

Full Length Research Paper

Nature and dynamics of climate variability in the uganda cattle corridor

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The study was conducted in the districts of Nakaseke and Nakasongola stratified into four farming systems of crop dominance, pastoralists, mixed crop and livestock and fishing. The study was guided by two research questions: (1) how do community residents perceive climate change/variability? (2) What is the trend and nature of climate variability and how does it compare with people's perceptions? Ninety eight percent (98%) of the respondents reported that the routine patterns of weather and climate had changed in the last 5 to 10 years and it has become less predictable with sunshine hours being extended and rainfall amounts being reduced. This compared well with the analyzed secondary data. Over 78% respondents perceived climate change and variability to be caused by tree cutting other than the known scientific reasons like increase in industrial fumes or increased fossil fuel use. Climate data showed that over the period 1961 to 2010 the number of dry spells within a rainfall season had increased with the most significant increase observed in the first rainfall season of March to May as compared to the season of September to November. The first dry season of June/July to August is short while the second dry season of December to February is long during the study period. The two rainfall seasons of March to May and September to November seem to be merging into one major season from May to November. Temperature data shows a significant increasing trend in mean annual temperatures with the most increase observed in the mean annual minimum temperatures than the maximum temperatures.

Key words: Climate variability, community perceptions, Uganda cattle corridor, dry spells.

INTRODUCTION

Climate variability has been identified as a major challenge hindering most developing countries from

attaining Millennium Development Goals (UNDP, 2007). Climate variability manifests as floods, droughts

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Abbreviations: AIACC, Assessments of impacts and adaptation to climate change; GDP, gross domestic product; HHS, household survey; IPCC, Intergovernmental Panel on Climate Change; SPSS, Statistical Package for Social Scientists; UBOS, Uganda Bureau of Statistics; UNDP, United Nations Development program; WMO, World Meteorological Organization.

erratic and unreliable rainfall and other extreme weather events, and has not only negative impact on natural and human systems but also creates serious developmental challenges in developing countries (AIACC, 2007).

These developing countries (most of them in Africa) are the most affected due to their dependence on climate sensitive economic sectors such as rain-fed agriculture, and their limited economic, technological and human capacities to respond to climate change and variability induced stress (Huq et al., 2004; IPCC, 2007).

Agriculture constitutes the back bone of the economies of most developing countries. In Uganda, agriculture contributes up to 22.5% of the GDP, provides employment to 66% of the total working population (UBOS, 2011). Most of this agriculture is rain-fed and therefore susceptible to climate variability and change impacts.

In Uganda, there is a strip of land stretching from the south west to the north eastern part of the country commonly known as the Uganda cattle corridor. This region has experienced contrasting climate change related conditions such as prolonged droughts, unpredictable rainfall onsets and withdraws as well as floods among other climate variability related phenomena (Kisamba, 2001). In addition to these climate variability related problems, community problems such as land disputes have also been common in this region mainly between pastoralists and crop farmers regarding the use of resources of land and water.

The nature of climate variability in this area is not well understood and how the impacts of climate variability affect the communities has not been well documented. This study therefore characterized the nature of climate variability by analyzing variations in major climatic parameters of rainfall and temperature and how they affect local communities in the central cattle corridor districts of Nakasongola and Nakaseke. The paper attempted to address two major questions: (1) How do community residents perceive climate change/variability? (2) What is the trend and nature of climate variability and how does it compare with people's perceptions?

MATERIALS AND METHODS

Study area

The study was focused on two cattle corridor districts of Nakaseke and Nakasongola in the central part of the corridor (Figure 1). The two districts had a combined population of 265,342 during 2002 population census and the projected population for 2012 was 347,600 (UBOS, 2012). The districts are composed of mainly four categories of communities: crop farmers dominated communities, livestock/pastoral dominated communities, mixed crop and livestock communities and fishing communities especially around Lake Kyoga.

The area experiences a fairly bi-modal rainfall season like most parts of the country with the first season beginning in March and ending in early June and the second season beginning in late August/early September and ends in November/December.

Selection of respondents

House-hold surveys (HHS)

In each of the two districts, communities were stratified into three strata: pastoral-majority areas; areas where pastoralists are a minority among settled agriculturalists, and areas of extensive grazing by mixed crop-livestock farmers. In each of the three (3) strata in each district, 30 villages were randomly selected using the village registers at the district giving a total of 90 villages per district. In each of the selected villages, 20 households were randomly selected, using the registers at Village Local Council offices giving a total of 1800 households for each district and 3600 households for the entire study area.

Data

Both primary and secondary data were used in this study to understand the nature and dynamics of climate variability in the two cattle corridor districts of Nakaseke and Nakasongola.

Primary data

A structured questionnaire was designed to capture the community perspectives of climate change and variability, indigenous knowledge and the coping mechanisms adapted by the communities during harsh conditions. The questionnaire was pretested before implementing it in the field using trained research assistants and the entire research team.

Secondary data

This consisted of historical data mainly on rainfall and temperature from 1961 to 2010. Soroti station in the same climatological zone as the study area was selected because of its complete historical weather and climate records. This consisted of daily rainfall and temperature data from which pentad, monthly and annual means were calculated. This data was obtained from the Department of Meteorology in the Ministry of Water and Environment.

Data analysis

Primary data

The questionnaire from the HHS was coded and results entered using epi-data software which was later exported to SPSS for further analysis. Graphs and tables and cross tabulations of variables of specific interest are then presented for discussion.

Secondary data

The data was checked and quality controlled using WMO (1970) guidelines. Trend analysis on various climatic parameters mainly rainfall and temperature were used to determine the variations in pentad, monthly, seasonal and annual variations of these climatic parameters in the study area from 1961 to 2010. Other parameters including onset and cessation of rainfall seasons, dry spells within a rainfall season, length of both wet and dry season were derived from pentad and monthly values of climatic parameters. Correlation and regression was then applied on the derived values to determine their relationships and their temporal variations.

Onset and cessation dates of rains: A number of studies have defined onset and cessation dates of the rainfall season for different

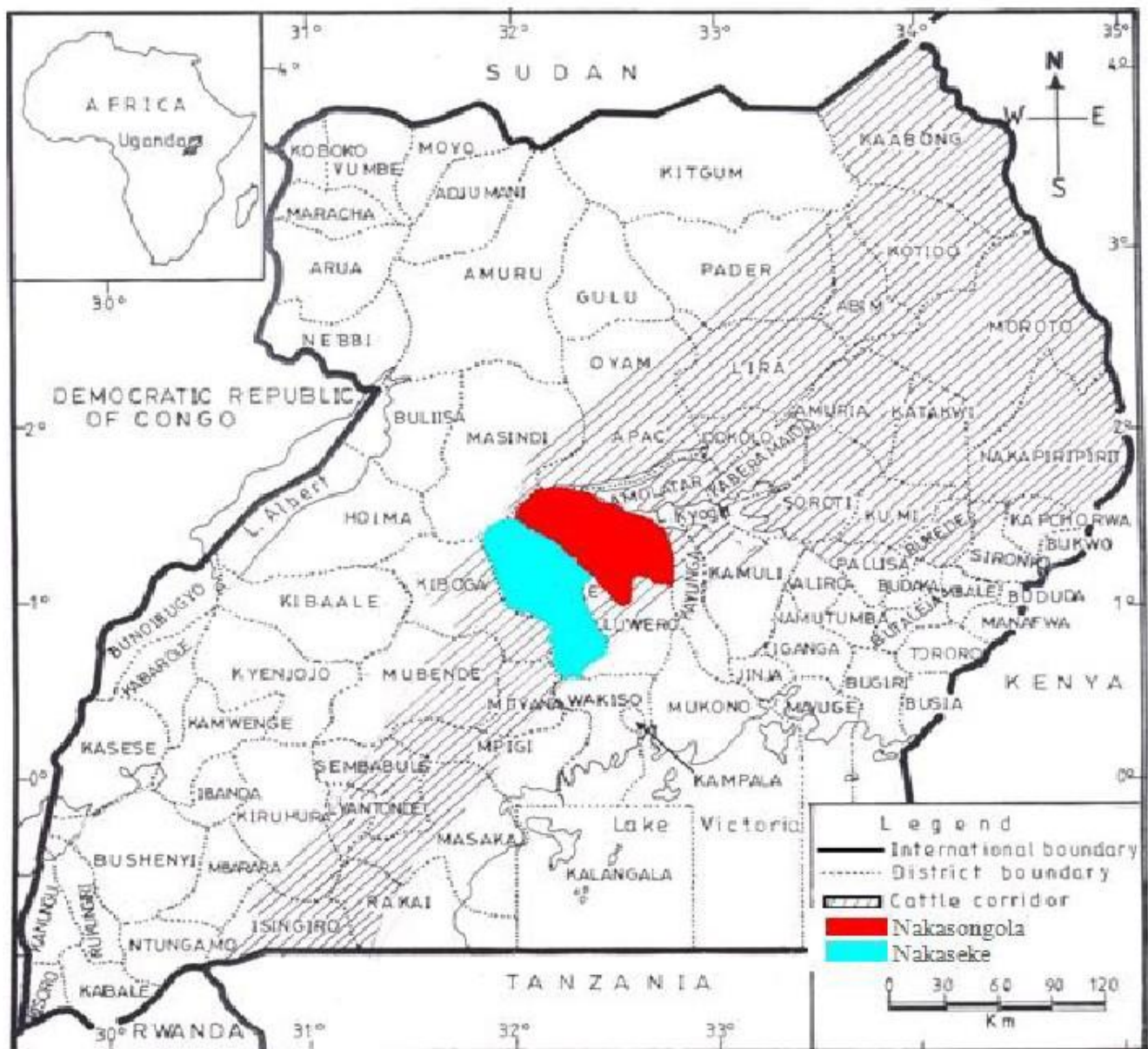


Figure 1. The Uganda cattle corridor and the districts of Nakasongola and Nakaseke.

regions across the globe. Dodd and Jolliffe (1994, 2001) in West Africa considered the onset to be the first period of 5 consecutive days in which at least 25 mm of rain falls, on condition that no dry period (seven days or more) occurs in the following 30 days. Nicholls (1984), in Australia defined onset as the date on which 15% of the mean annual rainfall, at a given station, has occurred. In Tanzania, Mhita and Nassib (1987) defined the onset as the first week receiving at least 15 mm, after a given date determined by local climatology and agricultural practices, provided that no two week dry spells occur in the next four weeks. Marengo et al. (2001), defined the start of a rainy season using five days averages (pentads) of daily rainfall where they computed the onset as a pentad in which rainfall exceeded a given threshold, provided that the average rainfall was well below the threshold for several pentads preceding onset and well above for several pentads after onset. Prior to the report of Marengo et al. (2001), Alusa and Mishi

(1973) had defined onset of a rainy season as a point when the pentad rainfall is consistently above the (1/73) of the total annual mean rainfall for a particular station. In this study, onsets and cessation dates were determined according to Alusa and Mishi (1973) and Marengo et al. (2001).

RESULTS

Community perception of climate change and variability

Community perception on changes in climate parameters

Most of the respondents (98%) interviewed perceived cli-

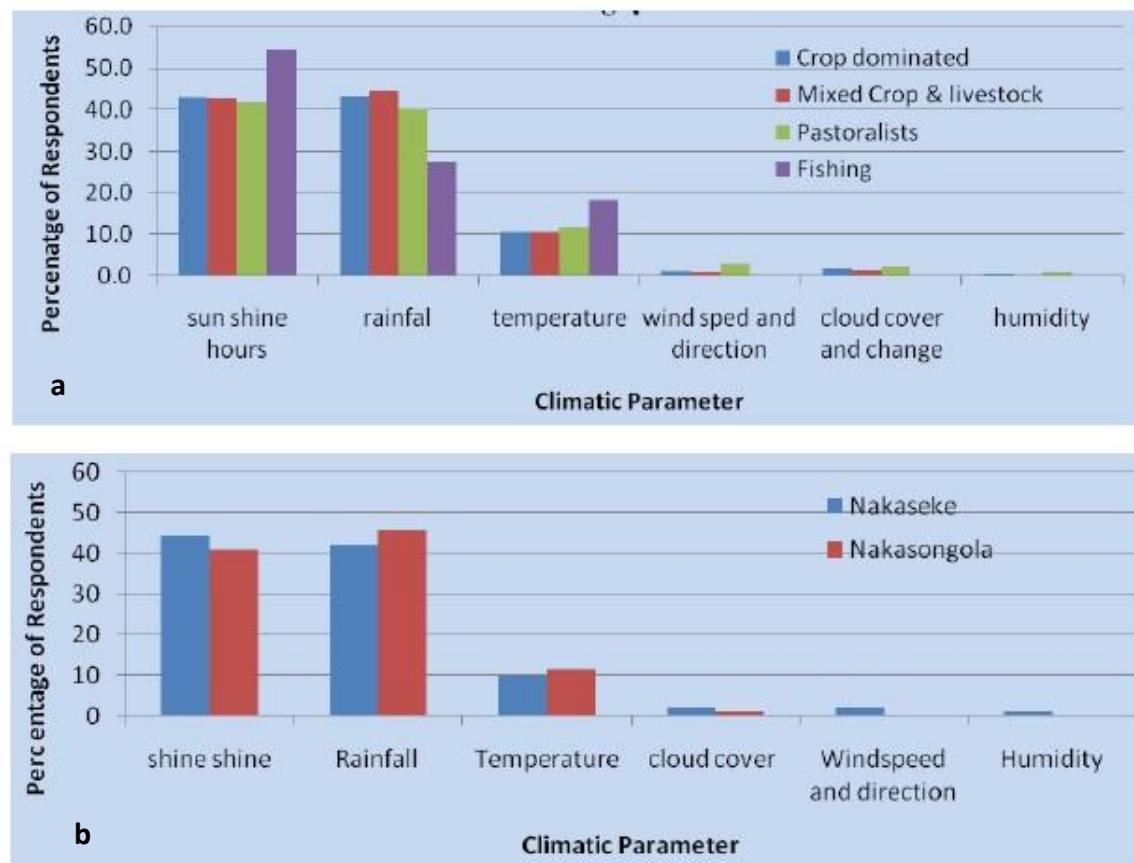


Figure 2. a. Perceived most changed parameter by communities in the different farming systems. **b.** Perceived most changed parameter by communities in Nakasongola and Nakaseke districts.

mate to have changed within the last 5-10 years as compared to 2% who either did not know or were not sure whether climate had changed (data not shown). About half of them believed sun shine hours and rainfall were the most changed climatic parameters while another 10% of them believed temperature had also changed. Very few respondents believed in changes in cloud cover, wind speed and direction and humidity (Figure 2a and b). Further, they believed (data not shown) that these changes are noticeable in increased sunshine intensity and duration; and in reduced rainfall amounts and distribution. This pattern was the same across the two districts and among the four farming systems studied (Figure 2a and b).

Community perception of causes of climate change and variability

The perceptions of communities on the causes of climate change and variability is shown in Figure 3a and b. A majority of respondents in both Nakasongola and Nakaseke districts believe that tree cutting is responsible for the changes and variability in climate (Figure 3a).

Very few of them however, believe that the perceived climate change and variability is caused by continuous cultivation, bush burning and overgrazing. Other reasons indicated by the communities were encroachment on wetlands, industrial fumes and pollution and brick making but these were suggested by very few members of the community. These perceptions were similar among communities in all four farming systems (Figure 3a).

Community perception of changes in seasonal weather

Nearly all the respondents reported changes in seasonal weather patterns during the last 5-10 years. Most of the respondents in all the four farming systems and in the two districts said the dry seasons have been the most affected as compared to the wet season (Figure 4a and b).

They reported that the length and intensity of the dry season has increased markedly as compared to what it was over ten years ago. The crop, mixed and pastoral communities said that in the past, the first dry season would fall from mid/end of December - February or early

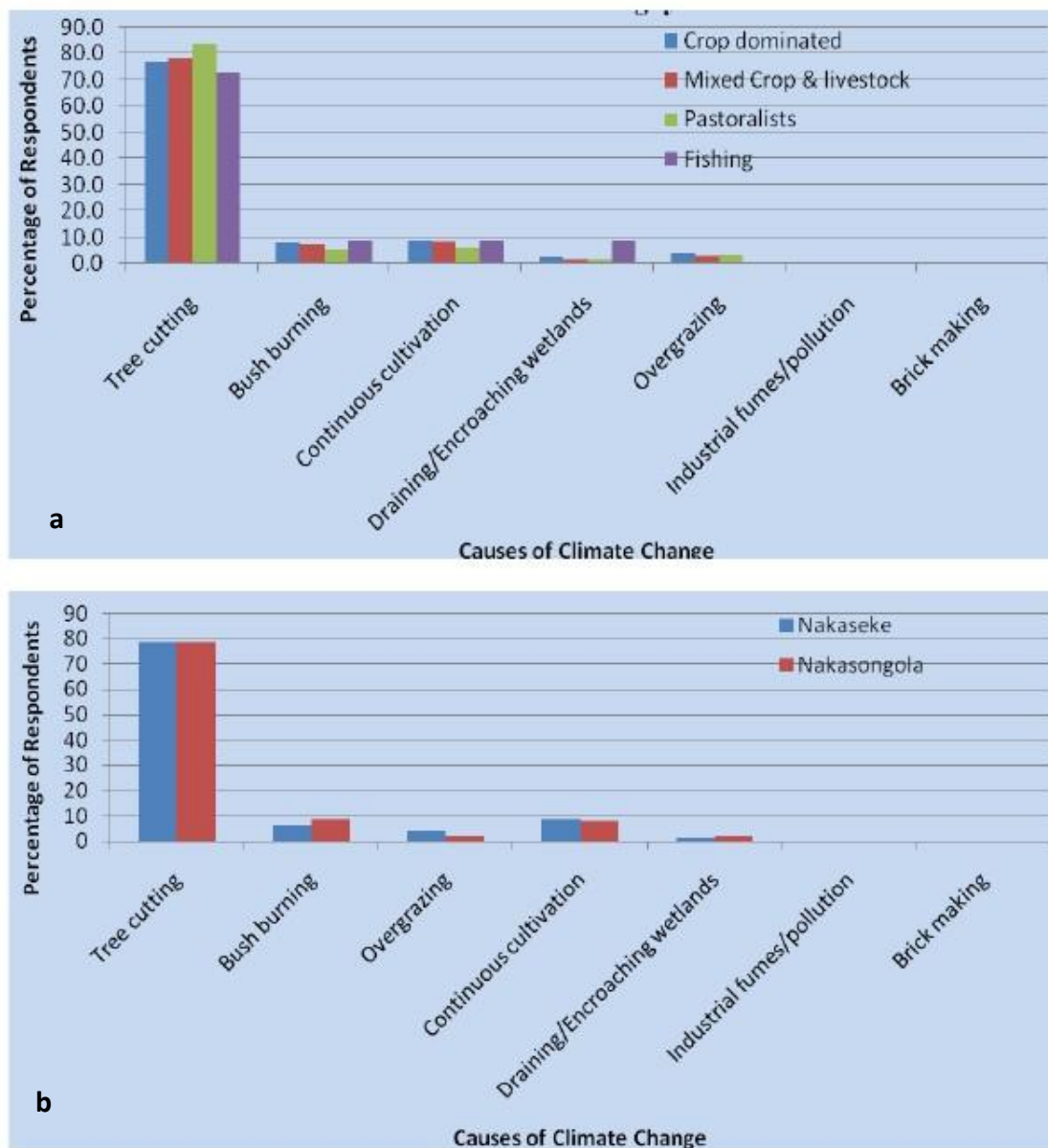


Figure 3. a. Perceived causes of climate change and variability by communities in the four farming systems. **b.** Perceived causes of climate change and variability by communities in Nakasongola and Nakaseke districts.

March at most, with the second dry season coming around June-July. In the recent years, the farmers have been experiencing longer dry months, with the second dry season rather unpredictable and stretching from mid-November to March and sometimes early April, and the first dry season beginning at the end of June to August and that this has affected most of their operations. They lucidly recalled the years or periods when they were hit by long or severe droughts, floods, and even lightning and added that they have experienced more long droughts in the past two years and that lightning is a recent phenomenon.

Communities in all the four farming systems pointed out that they now receive less rainfall, which is also not well distributed in the villages within their parishes and is extremely unpredictable. Most of them admitted that they now receive the first rains between Mid-March to May/early June and the second rains from August/mid-September to October/early November, yet in the past 5-10 years the rains would come as early as February and go up to early June and the second season from August till the end of November.

With regard to floods, the fishing communities said they had floods in 1997. They said that when Lake Kyoga

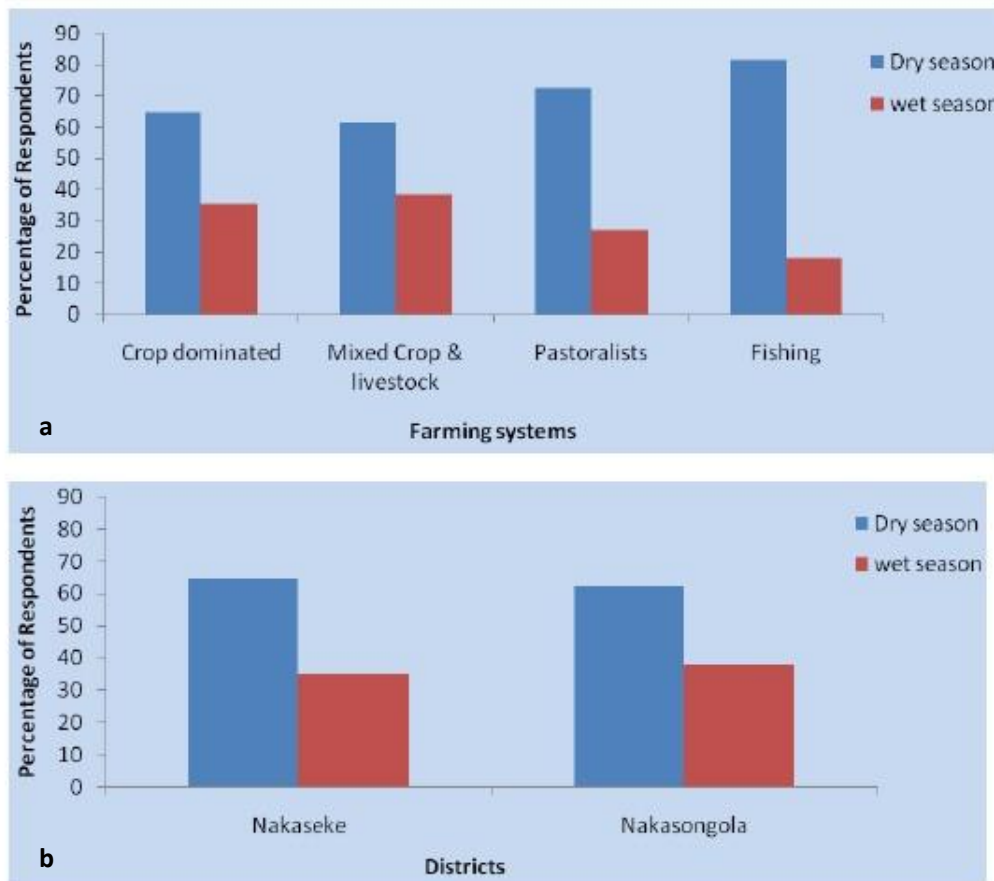


Figure 4. a. Perceived changed season reported by communities in the four farming system. **b.** Perceived changed season reported by communities in Nakasongola and Nakaseke districts.

flooded, it carried floating vegetation such as suds onto their lands and also blocked parts of the Nile and experts were called in from Egypt to unblock them.

Indigenous knowledge for prediction of wet and dry season

Indicators used by communities for prediction of onset of both wet and dry season are shown in Figure 5a and b. Increased cloud cover is the main indicator used by the communities for predicting the onset of rainy season. Other important indicators are appearance of full moon, emergence of new leaves of trees after dry season defoliation, and decrease in frequency and speed of whirling winds. Minor indicators are emergence of certain insects such as white ants (Termitoidae), from the ground, appearance of certain birds such as *Ebinyambala* and sudden increase in day or night temperature (Figure 5a). The indicators were the same among communities in the two districts (data not shown) and the four farming systems. However more fisher folks use increased cloud cover and emergence of new tree leaves for prediction of onset of wet season than their

counterparts, the crops, crop and livestock farmers and the pastoralists (Figure 5a).

Regarding the dry season, many members of the communities use cloudless night conditions, increase in wind speed at night and early sun rise as the most common methods used to predict the coming of a dry season (Figure 5b). Other indicators are: increase in frequency and speed of whirl winds, misty conditions in the morning, increased frequency of wind storms and appearance of certain birds such as *Nyanja*. These indicators were used by communities in the two districts and in all the farming systems except the fisher folks many of whom depend on cloudless conditions and early sun rise as predictors of onset of dry seasons (Figure 5b).

Empirical evidence on climate variability and change

Rainfall

Variations in annual, seasonal, monthly and daily rain fall were considered during analysis where onset and cessation dates together with seasonal length for a period rang-

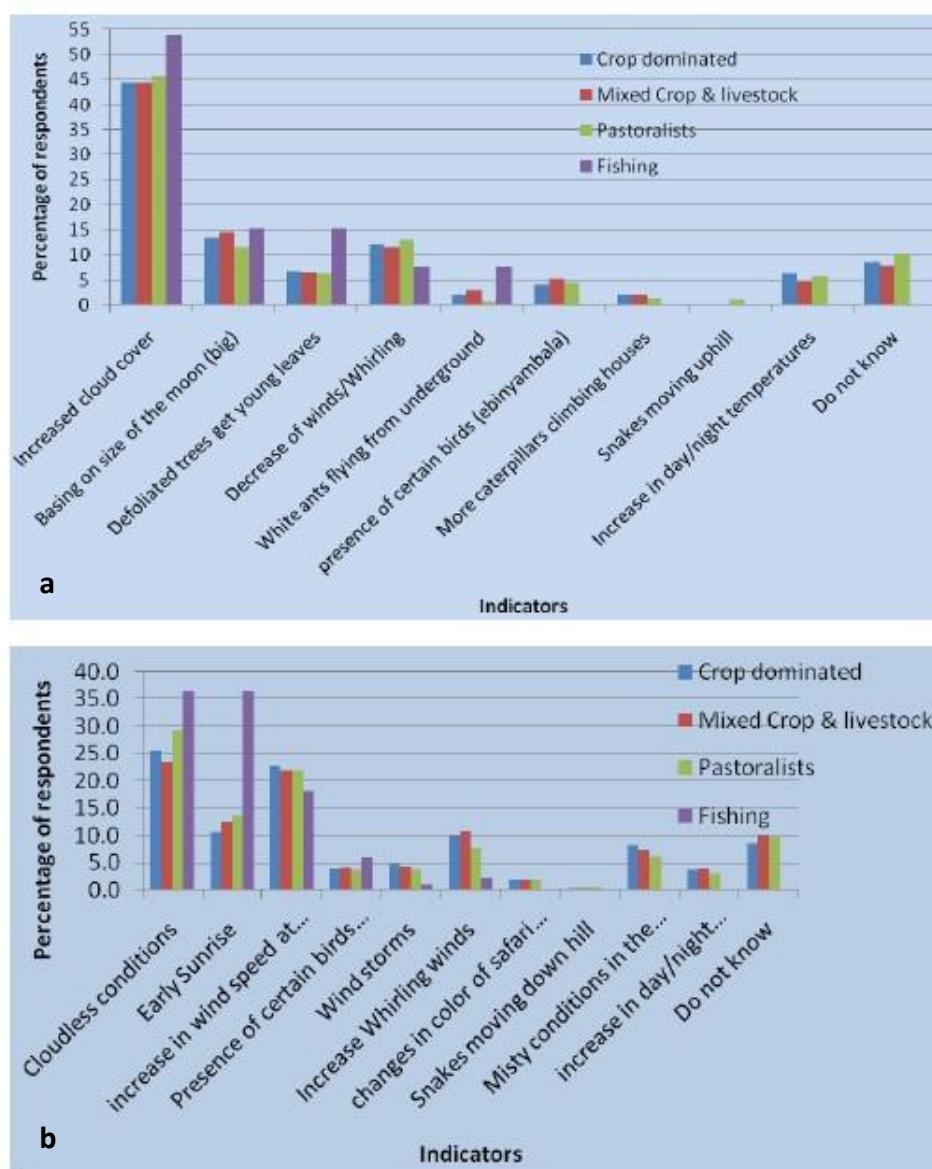


Figure 5. a. Indigenous knowledge of predicting the onset of a wet season reported by communities in the four farming systems. **b.** Indigenous Knowledge of predicting the onset of a dry season reported by communities in the four farming systems.

ing from 1961 to 2010 were deduced.

Annual and seasonal rainfall variations: Annual rainfall over the study area showed a fairly decreasing trend but the trend is not significant in the period 1961-2010 (Figure 6a). Similar non-significant trends are observed for the March to May (MAM) rainfall season (Figure 6b) and the September to December (SOND) season (Figure 6c). MAM seasonal rainfall has been variable and therefore less predictable as compared to SOND seasonal rainfall as observed in the coefficient of variation values calculated per decade from 1961/1970 to 2001/2010 (Table 1).

Monthly rainfall

Decadal monthly averages were calculated per decade from 1961/1970 to 2001/2010 (Figure 7). Monthly values show the merging of the two rainy seasons and the prolonged dry spell of December to February. The end of the first rainfall season and the start of the second rainy season is not clear. This is because the study area lies in a transition zone of the country between areas with a clear bimodal rainfall in south and areas with a unimodal rainfall in the North.

Rainfall seasonal length and onset of rains: There is a negative relationship between length of the growing sea-

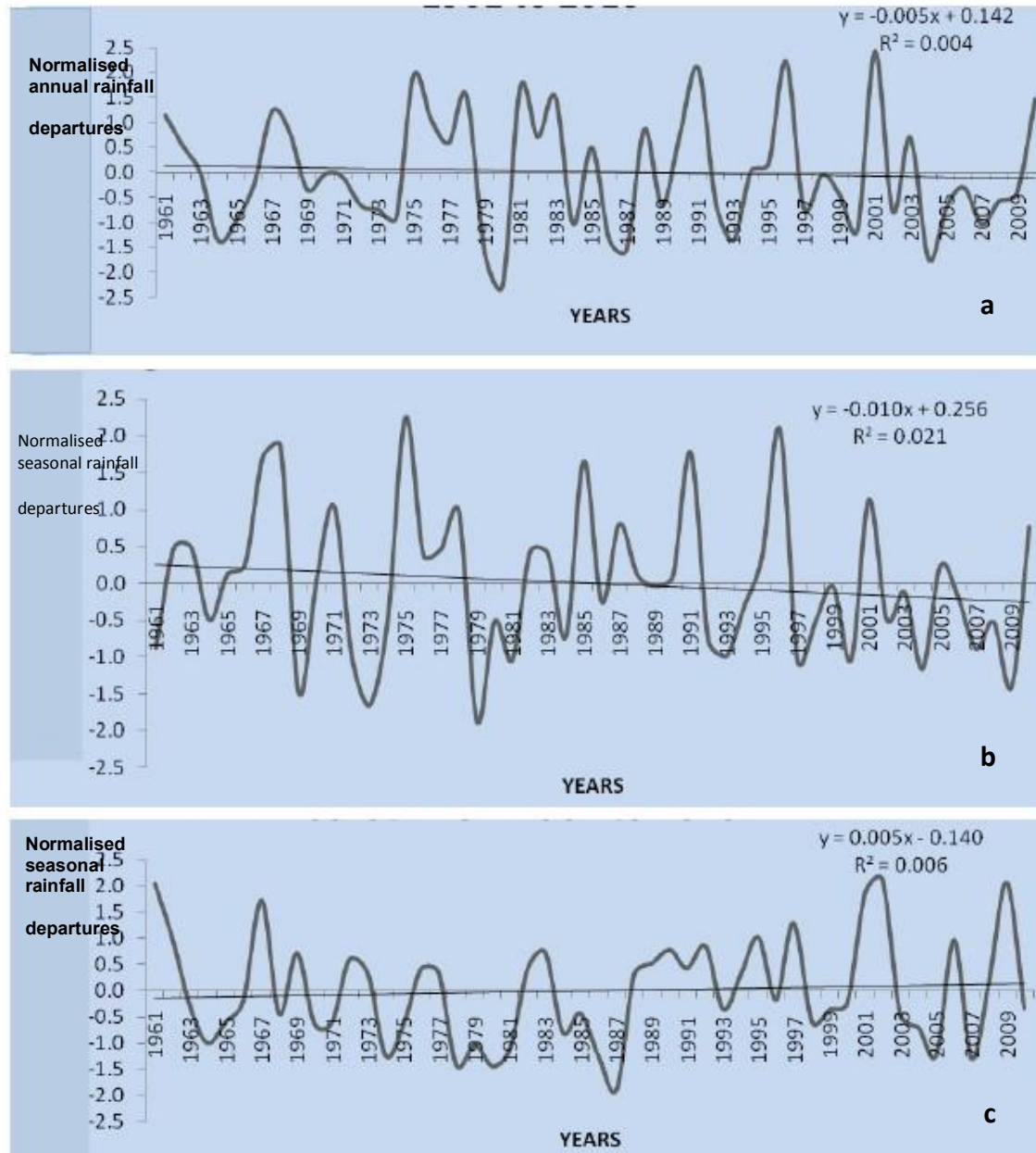
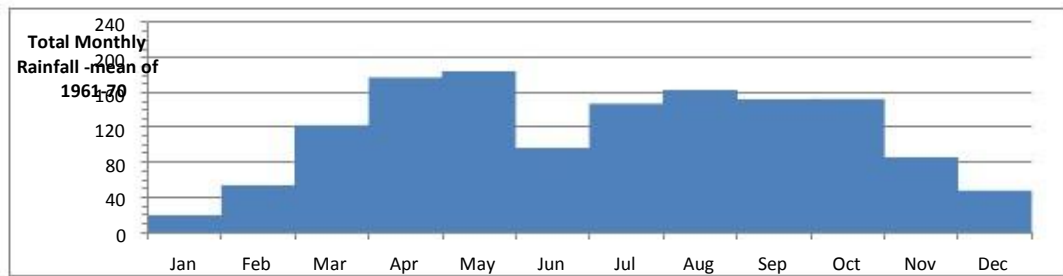


Figure 6. a. Annual rainfall departures for Soroti from 1961 to 2010. b. MAM seasonal rainfall anomalies for Soroti from 1961 to 2010. c. SOND seasonal rainfall departures for Soroti from 1961 to 2010.

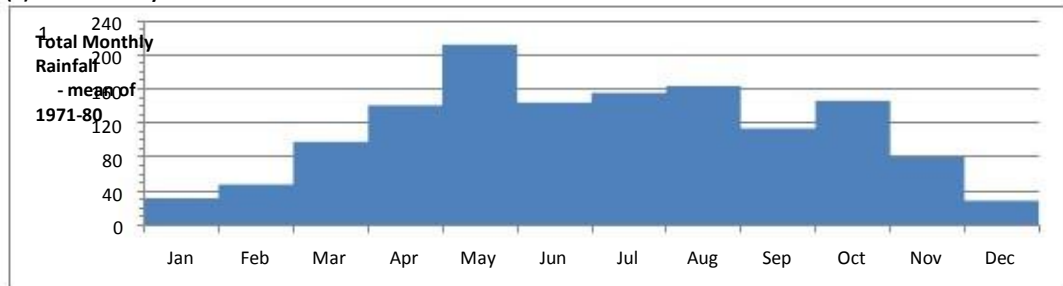
Table 1. Summary of seasonal rainfall per decade from 1961 to 2010.

Period	Mean total MAM seasonal rainfall (mm)	Mean total SON seasonal rainfall (mm)	MAM standard deviation	SON standard deviation	MAM coefficient of variation	SON coefficient of variation
1961-1970	483.2	389.8	137.3	94.4	28.4	24.2
1971-1980	449.8	339.7	172	72	38.2	21.2
1981-1990	474.8	335.4	100.7	87.5	21.2	26.1
1991-2000	448.9	398.7	151.1	45.1	33.7	11.3
2001-2010	420.6	397.6	107.2	88.8	25.5	22.3

(a) Total Monthly Rainfall Mean: 1961-1970



(b) Total Monthly Rainfall Mean: 1971-1980



(c) Total Monthly Rainfall Mean: 1981-1990



(d) Total Monthly Rainfall Mean: 1991-2000



(e) Total Monthly Rainfall Mean: 2001-2010

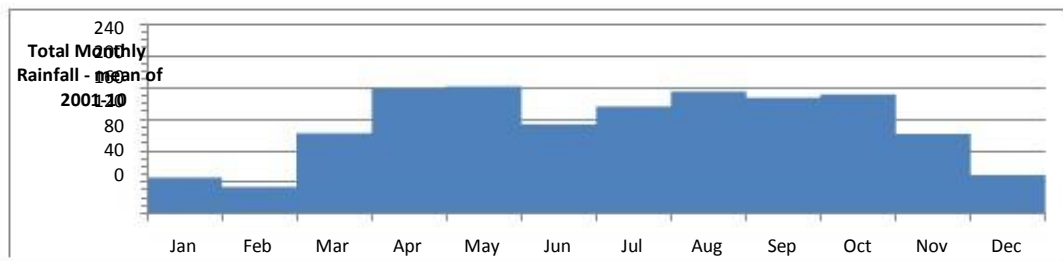


Figure 7. Total monthly distribution of rainfall in the cattle corridor from 1961/1970 -2000/2010: (a) Total monthly rainfall mean: 1961-1970; (b) total monthly rainfall mean: 1971-1980; (c) total monthly rainfall mean: 1981-1990; (d) total monthly rainfall mean: 1991-2000 and (e) total monthly rainfall mean: 2001-2010.

son and the start of the rains. The relationship is stronger in the second season than the first season (Figure 8a and 8b). This means early rainfall onset especially in the second season prolongs the length of the growing season and therefore farmers should take advantage of planting most crops when an early onset is predicted for the second season.

Dry spells in a rainfall season: The number of dry spells within a season has been increasing for the period 1961-2010. The increase is more pronounced in the first season than the second season (Figure 9a and 9b). This means crop failures are on the rise and hence food insecurity as reported by the community in the household surveys and focus group discussion.

Dry season length: Observations show that the first dry season (June to early August) is shortening while the second dry season (December to February) is intensifying (Figure 10). This also is in agreement with people's perceptions who reported that the dry season has been changing as compared to the wet season.

Temperature trends

There is a significant temperature increase in the study area especially in the minimum temperatures and the mean annual temperatures over a period of 17 years, from 1993 to 2010. The mean annual maximum temperatures show a non significant decreasing trend (Figure 11b), while the mean annual minimum temperatures show a significant increasing trend from 1993 to 2010 (Figure 11a) and the mean annual temperature show a fairly increasing trend (Figure 11c).

DISCUSSION

The community in general perceives climate to have changed in the last 5-10 years in the study area with sunshine and rainfall perceived to be the most changed climatic parameters in the area. They believed that the sunshine had increased in intensity as well as in duration as compared to last 5-10 years and that rainfall had decreased in amounts and distribution. The responses are similar to what was reported in other areas where such studies have been conducted (Thomas et al., 2007; Mertz et al., 2009; Gbetibouo, 2009; Rao et al., 2011) in Kenya and also reported that farmers perceived rainfall to have decreased in addition to increases in temperature. The community's response of sunshine to have changed was mainly seen as increased heat and prolonged periods of continuous sunshine (prolonged dry season). Empirical data from 1961 to 2010 shows that the total annual rainfall as well as seasonal rainfall for the two

major seasons has slightly decreased although the trends are insignificant. However, from 1997 to 2010 there is a sharp decrease in the amount of rainfall received especially in the first rainfall season of March to May which is a major season in the study area. Further analysis of seasonal rainfall shows that the number of dry spells within a rainfall season have increased especially in the first season which agrees with the community perception of an even rainfall distribution. The dry spells result in water stress which leads to crop failure and hence poor output. Empirical data also shows that early rainfall onsets result in longer rainfall seasons as compared to late onsets. This is important for agricultural planning basing on the seasonal predictions of rainfall onsets. This result compares well with Mugalavai et al. (2008) who also reported that predicted rainfall onsets determined the length of the growing season and hence the crops to grow in a particular season in western Kenya. The communities perceived the dry season to have changed most as compared to the rainy season where they had increased in intensity and duration. They reported mainly water shortages for themselves and their animals as well as shortage of food during these intensive dry seasons. However, empirical data shows that the two dry seasons have almost remained the same with the second dry season of December to February becoming more variable as compared to the June to August one.

The communities in the study area perceive tree cutting as a major cause of climate variability and change. They reported that charcoal burning and clearing of bushes for farm land are the major causes of tree cutting which has led to the observed climatic changes in the area. Very few community members (less than 1%) however thought that industrial fumes and pollution which are major contributors of atmospheric green house gases are the causes of climate variability and change. The small number of people is attributed to the low levels of education of most of the respondents.

Observations from secondary data show that on average annual rainfall has not changed significantly but there are variations in seasonal rainfall, rainfall distribution and increasing dry spells within a rainy season. The first rainfall season of March to May is more variable as compared to the second season of September to November in the period 1961 to 2010. Minimum temperatures have been increasing at a much faster rate as compared to maximum temperatures which show a relatively decreasing trend in the period of 1993 to 2010. On average, the mean annual temperatures have been increasing in the study area since 1993 leading to increased evapotranspiration and hence water stress for their animals and crops.

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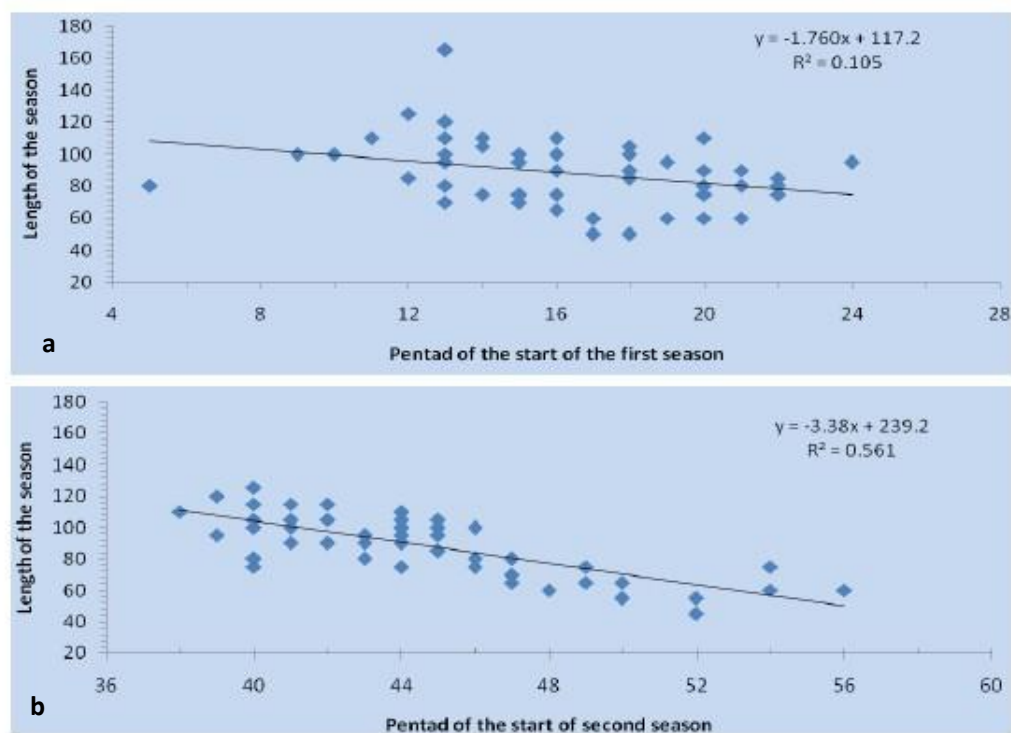


Figure 8. a. Length of the first season and start of the rains. **b.** Length of the second season and start of the rains.

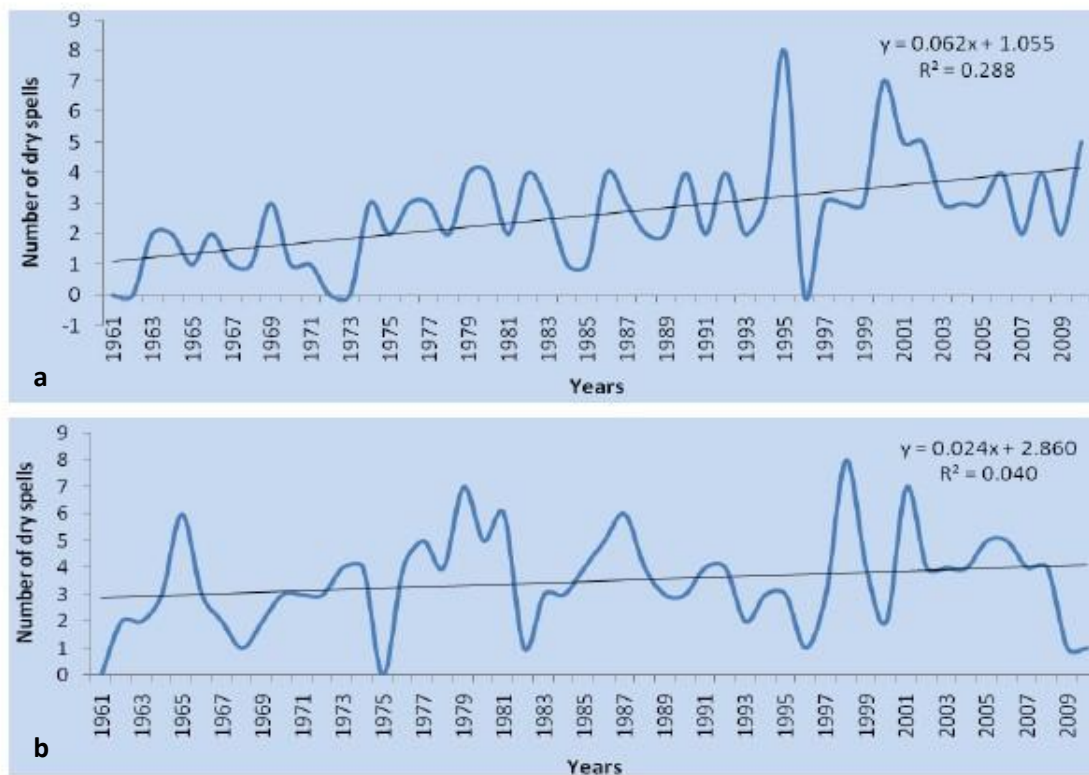


Figure 9. a. Number of dry spells in the first rainfall season. **b.** Number of dry spells in the second rainfall season.

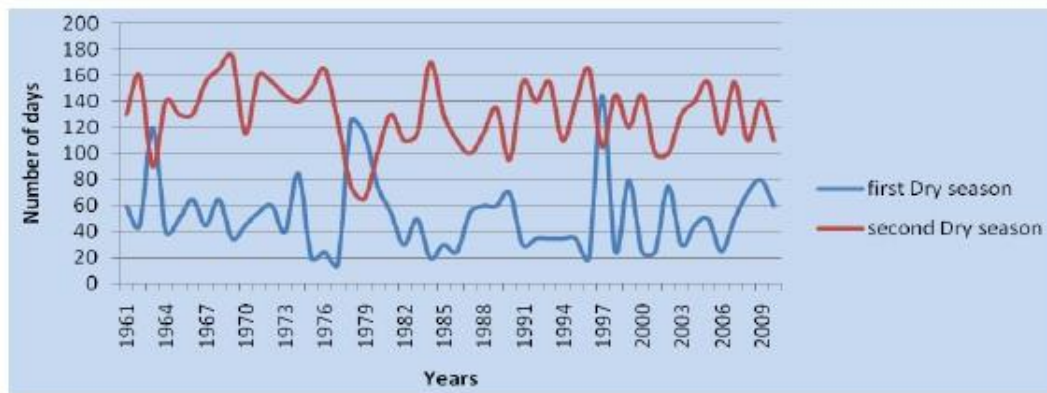


Figure 10. Variation in the length of the first and second dry seasons.

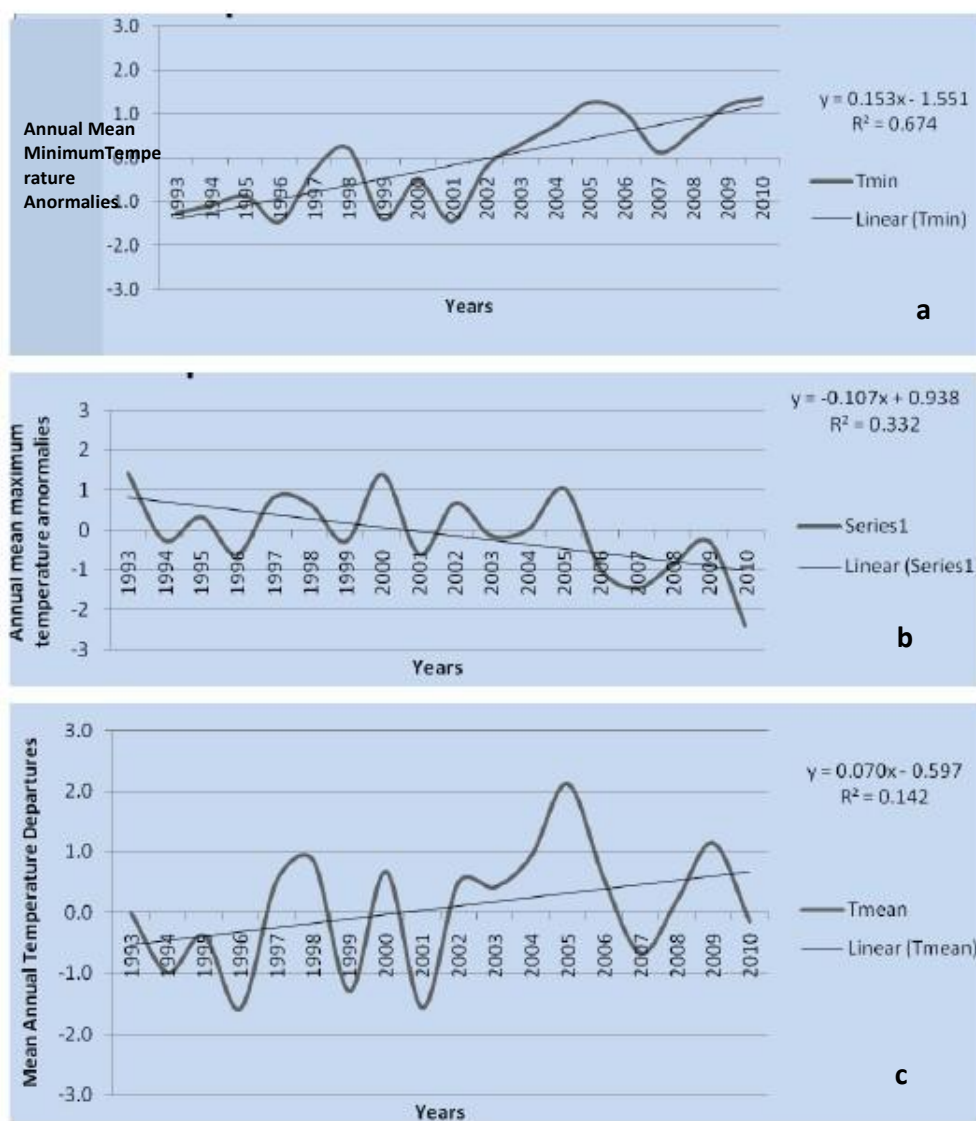


Figure 11. a. Variation of annual mean minimum temperature anomalies from 1993 to 2010. b. Variation in annual mean maximum temperatures anomalies from 1993 to 2010. c. Variation of annual mean temperature departures from 1993 to 2010.

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