COMMUNITY VULNERABILITY AND ADAPTATION TO THE IMPACTS OF CLIMATE VARIABILITY AND EXTREMES ON SIMIYU WETLANDS: The Case of Simiyu Wetlands, Lake Victoria Basin

Madaka TUMBO*[1]

1 Institute of Resource Assessment, University of Dar es Salaam, P.O. Box 35097,Dar es Salaam, Tanzania
* Corresponding author, email: madaka.tumbo@gmail.com

Abstract
This study aimed at assessing community vulnerability and adaptation to the impact of climate variability and extremes on wetlands and its implication for livelihoods in Simiyu catchment, Southwest of Lake Victoria, Tanzania. The results of this study provide baseline information on vulnerability assessments and development of adaptation strategies in the country. Moreover this study will likely contribute significantly to similar future studies on other wetlands within Tanzania. Rainfall anomalies were used to characterise wet and dry seasons. Questionnaire surveys and focus group discussions were used to establish the impacts and coping strategies used during extreme events of floods and droughts. The results showed high rainfall fluctuations between seasons and from one year to the other. They further indicated that normally the October –November –December (OND) and March-April-May (MAM) seasons do not have the same strength and sign of anomalies, that is there are seasonal variation within the same year. Communities living around the Simiyu wetlands are vulnerable to seasonal fluctuations as their socio-economic activities are highly dependent on rainfall since 87% of respondents practice rainfed agriculture. It is concluded that incidences of climate variations are increasing and have implications for livelihoods that depend on wetlands resources. The implication of these seasonal variations is the reduction in agricultural and livestock production. This has recently led to mixed croping along the wetlands and lake shores as a coping strategy. The responses of livestock keepers to seasonal variations in rainfall include holding vast and varied grazing grounds (transhumance) in order to ensure ownership of abundant grazing land.

Key words: Climate variability, wetland resources, vulnerability, adaptation

INTRODUCTION

Africa is considered more vulnerable to the predicted impacts of climate variability due to, among others factors, its overdependence on all form of natural resources (water, forests, fisheries and agriculture) and limited financial, technological and institutions capacities to respond to predicted impacts of climate change. It is therefore evident that climate change will impact Africa in various ways. The projected impacts of climate change by 2100 in Africa may include increases in temperature of 1.0° to 4.7 °C, reduced rainfall by -2 to –25%, increased evapo-transpiration up to 132% and reduced runoff up to 50% (Magadza, 1996; Hulme, 1996). The implications of such changes on water resources are among the most critical to society and ecosystems since the small amount of water found in the biosphere has a large significance for ecosystems and society (Carpenter, *et al*., 1992). The availability of water influences major biome types and potential agricultural productivity (Carpenter *et al,* 1992). Similarly, human depends directly on freshwater for drinking, irrigation, industries, transportation, recreation and fisheries. Expanding human

populations and changes in global climate will exacerbate already severe stress to freshwater resources in Africa (Ausubel, 1991; Chenje and Johnson, 1996; URT, 2003). Sustained variations in global climate can further have enormous effect on distributions and interactions of species (Carpenter *et al.,* 1992).

More than 70% percent of the population in Tanzania is rural and practices subsistence agriculture which is largely rainfed (WHO/UNICEF, 2000). The analysis of current economic and environmental trends in Tanzania reveals an increasing competition over access and uses of freshwater resources including wetlands. Rapid population growth, increasing demand for food, high climate-induced rainfall variability and frequent droughts are putting enormous pressure on wetlands resources. However, there is little information on wetlands responses to climate variability and its implications on rural livelihoods in Tanzania and is often not included in national policies and strategies. Although the National Initial Communication to UNFCC (URT, 2003) included an assessment of impacts of climate variability on countries water resources, the emphasis was on the impacts and not communities responses to such changes. Therefore, information is needed for the purposes of increasing an understanding of the linkage between wetlands ecosystems, climate variability and community's livelihoods which will help in understanding the level of preparedness of communities depending on wetlands ecosystems and their adaptation strategies to impacts of climate variability. This study assessed vulnerability and adaptation of communities living around wetlands at the mouth of River Simiyu discharging into Lake Victoria to document the impacts of variations of hydrological extremes (droughts and floods) on livelihoods of communities depending on wetlands resources.

This study assessed communities' vulnerability and adaptation to the impacts of climate variability in Simiyu. Specifically, this study investigated the hydrological extreme events (droughts and floods) and the impacts of these variations on communities dependent on wetlands resources. Furthermore, the study assessed past and present adaptive strategies to climate variations, current and potential adaptation measures that could lessen vulnerabilities to climate variability.

OBJECTIVES

Main Objective

The main objective of this research was to assess the vulnerability and adaptation of communities' livelihoods to the impacts of climate variability and extremes on Simiyu wetlands.

Specific Objectives

The specific objectives were to:

1. Identify the hydrological extreme events in the study area.
2. Identify wetlands goods and services that sustain communities' livelihoods.
3. Assess impacts of climate variability and extremes on wetland resources that support communities' livelihoods.

4. Assess the communities' response to the impacts of climate variability and extremes.

DATA AND METHODS

Data

Rainfall data for 13 stations within and around the Simiyu catchment were obtained from the Department of Water Resources Engineering of the University of Dar Es Salaam. The rainfall records were of variable quality and length and necessitated the selection of the most suitable records for characterization of drought and flood periods. The selection criteria included minimum record length of 20 years, less than 15% of missing seasonal rainfall and spatial uniform distribution of rainfall stations. These criteria retained four (4) records for analysis.

Primary socio-economic data were collected during field household surveys in three villages Bubinza, Nsolla and Ilungu surrounding and exploiting wetlands resources. Household questionnaires, interviews and focus group discussions were used in the process. A specific time frame which can be remembered by participants was used to investigate climate variability impacts on wetland based livelihoods.

Methods

Seasonal rainfall anomalies were used to characterise years. The year was divided into four known seasons, the short rains (October-December, OND), intermediate January-February (JF) season, the long rains (March-May, MAM) and the dry June-September (JJAS) season. Seasonal rainfall amounts were computed only for seasons with non-missing monthly rainfalls. Seasonal rainfall anomalies were calculated as standardised (division by standard deviation) differences between seasonal rainfall amounts and their long-term averages. That is

$$X_{an,i} = \frac{X_i - \overline{X}}{\sigma_X} \qquad \text{(eqn.1)}$$

where X_{ani} is rainfall anomaly in month *i*, X_i is rainfall for month *i*, $\overline{X}$ and σ_X are the long term average and standard deviation of rainfall in month *i*.

The anomalies were used to classify years according to rainfall abundance or deficit. Plots of series of rainfall anomalies were visually analysed to provide limits that appropriately define different levels of wetness and dryness of the year that reflect actual observations. The procedure established five classes (Table 1).

Table 1: Criteria for selection characterization of hydrological years

Criteria	OND	JF	MAM
Extreme wet year	Anomaly > 2.0	Anomaly > 2.0	Anomaly > 1.50
Wet year	2.0 ≥ Anomaly > 1.0	2.0 ≥ Anomaly > 1.0	Anomaly ≥1.00
Normal	1.0 ≥ Anomaly ≥ -1.0	1.0 ≥ Anomaly ≥ -1.0	1.0 ≥ Anomaly ≥ -1.0
Dry year	-2.0 ≥ Anomaly >-1.0	2.0 ≥ Anomaly > 1.0	≤-2.0
Extreme dry year	Anomaly ≤-2.00	Anomaly ≤-2.00	Anomaly ≤-2.5

RESULTS

Identification of wet and dry years

Results are presented and discussed only for the two main rainy seasons (OND and MAM) where agricultural activities are predominant. The time series of OND and MAM anomalies indicated that mostly the two main rainy seasons do not have the same classification as wet or dry in the same hydrological (October – September) year (Table 2). While long rains were extremely abundant in Simiyu only in 1937, the short rains were abundant in 1961 and 1997 (Fig 1). The results further indicated the high reccurrence frequency of dry and wet conditions during the short rains compared to long rains (Table 2). Series of rainfall anomalies further indicated that the extreme driest long rains in Simiyu were experienced in 1973 and 1984 (Fig 1b) correspond to La Niña droughts of 1972-1976 which most parts of northern and northeastern Tanzania (Nyenzi *et al*., 1999) and widespread droughts of 1984 in East Africa (Ogallo and Nasib, 1984).

Table 2: Characterization of Years According to Rainfall Amounts

	Season	
Year classification	Short rains (OND)	Long rains (MAM)
Extreme wet	1961, 1997	1937
Wet	1941, 1951 ,1972, 1982,1994	1981
Dry	1940, 1947 ,1964 ,1966,1970,1993	1933,1953
Extreme dry	1990	1973,1984

Agricultural productions during wet and dry years

Results of field surveys indicated that wet years experienced higher agricultural productions (Table 3) and livestock productions (Table 4) than in normal and dry years. This is attributed by the abundance of water which is available for agricultural activities. In dry years, all the villages experienced low crop productions (Table 3). This was particular during the recent 6 years and was attributed by prolonged hydro meteorological drought that has been experienced in the study area since 2000. This has resulted in the decline of surface water resources including drying up of wetlands and lowering of Lake Victoria levels and consequently reduced water availability for agriculture. Low agricultural productions resulted in low per capita income, since the area depends mainly on agriculture.

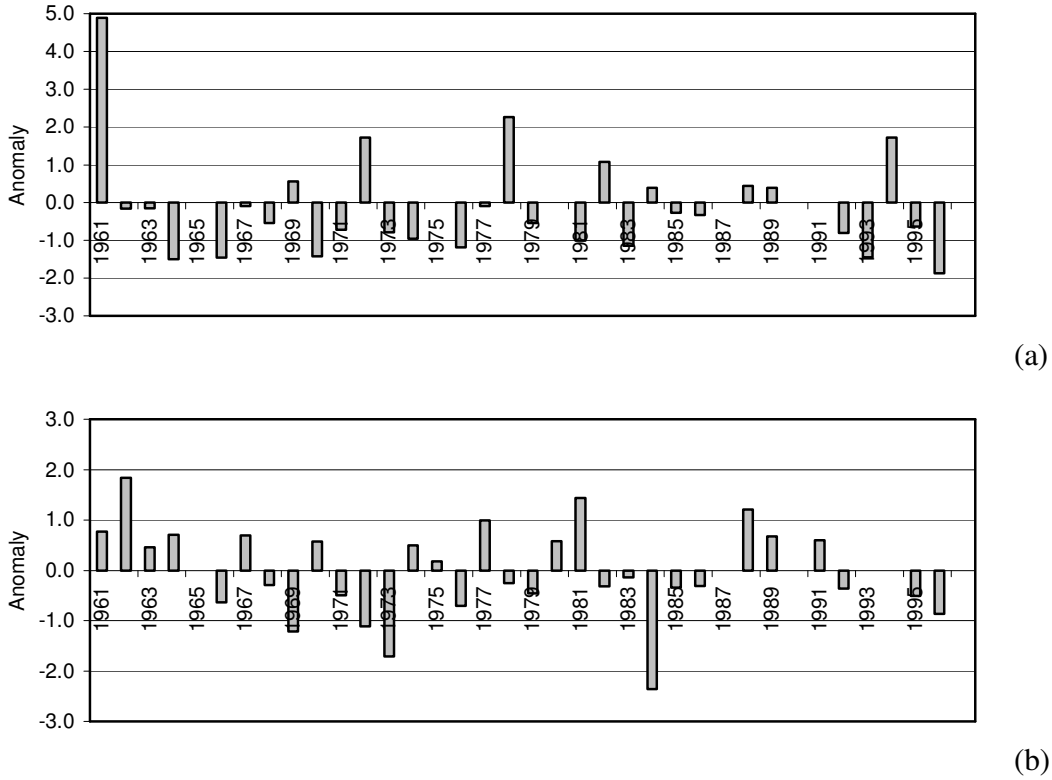

Fig 1: Time series of normalised anomalies of a) OND and b) MAM seasonal rainfall amounts at Ngudu Station (ID 09233005).

Table 3: Crops production and sales (area: acres; production: kg).

Crop	Normal years (eg 2002)		Dry years (eg 2005)		Consump-tion (kg/mon/hh)	Sale price (TShs/kg)
	Area	Prod	Area	Prod		
Rice	65.25	89,440	45.25	19,840	30	250
Maize	70.50	113,000	62.5	9,285	60	150
Cotton	50.00	44,542	15.00	2,770		300
Cassava	10.50	10,320	6.50	3,420	40	
Water melons	6.25	12,000	6.25	8,500		300
Tomatoes	20.25	224,800	20.25	24,050		100
Sweet pota-toes	10.00	360,000	10.00	359		
Dengu	21.00	32,020	11.00	3,640		1000

Table 4: Number of Livestock for Different Years

Name of Village	Dry year (2005)		Normal year (2002)		Difference (Normal-Dry)	
	Cattle	Goat	Cattle	Goat	Cattle	Goat
Nsola	900	102	1049	142	149	40
Ilungu	616	3	913	11	297	8
Bubinza	502	20	786	68	284	48
Total	2018	125	2485	221	730	96

It was identified that the difference for the number of cattle between normal and dry years is not very larger compared to that for goat (Table 4). This was attributed to a higher economic value of cattle than of goats or sheep. This caused greater attention being paid to cattle more than to sheep and goats and consequently cattle receive adequate treatment when suffering from any sort. This lead to their survival compared to sheep and goats and their decrease during the dry years could be resulting from their sell rather than death.

As a coping strategy to frequent droughts in Simiyu, communities are practising shifting agriculture, shifting their farming areas from the uplands into lowlands and drying wetlands. Currently, about 73% of the village population is farming in the wetlands and low land areas due to the prevailing situation of unreliable rainfall and lengthening of dry spells. Despite such efforts, the recent prolonged drought has resulted in low agricultural production. This situation has led to seasonal food shortages of one to six months normally between December and May.

Water supplies during wet and dry years

Communities surrounding Simiyu wetlands obtain water for domestic and agricultural uses from various sources including private piped connections, surface flood water, groundwater (shallow wells and boreholes) and springs. An average daily water consumption of a household is 80 litres from a combination of these sources. However, the major source is groundwater which accounts about 77-89% of the total supply, the lower percentage during the dry years. This indicates the heavily dependence upon a single groundwater source and during drought, when groundwater levels are low, water becomes scarce and people had to walk long distances to collect water. The situation is worse for communities in Nsola and Ilungu villages which rely only on a single borehole which frequently dries during severe droughts leaving only Kisamba spring in Bubinza village, the lake and water vendors as sole sources.

Runoff drainage problems during wet years

Prolonged inundation is a major problem related to runoff drainage in the study area due to the nature of terrain (flood plain). Low-lying plains within and around Simiyu are frequently inundated with flood water and consequently are affected by the effects of prolonged inundation including outbreaks of water borne diseases and loss of residences, properties and infrastructure, crops. This is illustrated during the floods of 1961, 1997 and 2006 when the area was inundated for several weeks. The inundation significantly af-

fected crops, infrastructure and residences and as temporary coping strategy, villagers had to resettle in schools and village stores. Villagers were unable to cultivate the land and consequently productions dropped for some crops like rice, maize, cassava and green vegetables while complete failure of water melons and tomatoes was experienced.

Community vulnerability during wet and dry years

Within the context of climate studies, the most vulnerable are considered to be those who are most exposed to perturbations, have a limited capacity for adaptation and are least resilient to recovery (Bohle *et al* 1994). Based on our wealth ranking (Table 5), results of information analysis indicated that the poor wealth category is vulnerable to impacts of climate variability. Among the contributing factors to such high vulnerability risk are possession of small land and lack of agricultural areas within the wetlands, spending much of their time as labourers as coping mechanism to manage food shortages and spending of their little income on renting small farms in wetlands for potato cultivation.

Among the major coping strategies of the most vulnerable group to droughts are engagement in casual off-farm activities such as water vending, brick making, providing non-motorised transport (bicycle) and trading of firewood and charcoal. In coping with drought conditions, stored dried cassava and potatoes (michembe and udaga) and occasional purchases of cereals are among the major strategies while government assistance is essential in critical conditions.

Table 5: Household wealth status and crop production in the village.

Wealth status	Fraction of population (%)	Crop Production (kg)
Well off	3.9	366,000
Average	49.4	51,920
Poor	46.8	22,160
Total	100.0	440,080

It was further identified that villagers were not planning measures that will reduce the impacts of recurrent floods and droughts. Their only strategy was spiritual on making prayers once they are hit by the event. It was observed that the low level of education and lack of access to basic information like early warning information and weather forecast attributed the situation.

Community adaptation during wet and dry years

Coping with impacts of climate variability depends on how severely stressed people are or their level of vulnerability and on their resilience or the decisions and/or action communities may take to minimise the impacts. From Table 4.14, it is observed that 19.5% of respondents are engaged in casual/off-farm labour and trade (like selling water, making bricks, providing transport (bicycle), selling firewood and charcoal in order to cope with climate variability impacts. About 16.9% depend on government assistance. This is followed by those who depend on dried cassava and potatoes (michembe and udaga) and buying food (13%). About 9.1% are engaged in selling firewood where and 6% of respondents sold their assets in order to cope with the drought. About 2.6% of respondents cultivated crops in wetlands using residual moisture and along Lake Victoria. Cultivation

along Lake Victoria and in wetlands involves a mixed farming practice that is planting different crops in the same fields in order to minimize the risk of crop failure.

Mixed farming is used as a strategy to ensure that, if one crop fails because of drought, another crop can survive due to differences in crop cycles, rooting depths, water requirements and so on. The most common and widespread combination is maize together with cassava, groundnuts (*Arachis hypogea*) and cowpeas (*Vigna unguiculata*). In some areas farmers include beans (*Phaseolus vulgaris* or *Phaseolus aureus*) in this combination. In other areas sweet potatoes are grown as a monocrop. Other crops grown in the basin include rice (in a wet year) and cotton as a cash crop. During focus group discussions it was observed that the poorest households depend more heavily upon a combination of crops and/or natural resources (usually common resources) for their food security and income-generating activities than the better-off.

CONCLUSIONS

The study indicated that there are high rainfall fluctuations between seasons and from one year to the other and normally the OND and MAM seasons are not similarly abundant or deficit within the same hydrological year. Their climate-induced variations of the years significantly affect socio-economic activities (mainly rainfed agriculture) and community livelihoods which are mainly dependent on wetlands resources. As a result, community livelihoods are vulnerable to climate variability and its extreme phases that correspond to drought and flood conditions in Simiyu catchment.

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