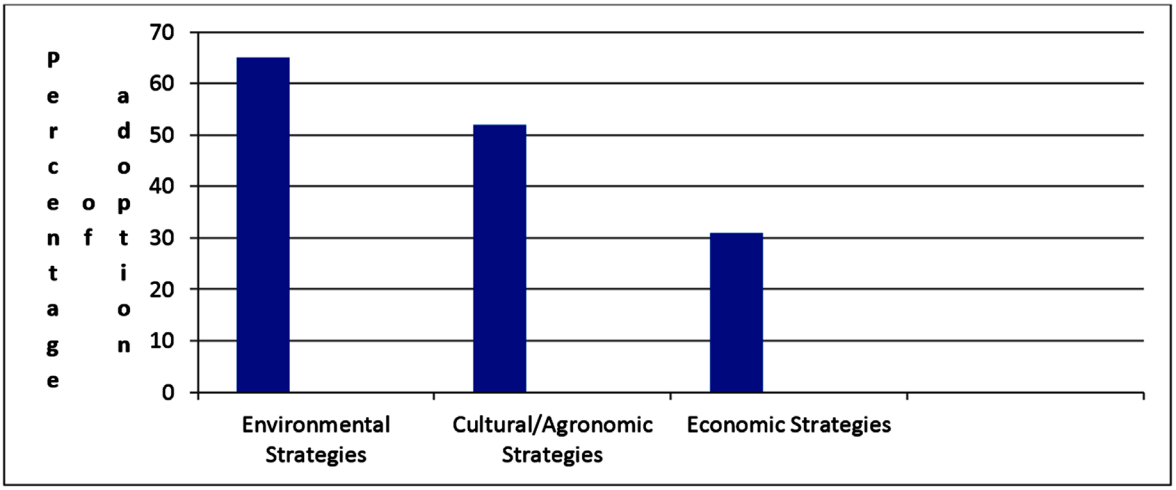
accepted.

Descriptive statistics such as percentages, frequencies and means were presented in tables, charts and graphs showing the number of farmers who think these institutions are important to dealing with the menace of climate change.

Results

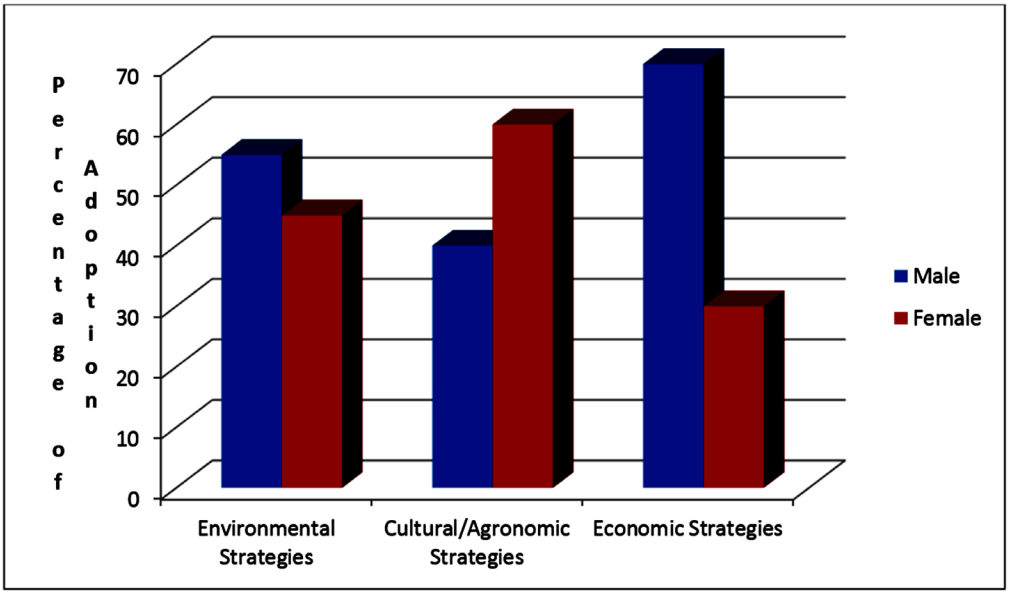
Generally, the results of the study on adaptation strategies were classified into three broad categories namely environmental, cultural/agronomic and economic strategies. Majority (65%) of the settlers adopted the environmental practices, whiles 52% also adopted the cultural/agronomic practices and less than half of the respondents (31%) adopted the economic practices. It is the view of the authors that adoption levels, though some above 50% adoption rate, are still not encouraging given the magnitude of interventions related to water management. Figure 2 illustrates the degree of adoption of the water management strategies under the broad categories.

Tables 1 illustrate the means and mean ranks



Source: Field Survey (2017)

Figure 2: Degree of Adoption of Water Management Strategies



Source: Field Survey (2017)

Figure 3: Degree of Adoption of Water Management Strategies by Sex

TABLE 1
Institutions Engaged in Water Management

Communities	Orbilli		Bagri		Metor		Dikpe		Brifochaa		Yikpe		Yarpele		Naburnye		Overall Sample	
Institutions	Mean Rank	Rank	Mean Rank	Rank	Mean Rank	Rank	Mean Rank	Rank	Mean Rank	Rank	Mean Rank	Rank	Mean Rank	Rank	Mean Rank	Rank	Mean Rank	Rank
Financial Institutions	5.55	5th	4.00	4th	5.05	5th	4.70	4th	4.80	5th	4.20	4th	4.55	4th	4.95	5th	5.55	5th
Forestry Commission	5.95	7th	5.20	5th	5.95	7th	4.80	5th	7.05	8th	6.83	7th	5.53	6th	4.88	3rd	6.58	7th
FBOs	5.20	4th	6.28	6th	2.20	2nd	6.95	8th	4.60	4th	5.35	6th	5.40	5th	5.33	6th	6.03	6th
NGO's	3.75	3rd	1.98	1st	4.95	3rd	4.45	3rd	3.55	3rd	3.90	3rd	3.85	3rd	1.95	1st	4.15	3rd
CwD	2.00	2nd	2.18	2nd	2.05	1st	2.10	2nd	1.65	1st	1.60	1st	2.05	1st	2.60	2nd	1.93	1st
CCAFS-P	1.75	1st	6.65	8th	5.00	4th	6.00	7th	5.50	6th	2.15	2nd	5.55	7th	5.40	7th	2.13	2nd
DAs	8.05	9th	3.85	3rd	8.50	9th	5.95	6th	2.05	2nd	5.00	5th	2.35	2nd	4.90	4th	5.35	4th
Traditional Authorities	5.75	6th	6.63	7th	5.30	6th	1.90	1st	6.80	7th	7.03	8th	7.13	8th	6.13	8th	7.73	8th
GNFS	7.00	8th	8.25	9th	6.00	8th	8.15	9th	9.00	9th	8.95	9th	8.60	9th	8.88	9th	8.55	9th
Diagnostic Statistics																		
Kendall's W	0.604		0.618		0.513		0.568		0.765		0.745		0.591		0.528		0.583	
No. of Observation	20		20		20		20		20		20		20		20		160	
Chi-Square Calculated	96.707		98.869		82.107		90.880		122.453		119.220		94.609		84.437		746.353	
Chi-Square Critical	15.507		15.507		15.507		15.507		15.507		15.507		15.507		15.507		15.507	
Df	8		8		8		8		8		8		8		8		8	
Asymptotic. Sig.	0.000		0.000		0.000		0.000				0.000		0.000		0.000		0.000	

Source: Author's computation from field survey (2017)

of the institutions according to the various communities and the pooled/overall sample of 160 respondents.

Discussion

Climate Change Adaptation Strategies

Adoption of adaptation strategies has become necessary for vulnerable male and female poor farmers due to their high exposure and sensitivity (Alhassan *et al*., 2018). A number of adaptation strategies were identified and grouped into three main categories namely; environmental, cultural/agronomic and economic strategies.

Under environmental strategies, communities that were close to the Black Volta River had been resettled away from the river and farm lands near the river have been reclaimed for conservation, to prevent siltation. In north-east Ghana, Antwi-Agyei *et al*., (2014) also found similar results. Another main siltation measure was the prevention of bush burning and discouraging deforestation along the river. If bush burning occurs frequently, the banks of the river would be exposed to climate perturbations and can easily lead to gully erosion, thereby causing siltation. The findings of the study confirms the assertions of Antwi-Agyei *et al*., (2017) who attributed felling of trees for charcoal production and fuel-wood and farming around water bodies as leading causes of climate change. Siltation has major consequences to the Black Volta River, one of which is the disappearance of water production points in the river, and hence reduces the volume of water that would have been autonomously produced on annual basis. Another environmental measure was that farmers who are also fishermen and practice fishing in the Black Volta River stopped using chemicals to fish.

The second category of adaptation strategy is the cultural/agronomic strategy. This includes ridging across the slope and the use of animal manure as a land fertilisation option. The results revealed that farmers are able to harvest animal manure in adequate quantities by providing proper housing methods for their animals. The manure is then used to fertilise their deteriorating lands. It is economically impossible and laborious to collect manure from animals which are not house at night, as they may not sleep at one place where the manure can easily be collected. Animal manure in modern, confined agricultural systems is collected to avoid stockpiles and often applied to cropland or grazing land to replenish soil fertility (Johnson *et al*., 2007). Animal manure improves soil structure and increases water holding capacity of soil.

The third category of adaptation measures employed by the farmers is the economic strategies. This included the planting of economic trees, though the survival rate was low, near the Black Volta River. Mango is an economic tree. Fruits obtained from mango production are sold to make income for the farmer. Another economic strategy is the blocking of some tributaries of the river to harvest water for dry season gardening. This finding goes contrary to that of Antwi-Agyei *et al*., (2017) who found that dry season farming poses potential threat to sustainable development. Their view is that, as more land is needed, the consequences would be increased land degradation and deforestation. However, the current finding is in line with that of Morton (2007) who found irrigation activities as a coping strategy to climate variability and change among the developing world.

Further findings are that, during the rainy season, there are usually floods along the river including the tributaries, so some settlers have constructed micro dams to help them have access to water for livestock watering and for household water usage. In some communities, some of the dams have been developed into aquaculture sites. For this reason, management practices which indirectly lead to climate change adaptation are being observed, and include preventing people from washing in the dams, regulation of water usage for irrigation to avoid wastage of water, prevention of road and building contractors from using the water for their construction work, regulation of water build-up in the dams during the wet season, filling-up of holes on the dam banks caused by erosion to prevent siltation of dams, preventing people from swimming and placing of big stones around the bank of the dam to make it difficult for crocodiles to bore holes and find their way into the water. The crocodiles are prevented from entering the dam because of the aquaculture activities that are undertaken. The possibility of the crocodiles destroying the cages and nets used to harvest fish is predicted to be high, hence the preventive measure.

Ranking of Institutions Engaged in Water Management

On the ranking of importance of the institutions, nine institutions were identified during a Focus Group Discussion and were presented to farmers to rank during an individual semi-structured interview sessions for all 160 respondents sampled for the study. The test statistics (Table 1) indicates that Kendall's coefficient of concordance, W was 0.583 which means that there is 58.3% agreement among the rankers of the institutions. The results also reveals that the calculated chi-square ($\chi 2$), 746.353 obtained from the analysis is greater than the chi-square critical (15.507) obtained from chi-square distribution of the statistical tables with 5% (0.05) significance level and 8 degrees of freedom. Therefore the null hypothesis that there is no difference in farmers' ranking of importance of formal and informal institutions was rejected. The probability value of 0.000 at 1% level of significance further backs the results obtained.

The overall sample show that CwD, CCAFS-P and NGO's are the three most important institutions in the management of water resources, with mean scores of 1.93, 2.13 and 4.15 respectively, in the study area. The

CwD were ranked first in Metor, Brifochaa, Yikpe and Yarpele communities but ranked second in Orbilli, Dikpe, Bagri and Naburnye communities. It can also be obtained that the overall sample results was the same as the result of Yikpe when the ranking of institutions such as CwD, CCAFS-P and the NGO's were compared.

On the other hand, the three least important institutions are Forestry Commission, Traditional Authorities and the Ghana National Fire Service which have respective mean scores of 6.58, 7.73 and 8.55. That notwithstanding, these institutions have an impact in society. According to Arthur and Dawda (2015), the traditional authorities in collaboration with District assemblies have made tremendous contribution to up-lift the rate of development in their communities. Such contributions include engagement in advocacy works to enlighten their people in the payment of rates and taxes and the provision of watchdog role towards community and state resources.

The CCAFS-Platforms are usually a multi-stakeholder of individuals working together as a unit to enforce and re-design effective methods of climate change adaptation at national and district level. The national level platforms are made up of senior officials and actors drawn from various government agencies with the mandate of integrating climate change adaptation into agriculture and food security policies (Totin *et al*., 2017). District platforms are individuals and organisations at the district and village level. Their role is more of operational – thus coordination of climate-smart related activities ensuring consistency with local needs (Vermeulen *et al*., 2012). Depending on the geographical location, platforms can exhibit significant variation (Totin *et al*., (2017). The authors further indicate the composition of platform stakeholders to include traditional authorities, government agencies, district assembly, NGOs/Civil society and farmers (Totin *et al*., (2017).

The NGOs on the other hand have helped many communities with boreholes, sanitation facilities and equipment, education to mention but few. NGOs have had an oversight responsibility of operating as a gap-filling in the absence of the government, which has sometimes resulted in conflicting relations with governments (Ulleberg, 2009).

Community watchdogs are usually selected members of a community who see to it that people do not over exploit water bodies that they depend on for their crop, livestock and aquatic activities. A victim of bad water management is fined an amount of GHC 50.00, and that serves as a deterrent to others.

Another important observation in the results was that financial institutions was ranked 4th in four communities and 5th in four other communities, but was ranked 5th in the overall sample. Financial institutions such as the World Bank (WB), African Development Bank (AfDB) among others act as donors in the fight against the menace of climate change in many developed and developing countries including Ghana.

The GNFS were the least importance (mean score of 8.55) among all the institutions identified and considered in the study. A quote from a male participant in a Focus Group Discussion indicates that; the concentration and impact of the GNFS activities are felt in the district capital, Lawra, but not in the villages. The reason could be attributed to the fact that the study was conducted in rural communities of the Lawra District. It is not uncommon to find GNFS controlling fire accidents in the urban centres. Moreover, the inadequate involvement of the GNFS in fighting climate change could be as a result of inadequate number of fire stations in the district, and indeed the nation as whole.

Forestry commission (mean score of 6.58) is responsible for the management of forest reserve in the Lawra District. The reserve is not a large one. It occupies about 0.25% (127 hectares) of the total land mass (52,737 hectares). Of the 127 hectares, about 31% has been converted into a protected area (GSS 2014). The annual bush burning as a result of human activities has always left the environment bare during the dry season. This also reduces soil fertility. This situation is

coupled with management problem making its contribution to reducing climate change negligible.

In a nutshell, while we recognise the important role played by institutions as they are mandated, it is time to have a paradigm shift from the core mandate to providing a network of collective efforts in the fight against climate change. Thus the forestry commission, traditional authorities and the Ghana National Fire Service are the three least important institutions that are contributing to water management related adaptation strategies.

Conclusion and Recommendations

Though the farmers in Lawra area depend on some available strategies for the management of water bodies, there still exists the exploitation of other natural resources. This poses a management problem despite the collective efforts being made by both formal and informal institutions to improve the inhabitants' adaptation strategies. However, the strategies adopted have been classified into three broad areas namely environmental, cultural/agronomic and economic strategies. Going forward, we recommend that the existing institutions identified should use opportunities available to improve their linkages in order to increase their capacity to enforce by-laws regarding the management of the Volta River in the Lawra area.

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References

Adams F. and Ohene-Yankyera K. (2015). Determinants of Small Ruminant Farmers' Decision to Participate in Veterinary Services in Northern Ghana. J*ournal of Veterinary Medicine and Animal Health*, 7(5), 193-204.

Agrawal A., Kononen M. and Perrin N. (2009). The Role of Local Institutions in Adaptation to Climate Change, Social Development Papers, *Social Dimensions to Climate Change*, Paper No. 118.

Akinnagbe, O. M. & Irohibe, I. J. (2014). Agricultural Adaptation Strategies to Climate Change Impacts in Africa: a Review. *Bangladesh Journal of Agricultural Research*, 39(3), 407–418.

Alhassan I. S., Kuwornu J. K. M. and Osei-Asare Y. B. (2018). Gender Dimension of Vulnerability to Climate Change and Variability: Empirical Evidence of Smallholder Farming households in Ghana. *International Journal of Climate Change Strategies and Management*, https://doi.org/10.1108/IJCCSM-10-2016-0156.

Amusa, T. A., Okoye, C. U., & Enete, A. A. (2015). Gender-Based Vulnerability and Contributions to Climate Change Adaptation Decisions Among Farm Households in Southwest Nigeria. *American-Eurasian Journal of Agriculture and Environmental Science*, 15(9), 1779–1789.

Antwi-Agyei P., Dougillb A. J. and Stringerb L. C. (2014). Barriers to Climate Change Adaptation: Evidence from North-East Ghana in the Context of a Systematic Literature Review, *Climate and Development*, 7(4), 297-309.

Antwi-Agyei P., Dougillb A. J., Stringerb L. C. and Codjoe S. N. A. (2017). Adaptation Opportunities and Maladaptive Outcomes in Climate Vulnerability Hotspots of Northern Ghana. *Climate Risk Management*

Arthur D. D. and Dawda T. D. (2015). Promoting Rural Development through Chieftaincy Institutions and District Assemlies: Evidence from Sissala East Distict, Upper West Region of Ghana. *Ghana Journal of Development Studies,* 12(1 & 2).

Bandaragoda D. J. (2000). A Framework for Institutional Analysis for Water Resources Management in a River Basin Context. Working Paper 5, Colombo, Sri Lanka,

International Water Management Institute.

Biney C. (2010). Connectivities and Linkages within the Volta Basin, available at www.gwsp.org/fileadmin/GCI_conference/Products/Pres_Biney_Connectivities.pdf.

Brown H. C. P and Sonwa D. J. (2015). Rural Local Institutional and Climate Change Adaptation in Forest Communities in Cameroon. *Ecology and Society,* 20(2),6.

Environmental Protection Council (1991). Environmental Action Plan. *Government of Ghana*, Accra.

Garrett H and Woodsworth R. S. (1981). Statistics in Psychology and Evaluation. Vikil, Feffer and Simon Pvt. Ltd, Bombay.

Ghana Statistical Service (2010). 2010 Population and Housing Census: Manual.

Ghana Statistical Service (2014). 2010 Population and Housing Census, District Analytical Report, Lawra District, Ghana.

IPCC (2007). Impacts, Adaptation and Vulnerability, Part B: Regional Aspects. Retrieved from Cambridge University Press, Cambride, United Kingdom and New York, NY, USA.

Johnson J. M. F., Franzluebbers A. J. Sharon Lachnicht Weyers S. L. and Reicosky D.C. (2007). Agricultural Opportunities to Mitigate Greenhouse Gas Emissions. *Environmental Pollution* 150, 107-124.

Kankam-Yeboah K., Obuobie E., Amisigo B and Opoku-Ankomah Y. (2013). Impact of Climate Change on Steamfow in Selected River Basins in Ghana. *Hydological Service Journal*. 58:4, 773-788.

Lambert, D. K. (2014). Historical Impacts of Precipitation and Temperature on Farm Production in Kansas. *Journal of Agricultural and Applied Economics,* 46(4), 439–456.

McCartney M., Forkuor G., Sood A., Amisigo B., Hattermann F. and Muthuwatta L. (2012). The Water Resource Implications of Changing Climate in the Volta River Basin. Colombo, Sri Lanka: *International Water Management Institute (IWMI)*. 40p, IWMI Research Report 146).

McGray H. and Sokona Y. (2012). Why Institutions Matter for Climate Change Adaptation in Developing Countries, World Resources Institute. http://www.wri.org/blog/2012/05/why-institutions-matter-climate-change-adaptation-developing-countries, Access online on 17th January, 2018.

Morton J. F. (2007). The Impact of Climate Change on Smallholder and Subsistence Agriculture, Natural Resources *Institute, University of Greenwich*, Kent ME4 4TB, United Kingdom.

Ndamani, F., & Watanabe, T. (2015). Farmers' Perceptions about Adaptation Practices to Climate Change and Barriers to Adaptation: A Micro-Level Study in Ghana. Water, 4593–4604.

Niang, I., Ruppel O. C., Abdrabo M. A., Essel A., Lennard C. Padgham J. and Urquhart P. (2014). Africa In: Climate Change 2014: Impacts, Adaptation and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros V. R., C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. o. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea and L. L. White (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1199-1265.

Osei S. (2017). Climate Change Adaptation Constraints among Smallholder Farmers in Rural Households of Central Region of Ghana, *West African Journal of Applied Ecology*, 25(2), 31-48.

Ripiye N. (2016). Natural Flood Management: The Role of Local Institutions. A Thesis Submitted for the Degree of Doctor of Philosophy (PhD), School of Science, Engineering and Technology Abertay University, Dundee, Scotland, Uk.

Rosenzweig C., Casassa G., Karoly D. J., Imeson A., Liu C., Menze A., Rawlins S. Root T. L. Seguin B., Tryjanowski P. (2007). Assessment of Observed Changes and Responses in Natural and Managed Systems. Climate Change 2007: Impacts, Adaptation

and Vulnerability. In: Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E. (Eds.), Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, pp. 79–131.

Thornton P. K., Ericksen P. J., Herrero M. and Challinor A. J. (2014). Climate Variability and Vulnerability to Climate Change: A Review. *Global Change Biology,* 20, 3313–3328.

Totin E., Roncolic C., Traorea P. S. Somdad J. and Zougmorea R. (2017). How does Institutional Embeddedness Shape Innovation Platforms? A Diagnostic Study of Three Districts in the Upper West Region of Ghana. NJAS - Wageningen *Journal of Life Sciences*, 84, 27-40.

Ulleberg I. (2009). The Role and Impact of NGOs in Capacity Development, from Replacing the State to Reinvigorating Education. *United Nations Educational, Scientific and Cultural Organisation. International Institute for Educational Planning.*

Uphoff N. and L. Buck (2006). Strengthening Rural Local Institutions Capacities for Sustainable Livelihoods and Equitable Development. World Bank, Washington, D. C., USA.

van de Giesen N., Andreini M., van Edig A. and Vlek P. (2001). Competition for Water Resources of the Volta Basin. In: Regional Management of Water Resources, Proceedings of a Symposium Held During the Sixth IAHS Scientific Assembly at Maastricht, the Netherlands, July 2001, IAHS Publication No. 268.

Vermulen S., Zougmore R., Wollenberg E., Thornton P., Nelson G., Kristjanson P., Kinyangi J., Jarvis A., Hansen J., Challinor A., Campbell B. and Aggarwal P. (2012). Climate Change, Agriculture and Food Security: A Global Partnership to Link Research and Action for Low-income Agricultural Producers and Customers, *Current Opinion in Environmental Sustainability* 4(1), 128-133.