Climate Variability and Food Security in Tanzania. The Case of Western Bagamoyo

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European Conference on Sustainability, Energy & the Environment 2015
Official Conference Proceedings

Abstract

Dealing with climate change is an economic necessity to avoid serious disruption to global and national socio-economic development (Stern, 2006). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) shows an increase of global average air and ocean temperatures leading to wide spread melting of snow and ice, as well as rising global average sea level (IPCC, 2007). While adaptation is an overriding priority for developing countries, mitigation is also a concern. Tanzania's ratification of the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol in 1996 and 2002 respectively, is a step towards ensuring that climate change issues are addressed at the national level (URT. 2012). Seven villages in Bagamoyo were selected. A total of three hundred people were interviewed, two hundred and eighty were reached through Focus Group Discussion. One hundred and forty were reached through Participatory Research Appraisal, and fifty four were interviewed as Key Informants. Official climatic data for rainfall and temperature of 37 years were obtained from District Meteorological Office. Mixed model of descriptive statistics and trend analysis/time series was used to analyse climatic data. Official data reveal that it is difficult to conclude that there is a decrease of amount of rainfall in recent years compared to the past. Rainfall and temperature doesn't have impacts on agriculture from the econometric point of view. Temperature has a slight change between years but increase in the recent years. Analysis of information from community members reveals extreme climatic events affecting food security.

Keywords: Climate change, agriculture, food security, adaptation, mitigation, sustainable development

Introduction

It is not possible to predict precise future climate conditions, but the scientific consensus is that global land and sea temperatures are warming under the influence of greenhouse gases, and will continue to warm regardless of human intervention for at least the next two decades (IPCC, 2007). Many people in the world structure their lives in concert with their environmental contexts. For various reasons associated with climate people can become vulnerable, that is, they are at a high risk of negative outcomes as a result of climatic events that overwhelm the adaptations they have in place (Galvin et al, 2004). There is growing concern that Global Environmental Change will further complicate achieving food security particularly for more vulnerable sections of society (Fischer et al., 2002; Rosegrant & Cline, 2003; Parry et al., 2004). If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased (ILO, 2007). New approaches to develop climate smart agriculture and improve the "hydro literacy" of rural communities can help poor farmers better withstand the shocks of a more variable climate (FAO 2012).

Agricultural production and the biophysical, political and social systems that determine food security in Africa are expected to be placed under considerable additional stress by climate change (FAO, 2007). Tanzania, like other sub-Saharan countries is highly vulnerable to effects of climate change mainly because of the lack of stable economic development and institutional capacity (IPCC, 2001). In order to study these processes in a local context, Bagamoyo district is chosen for closer examination. In many respects, the study area represents 'average' conditions in rural Tanzania and also provides an example from the hinterland of a growing metropolis, Dar es Salaam. Particularly, the roadside villages in the area have increasingly peri-urban characteristics, and the dynamics of food system change in such rapidly transforming socio-economic environment also require further exploration (Lerner & Eakin 2010).

Trend and Patterns of Climate Change in Africa with Reference to Tanzania

Climate change is already having significant impacts in developing countries and will affect their ability to achieve the Millennium Development Goals (MDGs) (IPCC, 2007; UNDP, 2008). Developing countries, such as Tanzania, are particularly vulnerable because of their high dependence on climate sensitive livelihood activities and low adaptive capacity. The 2004/05 drought and subsequent poor crop yield in many parts of the country have negatively impacted on Tanzania's efforts to address poverty and ensure food security and has led to severe power shortage (NAPA, 2007). Predictions show that the mean daily temperature will rise by 30C – 50C throughout the country and the mean annual temperature by 20C – 40C. Predictions further show that areas with bimodal rainfall pattern will experience increased rainfall of 5% – 45% and those with unimodal rainfall pattern will experience decreased rainfall of 5%–15%. All these changes will aggravate the situation leading to increased vulnerability of the communities to the impacts of climate change and also affecting the sectors of the economy especially agriculture, water, energy, health and forestry (NAPA, 2007).

Rainfall patterns in the country are subdivided into: tropical on the coast, where it is hot and humid (rainy season March-May): semi-temperate in the mountains with the short rains (*Vuli*) in November-December and the long rains (*Masika*) in February –

May: and drier (*Kiangazi*) in the plateau region with considerable seasonal variations in temperature. The mean annual rainfall varies from 500 millimetres to 2,500 millimetres and above. The average duration of the dry season is 5 to 6 months. However, recently, rainfall pattern has become much more unpredictable with some areas/zones receiving extremely minimum and maximum rainfall per year (NAPA 2007). Temperature in Tanzania also varies according to the geographical location, relief and altitude. This temperature variation has significant impact on the agro-ecological zones. To address the challenge, the government has undertaken several efforts including undertaking a Quick Scan on then Impacts of Climate Change in 2009; preparation of the National Adaptation Programme of Action (NAPA) in 2007, CDM Guide for Investors in 2004 and the Initial National Communication to the UNFCCC in 2003. These have contributed to better understanding of the present and future impacts of climate change and possible opportunities. In this regard a need for a better institutional arrangement has been underscored (URT, 2012).

Climate Change, Agriculture and Food Security

Agriculture is the mainstay of the Tanzanian economy contributing about 23.7% of GDP in the year 2011, 30.9% of export earnings and employs about 75% of the total labour force. Over the past decade, the agricultural sector grew at an average rate of 4.4%. The rate of growth in agriculture is higher than the average annual population growth rate of 2.9%, implying growth in incomes (URT, 2012. Attaining poverty reduction would require an annual agricultural growth rate of about 10% (URT, 2009). The agricultural sector comprises of crops and livestock sub sectors. Policy wise, the agricultural sector relates to crop production taking into account the synergies with other closely related policies like that of livestock, marketing and irrigation. On average, crop production contributes about 19.0% of GDP and grows at 4.1% (URT, 2008) while livestock production contributed about 5.9% of the GDP and grow at 4.3%. Food crop production is growing at a rate of about 2.8%, accounting for about 65% of agricultural GDP while cash crops account for about 10%. Maize is the most important crop accounting for over 20% of total GDP. Food and cash crops account for about 70% of rural incomes. There has been an observed decline in rainfall of 50-150 mm per season (March to May) and corresponding decline in long-cycle crops across most of Eastern Africa (Funk et al, 2005). It is from the light of the problems that this paper seeks to identify the trend and patterns of climate change that can be used for agricultural planning for better livelihoods of people at Bagamoyo district.

Methods and Materials

Study Area

Bagamoyo district is one of 6 districts of the Coast Region of Tanzania. Bagamoyo District as a whole had a total population of approximately 311,740 according to census in 2012. The district is composed of 22 wards (URT Census report 2012), which have a total of 82 villages. Bagamoyo was among 13 districts in Tanzania where the stakeholders' consultation during NAPA preparation were undertaken (Mahenge et al, 2012). In this study, seven villages of Western part of Bagamoyo were selected for closer analysis. The villages are Mkenge, Lugoba, Msoga, Diozile, Mindu Tulieni, Makombe and Saleni.

The reasons for selecting Bagamoyo district includes the average characteristics of the area in the Tanzanian context in terms of several poverty indicators and the dominant role of subsistence farming as the traditional source of livelihood (PHDR 2005). Several studies carried out in Bagamoyo district focused on climate change and food security, marine ecosystem, tourism, settlements and mangroves (Lyimo 2013, Yanda 2013, Mahenge et al, 2012, Mbwambo et al, 2012, Shaghude 2011, NAPA 2007). Different literature revisited shows that population increase leads to expansion of farm lands and grazing lands at the expense of forest and woodland areas. The present understanding of changes as a complex and interactive system involving population change and its impacts on agriculture is inadequate calling for a new study. The presence of rich literatures about the study area provides a good background understanding.

Figure 1. Map of the study area

Source: Bagamoyo District map and survey office

Primary Data Collection

An essential part of the research materials, data were collected during field work periods between September -December 2013 and January-March 2014. Additional secondary data was collected in December 2014. Altogether, the field work was carried out of which the most was spent in the study villages and a few weeks in

Bagamoyo town, Chalinze, and Dar es Salaam where additional information from governmental and private agencies was collected. The field work methods included 54 thematic interviews with key informants, 14 PRA exercises and 28 group discussions (FGD), as well as 300 structured questionnaire interviews.

Questionnaire Survey

A total of 300 household survey questionnaires were conducted where by seven villages were purposively selected and the questionnaire included questions regarding climate change such as seasonal rainfall and temperature, trend and patterns. The relatively high average age of the respondents made it possible to ask about the past events and particularly the situation in the past. In order to put more weight on the historical analysis, several questions basing on past climate and food security were included. During survey, respondents were also given more time to take up additional issues if such appeared. Random sampling was applied in a manner that the assistants or the researcher walked criss-cross through different sub-villages and selected approximately every 20th household for the interview. The average age of the surveyed was 41-55 years, the youngest interviewee being between 18-25 and the oldest above 65 years old. The sample involved about 5.0% of the total number of households in the studied villages according to the population figure from 2012. This means a margin of error of 6.0% with a 95% confidence level for the questions asked from all respondents.

Participatory Research Approach (PRA)

This was used through survey where purposive sampling through selecting adults and elders who have long time experience was used and the response being compared with the one obtained from the records. That's local perception on climate change. This involved both men and women. A total of 14 PRA were organized in all seven study sites/villages (each 2 PRA exercises). Local people from different backgrounds, regardless of their social position in their communities, were asked to participate. By doing PRA, the researcher, local people met development practitioners and government officials to articulate their livelihood conditions, their needs and their views so as to further develop their communities. The voice of the local people is central, since they are the experts of their specific livelihood and social conditions and environment (Kumar, 2002; Narayanasamy, 2009). They reflect the perceptions of the local people regarding seasonal variations on a wide range of items (Kumar, 2002, p. 148). The primary outputs of these exercises were calendars indicating the monthly variations in the climate patterns. Repeating the same exercise in a similar manner in all seven study villages gave some grounds for comparison and verification, which were then further reflected with available data.

Focus Group Discussion (FGD)

They were more participatory than the other PRA exercises, because the role of the researcher was more that of a facilitator of the discussion than a leader who determined the exercise process. Certain topics and questions were set beforehand, but many more emerged during the lengthy discussions. The participants included mostly village council members, women, youth groups and pastoralists. Group discussions are said to build up collective and creative enthusiasm, which leads to sharing familiarizing new ideas and concepts with an outsider who then familiarize with them (Chambers, 1992). In this regard, the population was sorted into groups, and described how each group accesses climate change. In this study, a total of 28

FGD (4 in each village) were organized. In each group, purposive sampling was applied in order ensure equal participation of certain segment of population such as gender, age groups, occupation and marital status.

Key Informants/Thematic Interview

Key informant interviews likewise, enable the study to obtain climate information from people with long term experience on the area as well as expert knowledge thus counterchecking the credibility of data from other sources. The questions involved were experience of climatic and food shocks, success and challenges information. The questions considered also political, economic and socio-cultural issues related to climate variability and food security. In this regards, a total of 56 key informants' interviews were conducted in all seven villages where 9 key informants were selected from each village. These were village elders (both men and women), government officers (national, district, ward and village levels), teachers, charcoal producers, shop keepers and traditional healers.

Demographic Data

Official population data from the area, including numbers of households and age groups by sexes, is available in national censuses made in 2012 (URT, 2012). The analysis started already during the early phases of the field work, so that data collection could be focused on issues and groups that are important for the studied phenomena. Usage of different qualitative and quantitative methods enabled triangulation, a form of crosschecking (Mikkelsen 2005: 96−97; Nightingale 2009). For examination of thematic interviews, group discussions, and conversations that stemmed up during the PRA exercises, the main method was textual analysis involving latent content analysis and matrix displays. Latent content means researcher's subjective interpretation and summarization of particular themes in the texts, which in this case were transcribed interviews. These themes, such as poor availability of rains or food shortages, are not necessarily represented with the same wording by different sources, and thus interpretation is needed (McBurney & White 2009: 234−235).

Findings and Discussion

We look at rainfall and temperature patterns and trend in terms of distribution and intensity, as both have major implications for agriculture and other livelihoods in the area. Looking at the temperature data, overall patterns and trend especially at the number of hot years and mean dry spell durations; the data are relevant to the evaporation rate and to crop production cycles, storage and also indicate the level of risk of heat stress, which affects both crops, and people's health and ability to work. To achieve this, the analysis is divided into first part secondary data analysis (rainfall and temperature) analysis where mixed modal of descriptive statistics and trend analysis/time series are used. The second part is based on primary data analysis (obtained from the field work) through household survey, PRA and FGD where triangulation and researchers interpretation are used.

Mixed Modal with Descriptive Statistics and Time Series Analysis

This part deals with the analysis and interpretation of the study from the quantitative data obtained on amount of rainfall as well as degree of temperature from 1978 to 2014 (37 years). For the purpose of in-depth trend and patterns, a mixed model of analysis was adopted. This model consists of both descriptive statistics as well as time series analysis. To establish the trends and patterns of rainfall average amount of rainfall as well as temperature was used for analysis purposes. The patterns and trend time series analysis was done based on years as well as months for both rainfall and temperature. Years are treated as fixed because they are constant throughout and act as independent variable because they have so many levels. The months are covariate because they are core variable which the investigation of their effects is based upon. The error effect is type III error meaning that the results obtained comes from the output (no influence of external variables). The mixed modal with time series is adopted because of frequency analysis and standard deviations and trend analysis is for observing in depth patterns and trend of rainfall and temperature in years and months and their significance difference.

Table1: Descriptive statistics of rainfall 1978-2014

Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Mean	**234**	**235**	**216**	**234**	**239**	**235**	**248**	**233**	**234**	**207**
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Mean	**238**	**219**	**255**	**220**	**218**	**262**	**222**	**243**	**209**	**199**
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Mean	**261**	**217**	**220**	**203**	**237**	**257**	**216**	**223**	**208**	
Year	**1987**	**1988**	**1989**	**1990**	**1991**	**2001**	**2002**	**2003**	**2005**	**2005**
Mean	**207**	**222**	**231**	**229**	**214**	**199**	**240**	**187**	**227**	**189**

The table 1 above shows the sample distribution of descriptive statistics for rainfall from 1978 to 2014. The statistics shows the average amount of rainfall throughout this period. The average amount of rainfall ranges between 187 and 262 (mm). The highest amount of rainfall was recorded in 1997 (262mm) and least amount was recorded in 2003. The general average trend and pattern show that the differences between the averages amount of rainfall of each year starting from 1978 to 2014 is generally small. Majority of the average amount of rainfall are two hundreds. With a general average rainfall being undulating the differences between the years are not huge. Observation indicates that is difficult to conclude that there is a decrease of amount of rainfall in recent years compared to the past. This is because there is lower and higher average rainfall in both recent and past years. For instance in 2014, 2012, 2011, 2007 and 2006 in comparison with 1978, 1979, 1987, 1980 and 1984. The implication to agricultural practice is that, it is difficult to establish a conclusion that next season there will be an increase or decrease of rainfall. Lastly there might be a seasonal variation rather than the amount of rainfall in a particular year.

Table 3. Model Statistics from time series analysis based on years and months of rainfall

Model	Number of Predictors	Model Fit statistics	Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	Statistics	DF	Sig.	
Rainfall-Model_1	9	.933	9.397	18	.950	0

The table three above shows the model statistics from the time series analysis on the years and months based on the average amount of rainfall. Rainfall- model_1 stands for one variable which is rainfall. The model result used 9 predictors out of 37 years rainfall variables. Model fit statistics is determined by R-square which is .933 implying that the value fits for model application as it is above .7. A statistical value of the model is rated at 9.397. Statistical Difference or degree of freedom (DF) of 18 and significance of .950 while number of outliers is 0. Rainfall does not raise any problem from an econometric point of view, many variables of such a nature from economic and business time series are non-stationary even after eliminating deterministic trends due to the presence of unit roots. From the model statistics it can be indicated that no significant difference is established between the years and the amount of rainfall as well as their months. This is indicated as (DF= 18, T=9.397, p> 0.05). The stationary R square statistics shows that 93.3% of the time the stationarity of the variable holds.

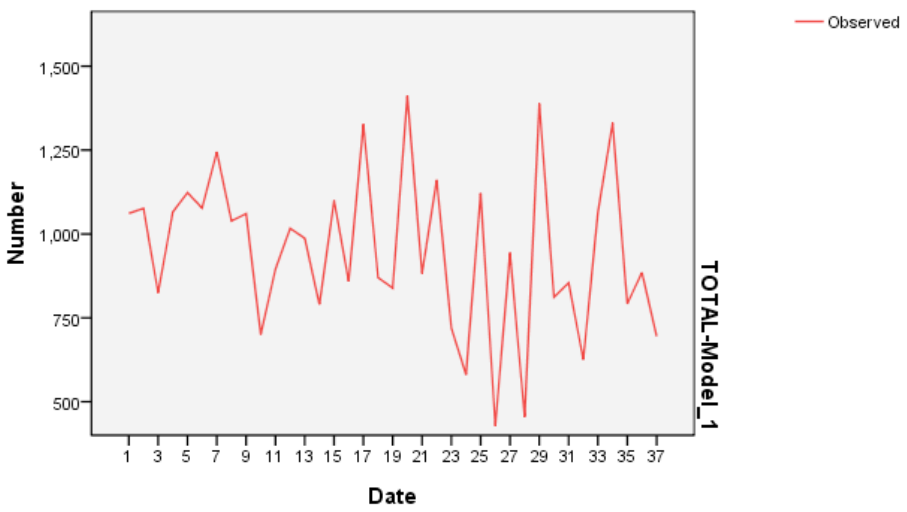

Figure 2. Time series trend and patterns for amount of rainfall from 1978-2014

The above graph shows the time series trend and patterns for the average amount of rainfall from 1978 to 2014. This shows that the general trend and pattern is undulating throughout the 37 year period. 1978 and 1979 shows an increase in the average amount of rainfall experienced across the months with value above 1000, this amount drastically decreased in the year 1980 with little rainfall value less than 1000. The trend led to a sharp increase between 1981 and peaked at 1984 with a rainfall value of 1,250. The trend and pattern continues with a sharp decline between 1984 till 1986 bringing the rainfall value to below 750 and a sharp rise from and fall from 1986 till 1996 and a rise between 1997 through 1999 which recorded the highest amount of rain. The general rise and fall again continued till the lowest amount recorded in the year 2003 with value less than 500. With this the second lowest amount of rainfall was recorded in 2005. From this point the rise and fall of the rainfall was experienced until a second highest amount recorded between 2005 and 2007. There was also a drastic decrease from 2011 to 2014 on the amount of rainfall with the value of the last year recorded with little below 750. From the observations, it is difficult to establish a clear conclusion that in recent years; rainfall has decrease. The evidence is too narrow.

Table 4. Descriptive statistics for Temperature from 1978 to 2014

Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Mean	175	176	176	176	176	176	176	176	176	177
Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Mean	177	176	177	177	177	177	177	177	177	177
Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Mean	177	178	177	177	178	178	179	178	178	179
Year	2008	2009	2010	2011	2012	2013	2014			
Mean	179	170	178	180	180	179	180			

The table 4 above shows the sample distribution of descriptive statistics for temperature from 1978 to 2014. The statistics shows the average temperature degrees based on approximations throughout this period. The average temperature was considered from both the minimum and maximum temperatures obtained across years and months for the analysis. The average temperature from the stipulated period ranges between 1978 through to 2014. It can be observed that the highest temperature was recorded in 2011, 2012 and 2014 and least amount was recorded in 2009. The general average patterns and trend shows that the differences between the average temperatures of each year starting from 1978 to 2014 are generally minimal. Majority of the average differences are sometimes less than 1. With a general average being undulating the differences between the years are not huge. Additional observation shows that there is an increase of temperature in the recent years compared to the past.

Table 6. Model Statistics from Time series analysis based on years and months of Temperature

Model	Number of Predictors	Model Fit statistics	Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	Statistics	DF	Sig.	
TOTAL-Model_1	4	.987	12.852	18	.800	0

The table six above shows the model statistics from the time series analysis on the years and months based on the average (minimum and maximum) temperature. Temperature doesn't raise any problem from an econometric point of view, In order to ensure effective trend and patterns in temperature for the period stated the times series model of best fit was done to ensure this stationery variable. The model statistics indicates that due to hugeness of the data no significant difference is established between the years and the amount of temperature as well as their months. This is indicated as (DF= 18, T=12.852, p> 0.05). This in effect does not mean that no differences lie between the years and their average temperature throughout the period. The reason may be attributed to the compact nature of the data as well as the minimal differences between each year and months temperature in degrees Celsius.

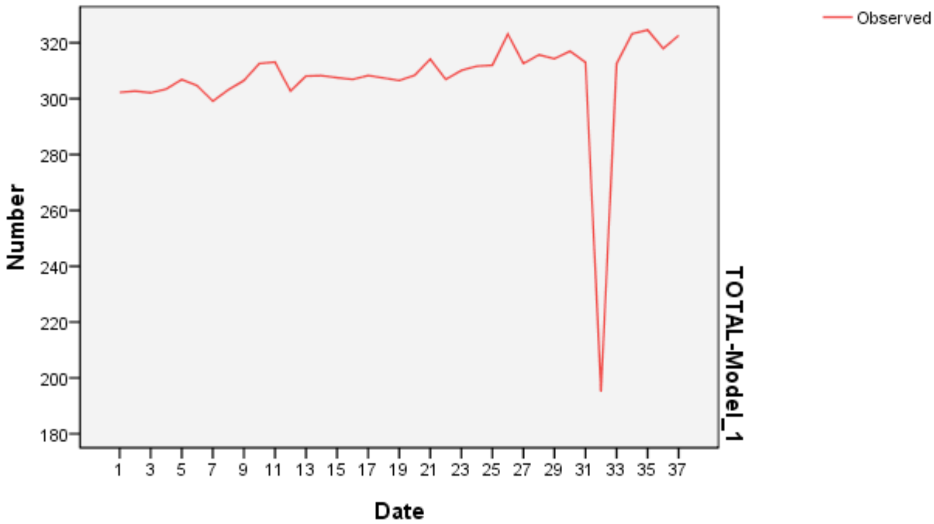

Figure 3. Time series trend and patterns for average temperature from 1978 to 2014

The above figure shows the time series trend and patterns for the average amount of temperature from 1978 to 2014. This shows that the general trend and pattern is undulating throughout the 37 year period. 1978 to 1980 shows a slight increase in the average temperature experienced across the years with value above 300, this amount decreased slightly in the years 1981 to 1983 with a little fall below 300. The trend led to a sharp increase between 1984 and peaked at 2002 with a temperature average value of 320, this lead to a little decline in the continues until a drastic decline in 2009 with a value above 180 and little below 200. The trend and pattern continues with a sharp rise in temperature between 2010 till 2014 bringing the rainfall value to 320 and above. The general rise and fall again continued till the lowest amount recorded in the year 2003 with value less than 500. Generally, with a general undulating trend and patterns of temperature throughout the period, the lowest temperature difference is hugely experienced.

Primary Information on Patterns and Trend of Climate Change

Primary data are used to compare climatic records and local perceptions on climate change. Villagers' observations through survey at all seven study sites/villages indicate that conditions are changing in multiple ways. The challenge for policy-makers is to understand how future climate change might further affect the rural people, and to try to set priorities for adaptation. The timing and intensity of rainfall are no longer reliable; rains early in the season are heavier than they used to be, but later in the rainy season, conditions may be dry. When asked if they observed changes in climate over some years in comparison to the situation today, about 95% said yes. Regarding experience on droughts or dry spells over some years in comparison to recent years 56.3% experienced a lot more, 38.3% experienced more, 2% said there was no change, 2.7% said no less than before, and 0.7% said did not exist at all. Coming to experience on floods in last 20 years and current, only 3.3% said that they experienced a lot more, 1.3% yes more, 35.7% said about the same as before, 50.7% said no less than before, and 9% said they didn't experience floods at all.

Thematic interviews conducted at all villages, indicate that the current trend of rainfall is unpredictable and the future is all about drought. According to respondents interviewed trend shows that climate variability is rampart where by some years ago there were two seasons of rainfall, that is “vuli” (short season between Sept-January) and “Masika” (long season between March-June), but now the trend has changed to one season and unpredictably. One of the examples given by majority respondents during interviews at Mkenge village was Mkombezi River which had enough water in the past years but during interview in November 2014 the river was dry. Through observation, a researcher witnessed a dry river Mkombezi where by cattle and villagers were fetching water from underground (see figure 2). It was informed that in past years, river Mkombezi provided enough water for domestic use and cattle.

During FGDs, people’s comments show that their main shock being climate change i.e. temperature and rainfall. The trend of rainfall is unpredictable and the amount is small comparing with past. The leanest months are April-June. Some respondents give reasons for climate change in the recent years being deforestation. Villagers complain that the government is too weak to take measures against people involved in deforestation. At Mkwama sub-village (Mkenge village), where the majority inhabitants are Maasai (pastoralists) the major shock in the context of climate is drought. Only in 1997/1998 when the village experienced flooding (Elnino) but since then drought has increased. Interview with some village elders such as former Village Executive Officer (VEO) informed that in recent years the major changes are absence of floods and increased drought as well as change in rain season from bimodal to single season and its variation.

The findings show that majority of people in the study area understand climate change as a change of weather in an area. Other factors explained as change of situation of environment, drought, change in rainfall, and presence of hot and cold, change in temperature, absence of rainfall, and change in condition of season, absence of water and change of wet to dry. Looking at the meaning of climate change, the analysis shows that people are aware of climate change, only that everyone could explain it in different wording. Community perceptions on the indicators of climate change varied but rainfall was the most influencing factor followed by drought, temperature and summer. From this analysis, one can draw a conclusion that community members in the study area are influenced by the agriculture being a rain fed kind of economy.

Conclusion and Recommendations

In this study, the analysis of rainfall data indicates that there is no big evidence of change of trend and patterns over 37 years. But one can establish a seasonal variation within a year from January to December. The model indicates that there is no significant change of rainfall patterns and trend in 37 years from January to December ($p < 0.05$). The analysis on temperature data indicates that there trend and patterns in 37 years doesn’t show huge difference, meaning that the values are too close thought-out. However there is an increase of temperature in the recent years compared to the past. The model reflects that there is no significant difference between temperatures in 37 years and its months from January to December.

The analysis of the trend and patterns of climate change is very important for agriculture planning and implementation. The implication of this on agriculture is that it is difficult to predict whether in the future, rainfall will increase or decrease. No determinants for change of seasonal production yearly. However, the change of seasons within year can help recommendations to farmers for early warning that cropping patterns should determine the kind of crop depending on which month; for instance during low rainfall people can decide to grow crops which do not require high amount of rainfall, and vice versa. The implication of temperature increase can help crop cultivators on early warning that the existence of pests and diseases may accelerate crop failure which can help adaptation through the use of pesticides and even cropping patterns.

Community perceptions on climate change trend and patterns reveals that in the recent years there has been a decrease of rainfall and increase of temperature. The weather patterns have become unpredictable and this has affected community members in the study area their livelihood activities. Generally agricultural activity in the study area is rain fed and natural resource dependent. It is wealth knowing that community members understand the linkages between climate change and their livelihood. Looking at the future of Bagamoyo district, there is a great deal of uncertainty about climate hazards. No single, clear message emerges from the analysis, and the climate data graphs require careful reading and interpretation.it learned that it is important to be cautious in predicting the future, and to compare different sources of data.

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