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Coping and Adaptation Strategies to Climate Change Impacts: The Case of Rural Community in Vuga Village-Lushoto District

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1.0 Introduction

Currently, Climate change and variability is a global challenge (Boko *et.al.* 2007). It is widely accepted that the impacts of climate change are, and will continue to be more pronounced in poor countries particularly East Africa countries (Paavola, 2001). It is projected that, climate change will have a significant impact on livelihoods and living conditions of the poor in developing countries due to less adaptive capacity compared to their counterparts. Long-term changes in climate will disproportionately affect regions in both the semi-arid and arid parts of the globe and the more humid tropics. Within these areas, the effects of climate change vary across regions, farming and food systems, households and individuals. The United Nation's Intergovernmental Panel on Climate Change (IPCC) has stated that Africa in general and sub-Saharan Africa in particular is highly vulnerable to the impact of climate change "because of factors such as widespread poverty, recurrent droughts, inequitable land distribution, and over-dependence on rain-fed agriculture" (IPCC 2001). The African continent is warmer than it was 100 years ago (Hulmes *et.al,* 2000). Historical data show that, the temperature in this continent increased by 0.70c during the 20th century and rainfall decreased in the Sahel and the Eastern Central Regions (*Ibid*). This implies to threaten many sectors including those related to food security, water resources, the productivity of natural resources, sea-level rise, desertification, and the spread of disease.

Climate change is changing hydrological cycles, weather patterns, raised sea levels and increased the intensity and frequency of extreme weather conditions all of which have a momentous impact on the livelihoods and living conditions of the poor in developing countries especially in rural communities (FAO, 2007). Projections of climate change point to increases in climate risks as a result of mid-continent drying increased frequency and severity of some climate extremes, and greater variability in rainfall. In East Africa, a warming of 0.5 ^{0}C per decade is expected with the increased frequency and magnitude of elevated temperatures (Pascal et al, 2006). A more El-Nino like climate is projected but dry regions are expected to get more drier while wet regions more wetter (Hulmes *et al* , 2000) thus a high likelihood of more extreme events such as droughts , floods and episodes of heavy rains that have profound impacts on the agricultural systems (food production) and human health.

2.0 Statement of the problem

Tanzania economy is more dependent on climate sensitive sectors; agriculture (farming and livestock keeping) sector inclusive. Several studies including the URT (2011), documented the effects of climate change on agriculture, health, coastal zones, energy, water, forests, biodiversity and ecosystem services in Tanzania. However, coping and adaptation strategies to climate change impacts on rural communities have not been well studied and documented in Tanzania context. Efforts on examining the extent to which different sectors have been threatened by climate change impacts, the coping and adaptation strategies are most important for enhancing community livelihoods. This is due to the fact that, it reveals the existing situation on how the community is vulnerable to the impacts of climate change. Therefore, the study intends to examine the coping, adaptation and mitigation strategies to climate change impacts on rural communities.

3.0 General objective

The study intends to examine coping, adaptation and mitigation strategies to climate change impacts on rural communities.

3.1 Specific objectives

i. To document the experienced impacts of climate change on rural community livelihoods
ii. To document and analyze the coping and adaptation strategies by the rural community
iii. To examine the challenges and opportunities of the coping and adaptation strategies

3.2 Research questions

i. What are the experienced impacts of climate change on rural community livelihoods?
ii. What are the coping and adaptation strategies of rural communities?
iii. What are the challenges and opportunities of the coping and adaptation strategies?

4.0 Study justification

The study explored the resilience level of the rural community through coping, adaptation and mitigation strategies to climate change impacts on their daily livelihoods. This indicates the degree of vulnerability of the rural community to the impacts of climate change on their daily livelihoods. This information is fundamental especially in planning for community development projects in the whole process of fighting impoverishment in the country. The study results are useful to other researchers, policy makers and community project development partners.

5.0 Literature review

5.1 Definitions of key terms

5.1.1 Climate change

Climate change refers to a systematic change in the key dimensions of climate including average temperature, wind and rainfall patterns over a long period of time while climate variability in turn consists of a shorter term variation in the same dimensions of climate (Paavola, 2001). Carter 2001, it defines "climate change" as a change of climate which is attributed directly or indirectly by human activity that alters the composition of the global atmosphere.

5.1.2 Coping

Coping refers to actions taken in response to an extreme event, like a storm or drought, to ensure survival and often results in a long-term decrease in wellbeing. Coping is what happens in the absence of pro-active adaptation that reduces vulnerability of people and ecosystems to climate and extreme events (IPCC TAR, 2001 a).

5.1.3 Adaptation

Refers to the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC TAR, 2001 a). For this study, adaptation refers to individual adjustments from daily livelihoods in response to actual climate change effects.

5.1.4 Livelihood

Livelihood includes material assets such as access to land, other natural resources, financial capital and credit, tools and inputs which are put into productive activities. It also reflects human capabilities (the knowledge and skills of the family), social and political factors such as contact networks and the openness of government institutions (Carney, 1998).

5.2 Theoretical background and empirical studies

This study is guided by Anthropogenic Global Warming (AGW) theory. This theory it tries to link human activities with global climate change. This theory of climate change contends that human emissions of greenhouse gases, principally carbon dioxide (CO_2), methane, and nitrous oxide, are causing a catastrophic rise in global temperatures. The mechanism whereby this happens is called the enhanced greenhouse effect (Gore, 2006). Energy from the sun travels through space and reaches Earth.

The earth's atmosphere is mostly transparent to the incoming sunlight, allowing it to reach the planet's surface where some of it is absorbed and some is reflected back out as heat into the atmosphere. Certain gases in the atmosphere, called "greenhouse gases," absorb the outgoing reflected or internal thermal radiation, resulting in Earth's atmosphere becoming warmer than it otherwise might be (*Ibid*). According to IPCC 2007, continued burning of fossil fuels and deforestation could double the amount of CO_2 in the atmosphere during the next 100 years, assuming natural "sinks" don't grow in pace with emissions

It is estimated that, up to 0.7°C warming of the past century-and-a-half and 0.5°C of the past 30 years is mostly or entirely attributable to man-made greenhouse gases. They dispute or disregard claims that some or perhaps that entire rise could be an earth's continuing recovery from the Little Ice Age (1400-1800). They use computer models based on physical principles, theories, and assumptions to predict that a doubling of CO_2 in the atmosphere would cause the earth's temperature to rise an additional 3.0°C (5.4°F) by 2100 (Gore, 2006).

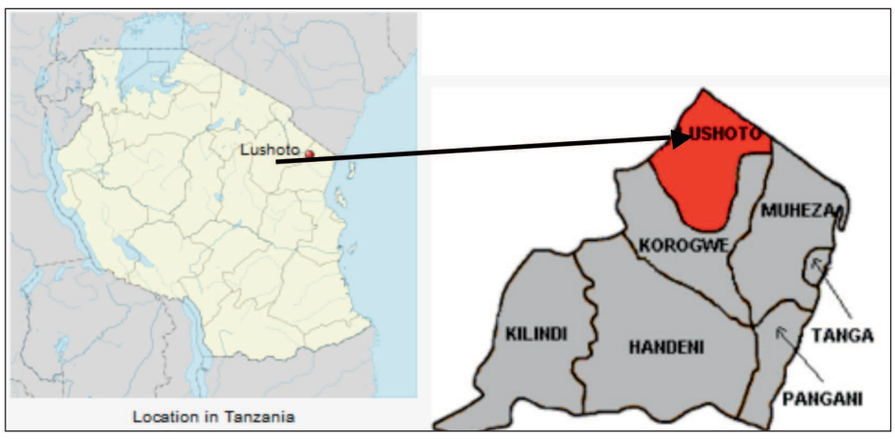
The agriculture sector is the backbone of Tanzania's economy, as well as having a key role in sustaining livelihoods. It is also a very climate-sensitive sector that the future climate change has the potential to exacerbate current production risks in agriculture, either from changes in temperature and rainfall trends, from enhanced variability, or from other effects. A number of previous studies have considered the potential effects of climate change in Tanzania, and because these consider different impacts and use different projections and models, they provide a wide range of results. Under some projections and with certain models, some studies predict very negative impacts on the sector (URT, 2011). Moreover, climate change is likely to affect human and livestock health in Tanzania. This has attributed to the effects of heat extremes or flood injury, indirectly, for example, through the changes in the transmission of vector, food or waterborne diseases. On the other hand, food insecurity will contribute to health problems particularly poor people in rural areas whose resources and livelihood opportunities are limited. There is also a wider set of indirect impacts of climate change on health, which are linked to other sectors (Ibid). The main focus of adaptation strategies is to reduce vulnerability to climate-induced changes and to sustain and enhance the livelihoods of poor people so as to maintain a living. These strategies consequently need to be entrenched in an understanding of how the poor and vulnerable sustain their livelihoods, the role of natural resources in livelihood activities and the scope for adaptation actions that reduce vulnerabilities and increase the resilience of poor people. This can be done on the effects of climate change although it is just one of the many factors that influence people's livelihoods.

6.0 Research methodology

6.1 Description of the study area

Vuga village is among of the villages found in Lushoto District. The district is among the eight districts of Tanga region namely, Pangani, Muheza, Korogwe, Kilindi, Handeni, Tanga, Mkinga and Lushoto Districts (Map 1). Lushoto district it lies between 38° 10' and 38° 36' E and 4° 24' and 5° 00' S with altitudes ranging from 800 to 2300 m above mean sea level. The population density ranges from 68 to 400 persons per square km. The district has an area of 3500 km^2 with a population of 492,441 (URT, 2012). The study village had a population of 11,128 and the average household size of 4.7 (*Ibid*). The area falls under rainforest vegetation type and soils are generally latosols. The rainfall is in bimodal pattern; short rains from October to December and the long rains from March to June. The rainfall ranges from 600 mm to more than 1200 mm. The existing land use pattern is divided into four categories, namely; dry land farming contributing to 58%, tree crops and irrigated area (11%), forest reserve (16%) and grazing area (15%).

Map 1: Location of Lushoto District



Source: Google earth

6.2 Research design

This study employed a case study research design. The design enabled the researcher to collect rich information that suited the study. Also it exposed the researcher to the real situation that exists in the study area.

6.3 Sampling and sample size

The study used a simple random sampling technique whereby each individual in the village had an equal chance of being involved in the study as a sample representative. A sample of 60 households from six hamlets (each 10 households) was taken to represent the entire households in the study area. Hamlets involved are Lunguza, Kigongo, Baghai, Sakula, Bazo and Chongo hamlets.

6.4 Types, sources and data collection procedures

Both primary and secondary data were collected. Primary data include indigenous systems on coping and adaptation from different community livelihoods to climate change impacts. Self-administering of semi-structured questionnaire consisting of open and closed ended questions collected data such as experienced impacts of climate change, specifically livelihood activity practiced by the specific respondent, coping, adaptation and mitigation strategies to climate change impacts; and the challenges and opportunities of coping and adaptation strategies. Focus Group Discussion (FGD) used to collect primary data from a group of 12 elite people in the village. Secondary data including government efforts on enhancing coping, adaptation and mitigation strategies were collected through documentary reviews.

6.5 Data analysis and presentations

Both qualitative and quantitative data were fully analyzed. Content analysis suited the qualitative data while quantitative data were analyzed through Statistical Package for Social Science (SPSS) software Version 20 for generating descriptive statistics that helped to make linkages of study variables. Finally, the outputs are presented in tables for easy interpretation.

7.0 Results and Discussion

7.1 Respondents typology

Understanding respondents' typology in any study is very imperative so as to link their characteristics with the existing problem under investigation. This helped to capture the level of understanding of climate change and variability issues; and the adaptation and mitigation options that a particular society could employ as a strategy of increasing resilience to the observed impacts of climate change and variability on their daily livelihoods.

7.1.1 Age, sex and education level of the study respondents

Age structure, sex and education level of the respondents were considered to be key factors that could reflect positively to the problem under study. This is due to the fact that, climate change and variability impacts in any locality can be observed as a historical trend that need an adult person to give the trend on what has occurred for a certain period of time (i.e. age of the respondent matters). Therefore, the study involved respondents between the ages of 30-75 years. Of the 60 respondents, 20 (33%), 30 (50%) and 10 (17%) respondents belongs to 30-45, >45-60 and >60-75 age groups respectively (Table 1).

Table 1: Age of respondents

Age group	Number of respondents	Percent
30-45	20	33
>45-60	30	50
>60-75	10	17
Total	**60**	**100**

Source: Survey, 2013

Moreover, vulnerability to climate change is sex and gender sensitive. This is due to the fact that, male and females normally differ in the resilience level to the impacts of climate change and variability and therefore,

differentials in the degree to which the impacts can threaten their livelihoods exist. The study found that, the number of males interviewed (40 respondents) was three quarters of the female respondents (20 respondents). This is due to the reason that, normally females in the African tradition perspective are not courageous to give information of their households especially in the presence of their husbands. This information is supported by other similar studies carried in different parts of Tanzania. For example Hizza (2011), male respondents were 70% and female were 30% and Komba and Hizza (2013), male respondent were 97% while female respondent were 3%. This calls for the need to emphasize on equality in information sharing between sex groups and free involvement in various studies so as individuals to present their ideas and understanding in various issues.

The education level of the respondents considered to be among the key factors on how the general understanding of the environments could influence the feasible adaptation and mitigation options that could reduce the degree of being exposed to the risks attributed to climate change and variability impacts. The findings show that, of the 60 respondents 2 (3%) only of the respondents had no formal education compared to their counterparts (Table 2). This implies that, the government efforts for attaining the millennium development goal of universal education is likely to be attained by 2015 and therefore, information sharing on the climate change and variability impacts, adaptation and mitigation options could be easily facilitated due to the level of understanding of the citizens in the country.

Table 2: Education level of respondents

	Frequency	Percent
No formal education	2	3
Primary education	42	70
Secondary education	6	10
Post education	10	17
Total	**60**	**100**

Source: Survey, 2013

7.2 Observed impacts of climate change and variability on rural community livelihoods

It was important to document the general understanding of climate change in the study community. Identification of livelihood activities undertaken by the respondents and the observed impacts of climate change to the livelihood activities practiced in the study area was inextricable. This is due to the reason that, it becomes easier to link issues on the subject under investigation when it is clearly understood by the respondents under inquiry.

7.2.1 General understanding of climate change

The study observed that, 45 (75%) respondents link climate change with the variability of rainfall patterns and long drought seasons in their area. However, they were not able to tell exactly the duration that such changes could be used to justify the observed changes as indicators of climate change. This implies that, climate change is not a new phenomenon to them; however more knowledge on the subject is needed so that the community could have the common understanding which is an important element for developing coping, adaptation and mitigation strategies to the impacts of climate change and variability.

7.2.2 Livelihood activities undertaken in the study area

The livelihood activities undertaken in the study area found to be climate sensitive; farming and livestock keeping. The study found that, of the 60 respondents, 30 (50%), 10 (17%), 14 (23%) and 6 (10%) practice one or more than one livelihood activity such as farming, farming and government employment; farming and livestock keeping; farming, livestock keeping and business activities respectively (Table 3). This implies that, the communities' livelihoods are more likely to be affected by the impacts of climate change in the absence of appropriate strategies to overcome the future impacts of climate change in the country as well as at a global scale. However, livelihood diversification could strengthen resilience level of the community that could reduce the degree of being highly vulnerable to the impacts of climate change and variability and hence achieving a better living.

Table 3: Respondents livelihood activities

	Frequency	Percent
Farming	30	50
Farming and government employment (Primary teacher)	10	17
Farming and Livestock keeping	14	23
Farming, Livestock keeping and small business	6	10
Total	**60**	**100**

Source; Survey, 2013

7.2.3 Observed impacts of climate change on the livelihood activities

The study findings show that, the community is exposed to different impacts of climate change on their daily livelihoods. Of the 60 respondents, 20 (33%), 13 (22%), 10 (17%), 9 (15%) and 8 (13%) respondents reiterated that, the experienced impacts of climate change in the study area are drought and decrease in river discharge, poor pasture, poor harvests, pest and diseases; and human and animal diseases respectively (Table 4). One of the respondents reported that;

"Nowadays rainfall is no longer reliable and predictable; growing seasons have changed and this condition affects our agricultural products to the highest degree and therefore, it leads to food insecurity to most of the households in the area. I predict the condition of food security to be shoddier in the future if the observed impacts of climate change will continue existing".

The research findings imply that, livelihood activities of the local communities will continue experiencing the impacts of climate change and therefore, efforts of reducing poverty in the country will be threatened to a great extent. This calls for integrating climate change issues into the policy dialogue for developing appropriate mechanisms that could help to reduce the extent of being exposed to shocks, trends and risks attributed to climate change impacts.

Table 4: Observed impacts of climate change and variability

	Frequency	Percent
Drought and decrease in river discharge	20	33
Poor pasture	13	22
Drought and food shortages	10	17
Pests and diseases	9	15
Human and animal diseases	8	13
Total	**60**	**100**

Source; Survey, 2013

7.3 Coping and adaptation strategies to climate change impacts

These are short and long term mechanisms that an individual, a population or a community develops so as to counteract the observed impacts of climate change in order to ensure a living. This is due to the fact that, despite the observed impacts of climate change, still the human survival is imperative.

7.3.1 Coping strategies for climate change impacts

The study found that, the community has developed short term mechanisms (coping strategies) to increase resilience towards counterbalancing the impacts of climate change in the study area. Of the 60 respondents, 25 (42%), 20 (33%), 10 (17) and 5 (8%) argued that, in case of food shortages due to climate change impacts they normally switch themselves to reducing the number of meals per day, employ urban rural remittances, eating wild fruits and hunting of wild animals respectively (Table 5). This implies that, climate change is a reality for this community however some of the coping strategies developed, they are still climate sensitive that can continue experiencing climate change impacts and therefore, the community could be left to the higher degree of being exposed to the risks attributed to climate change impacts.

Table 5: Coping strategies

	Frequency	Percent
Urban rural remittances	20	33
Reducing the number of meals per day	25	42
Eating wild fruits	10	17
Hunting wild animals	5	8
Total	**60**	**100**

Source: Survey, 2013

7.3.2 Adaptation strategies to climate change impacts

It was necessary to examine the long term strategies developed by the community as a response to the climate change impacts. This is due to the fact that, sustainable livelihoods could be achieved only if long term strategies are fully implemented. The community has developed several adaptation measures to the impacts of climate change including; cultivation in wetland areas (25%), cultivation near water sources (23%), growing drought resistant crops (22%), destocking (17%), adoption of family planning techniques (8%) and casual labour employment (5%) (Table 6). Despite the adaptation strategies developed by the community, there is a possibility of continuing to experience more impacts on their daily livelihoods due to the reason that some the strategies are not environmentally friendly. For instance cultivation in wetland areas and near water sources it could alter the hydrological systems of the area and make a large part of the area to experience drought due to lack or inadequate water and therefore failure to support farming through irrigation systems. This is proven by drying up of several natural springs ("*Nkunisa*") in the study area caused by cultivation near water sources. One of the respondents explained that;

"*Human activities in the study area caused the drying up of four natural springs (e.g. Shift from producing coffee (less water demanding) to vegetables (more water demanding)) and if there will be no feasible interventions on safeguarding them; there is a clear possibility of the remaining six natural springs to dry up in the near future".*

This implies that, there is a need of offering environmental conservation education, farmer field schools on drip irrigation ("*Shamba darasa"*), and awareness of environmental policy especially in the allowable distance to be left from the water source where different economic activities are undertaken on the land so as to ensure sustainability of water resources. Growing of drought resistant crops (such as leguminous plants) also found to be the adaptation measure to the impacts of climate change adapted by 13 (22%) of the respondents whereas 10 (17%) of the respondents argued that, the prolonged drought season resulted to poor pasture and therefore, destocking could help as an adjustment mechanism to the observed impacts.

Table 6: Adaptation strategies

	Frequency	Percent
Cultivation in wetland areas	15	25
Cultivation near water sources	14	23
Growing drought resistant crops	13	22
Destocking	10	17
Adoption of family planning techniques	5	8
Working as a casual labourer	3	5
Total	**60**	**100**

Source: Survey, 2013

7.3.3 Mitigation strategies to climate change impacts

Overcoming the impacts of climate change in the future needs to have suitable mitigation strategies so as to counteract the projected impacts. However, the mitigation strategies differ from one location to the other depending on the socio-economic characteristics of the communities trying to address the expected future

impacts of climate change. The community is implementing some mitigation strategies to the impacts of climate change whereby, of the 60 respondents, 30 (50%) and 20 (25%) of the respondents argued that, they have started afforestation programs in their fields and abandoning the burning of plant residues respectively. They consider afforestation as a mitigation strategy due to the fact that, trees act as a carbon sink, and therefore it could reduce the concentration of carbon dioxide gas from the atmosphere which is considered to be the main cause of global warming that alters the global climate. Also burning of plant residues add carbon monoxide gas to the atmosphere when undergo same processes result to formation of carbon dioxide gas and hence the concentration of chlorofluorocarbons (CFCs) in the atmosphere that gears the atmospheric circulations to alter the global climate. It is true that a larger part of the forest in Lushoto district has been depleted irrespective of the restoration programs. This implies that, the government efforts and other environmental stakeholders should continue to emphasize communities on the benefits of the environment so that the virgin forests to be safe from degradation and hence environmental conservation. Furthermore, empowerment to the afforestation programs could be achieved in the presence of tree seed subsidies from environmental stakeholders that could motivate people to engage themselves in the campaign of restoring the degraded environment.

7.4 Challenges and opportunities of the coping and adaptation strategies

Despite the observed coping and adaptation strategies to the impacts of climate change in the study area, still they are associated with different challenges that contribute to weaken their coping and adaptation capacity but also opportunities that strengthen their adaptation capacity. The study found that, reducing the number of meals which is not nutritious (25%), poor access to drought resistant crops (22%) and lack of guarantee on urban rural remittances (16%) were the most pressing challenges that facing the entire community despite the observed coping and adaptation mechanisms to the impacts of climate change and variability (Table 7). This implies that, there is a likelihood of many people to have malnutrition during the period of food shortages in the village. This is due to the fact that, the food consumed by the respondents is not nutritious, access to drought resistant crops as alternative crops is questionable and lack of assurance for urban rural remittances (food and money from relatives and family members). This situation will affect the workforce to engage in different economic activities and hence impoverishment. Therefore, it will also affect the government efforts towards achieving poverty reduction in the country.

Table 7: Challenges of coping and adaptation strategies

	Frequency	**Percent**
Urban rural remittances not guaranteed	10	16
Reducing number of meals but not nutritious	15	25
Seasonality of wild fruits	7	12
Poor access to drought resistant crops	13	22
Lack of environmental conservation education	9	15
Poor prices on the alternative agricultural produces	6	10
Total	**60**	**100**

Source: Survey, 2013

The coping and adaptation strategies to the impacts of climate change found to be associated with some potential opportunities in the study community. Respondents argued that, t some extent they are sure of food availability in bad seasons through harvests from drought resistant crops (cassava and improved maize seeds) grown in the study area. Furthermore, the shift from coffee production (hilly areas) to vegetables in wetland areas (lowland areas) has assured them of getting money and buy food to support their living despite the fact that wetlands are degraded and there is a high possibility of altering the hydrological systems in the area which will have more impacts on community livelihoods in the future.

8.0 Conclusion

Impacts of climate change have been observed and proven to affect different livelihood activities including farming and livestock keeping in the study area. Climate change is not a new phenomenon to most of the respondents in the study area due to the fact that they were able to link issues that justify the thriving of

climate change including changing in rainfall patterns, prolonged drought periods and decrease in river flows. However, despite the observed impacts, community has developed some coping and adaptation mechanisms so as to reduce the degree of being vulnerable including, cultivation on wetlands and near water sources, growing resistant crops, destocking, urban rural remittances, reducing the number of meals per day and eating wild fruits. The mitigation of climate change impacts observed in the study area includes afforestation programs and abandoning the burning of plant residue. Challenges facing the coping and adaptation strategies include poor access to drought resistant crops and lack of guarantee on urban rural remittances. However, some of the opportunities associated with coping and adaptation strategies in the study found to contribute positively to the livelihoods of the study dwellers; the availability of food in bad seasons through growing drought resistant crops and income earned from vegetable production.

9.0 Recommendations

Despite the existing coping, adaptation and mitigation strategies to climate change impacts in the study area, still community empowerment for enhancing the strategies is inextricably. This is due to the fact that, the community has limited options for livelihood diversification that can absorb shocks and trends attributed to climate change impacts. Empowerment can be done through education on sustainable agriculture and environmental conservation, field farmer schools, a favourable environment for access to credits and improved farming implements; and access to markets for agricultural produce. This will enhance their efforts towards reducing the vulnerability and risks attributed to climate change impacts and therefore, more benefits will be accrued from the livelihoods that will contribute significantly to poverty reduction in the country.

10.0 Area for further research

The study proposes a research for investigating the cost-benefit and sustainability of wetlands in the study area. This is due to the reason that, currently wetlands are under pressure due to the shift from hilly to lowland cultivation as an adaptation strategy to climate change impacts.

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