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Climate Change: Impacts and Adaptation in Rural Community of Benishangul Gumuz Regional State, Western Ethiopia

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Abstract
Climate change is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC, 2001). Therefore this study, aimed to explain impacts and adaptation mechanisms to climate change in the State of Benshangul Gumuz Region. In order to have relevant information for the study field survey, structured interview and focus group discussion were employed. 371 household heads were purposely involved in the survey from different climate zones. Encouraging level of awareness was observed among the rural communities on the impacts of climate change and the mitigation and adaptation strategies. The study also revealed climate change had lead to gradual deterioration of agricultural production, loss in livestock productivity and crop cultivation as a result which, the requirement for fertilizers was increased on a plot of land. Shortages of water, spread of water and vector-borne diseases after the rainfall, extinct of cultural crops, drought and famines, shortage of pasture, incidence of both plants and animal diseases seasonal migration of people had increased. High level of awareness was observed in the application of different mitigation and adaptation strategies. These strategies were mainly indigenous to the region and the local community.
Keywords: Climate change, Impact, Adaptation Mechanisms

1. Introduction

There are now strong evidences, witnessed that the earth's climate is changing mainly as a result of the increasing concentration of greenhouse gases in the atmosphere as an end result emission from various human activities. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2001):

> *"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."*

(IPCC, 2011) has also concluded that more climate change is on the way resulting from past, current, and future greenhouse gas emissions with its potential adverse impacts on socio-economic development of nations.

Global warming is considered to be major threat for life on our planet. Observations show that global mean temperature at the earth's surface has substantially increased over the twentieth century (IPCC, 2007).This global warming and its multifaceted impacts are affecting the whole world in various forms. Several scientific studies have suggested that developing countries in particular are suffering from the burden of the ever changing climatic conditions (Olsen, 2006; Kurukulasuriya and Rosenthal, 2003, UN-OHRLLS, 2009).

Wide-ranging research findings have revealed that climate variability and change have significant impacts on global and regional food production systems particularly on the performance of common staple food crops in the tropical sub-humid climatic zone (UN-OHRLLS, 2009).For example, the most food insecure regions and most climate change vulnerable regions in Ethiopia are those that experience both the lowest and most variable rainfall patterns (UN-OHRLLS, 2009). This is particularly true in low-income countries like Ethiopia where adaptive capacity is low to respond climate change. (Haakansson, 2009) clearly stated that：

> *"In Ethiopia Water resources, agriculture, natural resources and biodiversity, human and animal health (due to vector-borne diseases) are the most sensitive and highly at risk to climate Variability."*

According Climate Change National Adaptation Programme of Action (NAPA, 2007), In Ethiopia, fluctuations in precipitation and temperature rates are directly affecting the production and productivity of the agricultural systems. Climate variability is indirectly affecting the agricultural production of an area influencing through the emergence and distribution of crop pests, livestock diseases, aggravating the frequency and distribution of adverse weather conditions, reducing water supplies and enhancing severity of soil erosion among other impacts (Watson et al, 1998). Climate variability and its associated impacts are inducing frequent crop failures, and declining livestock production and productivity leading to aggravated rural poverty in the region.

This is particularly true for the low-income and marginalized areas in north western, north eastern and western part of the country, where vulnerability is high and adaptive capacity is low. Abundant evidences show that high temperature and chronic water stress caused by climate change has already affected the Ethiopian agriculture especially the crop production and livestock rearing (EARO, 2002).

The western part of Ethiopia, where this study was conducted is evidently the hardest hit region of the country in terms of drought (Bezabih et. al; 2010). However, growing climate and land use changes as a result of the increasing climate variability such as rising temperature, erratic rainfall and the resultant water shortage coupled

with the continued deforestation and improper use of woodlands and other land resources has led to the substantial decline in agricultural productivity and rising food insecurity. Though little was known so far, evidences in the study area have shown that the increasing temperature, water shortage and the changing precipitation levels are affecting crop yields which further exacerbated the vulnerable communities' socio-economic development and status.

Despite a handful of empirical studies, in-depth analysis and well-established scientific evidences on the magnitude of climate change impact on agricultural crops and the likely socio-economic consequences on the livelihoods of the rural poor in the area was virtually lacked. At the same time, the existing opportunities to respond to climatic change in the study area were also under investigation. The study is therefore designed to: Discuss the extent of climate change impacts on socio-economic development; and Explore adaptation mechanisms by the community in responding to climate.

2. Research Methodology

The study employed mixed research method. Quantitative and qualitative data were collected and analyzed. The fundamental principle of mixed methods research is that multiple kinds of data should be collected with different strategies and methods in ways that reflect complementary strengths and non- weaknesses, allowing a mixed methods study to provide insights not possible when only qualitative or quantitative data are collected (Johnson and Turner 2003).

Sequential explanatory method is an expansive and creative form of research, not a limiting form of research (Creswell, 2003). It is inclusive, pluralistic, and complementary, and it suggests that researchers take an eclectic approach to method selection and the thinking about and conduct of research (Johnson and On wuegbuzie, 2004, pp. 17–18). As well, Morgan (1998) suggested that the sequential explanatory design is the most frequently used mixed methods approach.

There are different approaches of mixed research. For this research cross sectional survey was the main design preferred. Survey is data gathering at a particular point in time with the intention of describing the nature of existing conditions, or identifying standards against which existing conditions can be compared, or determining the relationships that exist between specific events (Mitchell et al, 2004). Classically cross-sectional survey method is used to scan wide information from people with different experience and back ground on the same issue in order to measure or describe any generalized features (Marczyk et al, 2005).

2.1. Sampling Design and Sampling Size

In order to collect the raw data needed to achieve the objectives of the research, a multi-source data collection method through stratified random sampling (SRS) was employed. In the first stage, the Woreda/districts/ was purposely selected and classified into three strata of high land (Dega), Midland (woyna-dega) and Lowland (kola) agro-ecological zones. The selection of woreda was also based on different cultural background to respond to climate change due to divers ethnic group in the region. Accordingly, in 'dega' climatic zone 'Wonbera' woreda (residence of shinasha and Gumuze people) and Tongo woreda(residence of Mao and Komo people); in woinadega climate Assosa wereda(residence of Berta people) and Bullen Woreda(residence of Shinasha and Gumuze people) ; and in 'kola' climate kemashi (residence of Gumuze people) and Komosha woreda(residence of Berta people) were taken. The woreda sampling was believed to be representative because it considers different agro climatic zones and five indigenous ethnic groups in the region. The consideration of ethnic group was due to the assumption that there were different responding mechanisms (culture) by different ethnic group to climate changes in different climatic zones.

From each Woreda, target kebeles were selected in such a way that the kebeles represent the Woreda in biophysical, agricultural and socio-economic aspects. Most importantly, the kebeles were selected in the condition that they represent the main farming practices, crop varieties, socio-economic status, climate problems and disasters, besides topographic features. By preliminary survey through means of phone the selected Kebles were listed below in table 3.1.

Table3.2. Sample Woredas, Kebles and sample size

No	Sample Woreda	Sample Keble	Estimated House hold population	Sample size
1.	Wonbera	Sankie	659	49
		Manasibu	629	46
2	Bullen	Maxa	670	50
		Emaji	552	40
3	kemashi	Daguba	451	33
		Dobi Badesa	502	37
4	Assossa	Abrhamo	451	33
		Selga	322	24
5	Komosha	Tereselam	231	17
		Asura	190	14
6	Tongo	Tajagesi	150	11
		Wanga gitan	236	17
Total	6	12	5043	**371**

Source: Preliminary survey: Phone interview with Keble /local/ administrators

By the formula $n = N/1+N(e)^2$ where n =the sample size; N =total population size; e =level of precision (Yamane T. (1967).

Then, total sample size "n" was: $5043/1+5043(0.05)^2 = 5043/13.6075 =$ **371**

In order to distribute sample size proportionately in 12 kebles stratified sampling was applied as indicated in table1.Finally, the respective sample households from each kebele was identified purposely and contacted for the socio-economic study.

2.2. Data Source and Collection Method

Three sets of primary data namely: climate data (temperature and precipitation), socio-economic and factors exacerbating impacts of climate change and data on traditional climate change adaptation mechanisms was collected. The first group of data (climate data) was obtained from the National and Regional Metrology Agency. The second group of data (socio-economic and climate adaptation) was collected from household survey via questionnaire, focused group discussion and field observation.

The observed data on climate variables mainly temperature and rainfall, from 1981-2013, of the study area was collected from the National and Regional Metrology Agency of Ethiopia. Accordingly, monthly rainfall and temperature data was collected from the National and Regional Metrological Station.

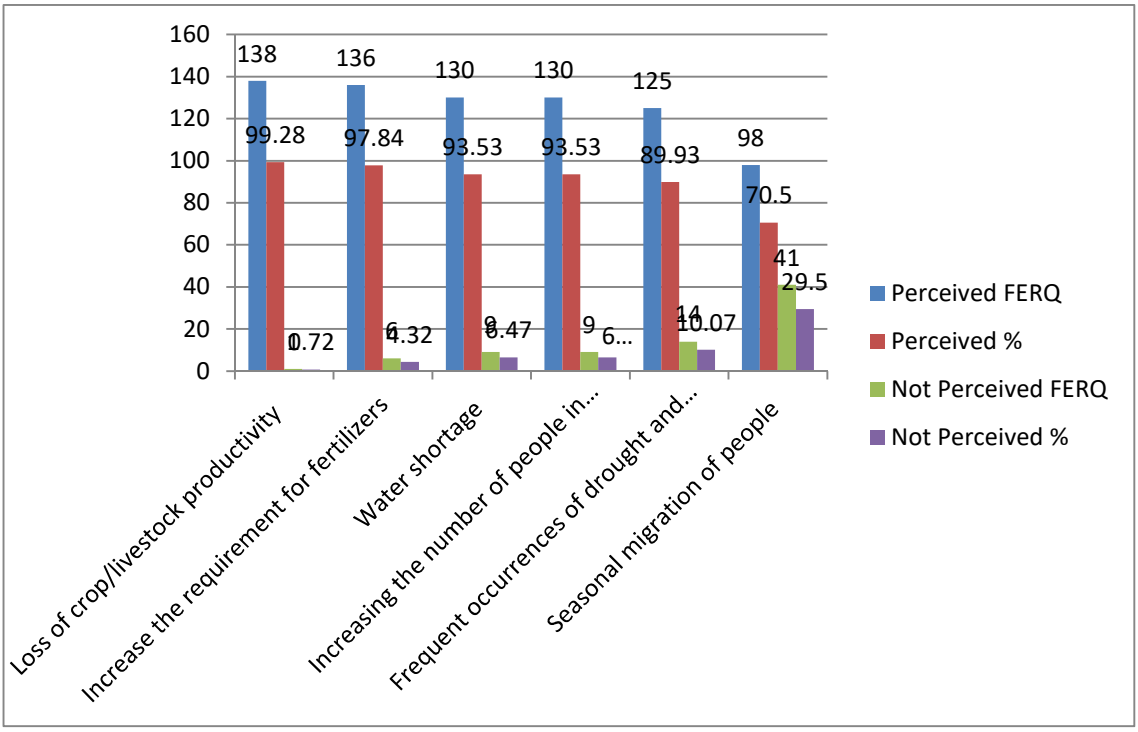
An in-depth household survey by using a semi-structured questionnaire and in-person interview was conducted to collect both the detailed socio-economic data and the customary climate change adaptation mechanism of the households. Farm households' cross-sectional data was obtained from a household survey.

Prior to conducting the household survey, key informants and community leaders were identified for focus group discussions with the help of the Woreda agricultural bureau and local development agents. Accordingly, one focus group discussion was carried out at Kebele level which contained 5-8 farmers in a particular kebele. The focus group discussions had played great role for the study to find out the real situation on-ground and also to explore and understand the local communities' knowledge, perceptions, awareness of climate change impacts and adaptation strategies practicing by the local communities. Then, key informant discussions were carried out at Kebele level in order to shed light on the general information of the main research problem.

3. Major Finding

3.1. Impacts of Climate Change

The study shows that there were different impacts of climate change in the area. As a result, an increase in the loss of agricultural production/crop cultivation/, frequent occurrences of drought and famine and loss of forestland, loss in livestock productivity/death of livestock/ were experienced in the area.



Furthermore, increasing of requirement for fertilizers and seasonal migration of people were common in rural areas of the region. A reduction of water availability especially in extensive drought –prone areas created competition among users, including agriculture and wetland ecosystem needs. The variability of rainfall has created a challenge to saw seeds at appropriate season/farming time/ because they unable to predict the weather condition. In addition, crop and animal disease was ever severe though government support was ever better. Many crop types which were cultural in the community become on path of extinction. The impact was common for both climatic zones-kola and 'dega' zone except that the severity in 'kola' was high. On the contrary, in 'dega' region the crop type had not significantly changed – the crops were the same that grown earlier and at present such as barley, wheat, beans and peas. Drought and famines, shortage of pasture, incidence of both plants and animal diseases increased in the death of animal and seasonal migration of people were high. Increase in flow variability, particularly the frequency and duration of large floods and long droughts would tend to reduce water quality and accessibility, biological productivity and habitat in the areas and led to drought and famine that would resulted in the seasonal migration of productive people in need of income generating jobs to support their family at home.

The community justify this by providing evidences: previously, 25 years ago rivers which flow all year round were now becoming declined and dried in winter. This was being followed by lack of drinking water for both people and their animals. See figure 4.1 and 4.2.

Fig.4.1 Stream in November declining

Fig4.2 Stream in February dried

Source; 2015 field survey

"*When we compare the situation today with the past, the climate has changed. This area was very productive in the past. Climate change has affected our areas, community and family for the last sixty nine years. Today people have left the area to find work elsewhere because we have not been able to save any of our food for the bad times because we never have any extra food''* the 65 years old responded.

The communities explained that the variability of rainfall created a challenge to saw seeds at appropriate season/farming time/ because they unable to predict the weather condition. In addition, crop and animal disease were ever severing though government support was ever better. Many crop types which were cultural in the community become on path of extinction. For example 'Zengeda'('mera') and 'appo' were almost disappearing while oilseed crop types like 'mesha' were disappeared. It was not only types of crop that changing but also the productivity per unit area is diminishing. Regarding animal disease there was illusion in communities. The confusion was that in past times no advanced medication for animals unlike present time but animal disease becoming more sever and complex now a days. Consequently, in combination with lake of grazing land animal product has become diminished. One has to mind that climate change is followed by such contradictory issues. Climate change also has become causative agent for disappearance of forest honey production with the absence of forest coverage in the area.

3.2. Public Adaptation Mechanisms

The survey result indicated that selling livestock to buy food was widely experienced means to escape" *the bad time*". Building water-harvesting scheme by collecting water during rainy season for dry season in ponds was applied only by few respondents. Even though, growing cash crops and vegetables under irrigation were known in a few woredas, its application as an adaption means was not negligible. Grain storage, migration to neighbor kebeles, rural to towns/urban, Sudan in search of employment was widely utilized as mechanisms. Changing of time of farming and use of fast growing crops such as cabbage, maze cucumber and the like were also commonly used. Some people have started to rehabilitate their environment for sustainable solution. For instance they started growing of forest and fruits such as bamboo and mango tree though the practitioners were few.

Fig4.3 Attempts to replace vanished Bamboo forest in kola area of Metkel zone

To consolidate this culture of afrestration, government support is needed because the seedlings were threaten by insects and mites. In 'dega' parts of the region, reforestations culture was widely prevailed than kola areas. Although indigenous forests were destroyed, the communities were replacing manmade forest. For 'dega' residents there was also better opportunity for practicing small scale irrigation than 'kola' areas though the exiting physical feature became hindrance for fully exploitation of water resource. They also made their culture to tracing to conserve their land and environment. Changing of crop type was also other way they used to adapt climate variability. Before 25 years for example 'mera', 'teff', 'appo' were common crop types but now a day these items were disappearing and becoming forgotten in money kebles. Instead new crop types like cocoa, seasam, Negro seed, and mango are commonly produced. Traditionally people able to found hen and cattle waste as best solution to destroy the extraordinary weeding that appeared following climate variability and less land productivity.

In adaptation to climate change, one of the greatest challenge in production of 'mera'(type of sorghum) , maze and negro seed was the appearance of extraordinary weeding type locally called 'woidiwa' and 'kenchira harge' in metkel zone kola area. It burns the crops that growing up. As reported, by informants, this was reported to government bodies though solution had not come yet. But, traditionally people able to find that hen and cattle waste were best solution to destroy the extraordinary weeding. However finding sufficient animal waste to cover plot of land because of limited number of animals is challenge. Therefore local government particularly agriculture sector should give due attention.

Recommendations

- Government and None governmental organizations that concerned with environment need to design projects that could rehabilitate indigenous forest (Bamboo and others) and crops.
- Government body, particularly the Regional Agricultural bureau, Assosa University and other responsible bodies should conduct intensive and extensive researches on environmentally friend cultural crops.
- Timely information about the weather condition of the local areas need to acceded for farmers in collaboration with the regional meteorology agency and mass media
- The educational/training programs should include local indigenous knowledge and practice in responding to climate change.
- Indigenous knowledge of the community on mitigation and adaptation strategies should be adopted and be further investigated and applied.

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