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Trend in climate variation in Karamoja Sub-region, northern eastern Uganda

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Abstract

This study focused at determining the spatial and temporal rainfall and temperature characteristics in Karamoja with a view of establishing the intensity of climate variability. The study utilized historical data (1947-1976) and NOAA reanalysis data (1979-2009).Results show that there is a general long term increase in rainfall totals as well as an adjustment in drought return period when the 1947-1976 and the 1979-2009 periods are compared. Climate variability is high (coefficient of variation >35%) with the existence of spatial oddities. Northern and central Karamoja have relatively more rainy days than southern Karamoja. Variability in the rainfall onset in Karamoja is greater than withdrawal; whereas rainfall onset may delay, a temporary rainfall break is observed around the 31st pentad and the cessation marking the beginning of the long dry season occurs around the 62nd pentad. A time's series analysis of temperature shows a general rise in minimum (0.9°C), maximum (1.6°C), and mean (1.3°C)temperature from 1979-2009. MAM, JJA, SON and DJF minimum, maximum and mean temperature equally showed a progressive rise in varying degree. This study debunks the notion that Karamoja is a homogenous semi-arid region. Therefore, it is vital for planners and decision makers to take into account heterogeneity when executing climate adaptation programmes.

Key words: Climate variability, forage, intensity, livestock, seasonality

Résumé

Cette étude a porté sur la détermination des caractéristiques spatiales et temporelles des précipitations et de la température dans Karamoja, en vue d'établir l'intensité de la variabilité du climat. L'étude a utilisé des données historiques (1947-1976) et les données d'analyse de NOAA de (1979-2009). Les résultats montrent qu'il ya une augmentation générale à long terme dans le total des précipitations ainsi que d'un ajustement en période de retour de la sécheresse lorsque l'on compare les périodes de 1947-1976 et de 1979-2009. La variabilité du climat est élevée (coefficient de variation> 35%) avec l'existence de singularités spatiales. Le nord et le centre de Karamoja ont relativement plus de jours de pluie que le sud du Karamoja. La variabilité dans l'apparition de la pluie dans la région de Karamoja est supérieur que vers la fin; tandis que l'apparition des précipitations peut avoir du retarder, la fin des précipitations est fixée autour de la pentade 31 pour la période de MAM. Une série de temps d'analyse de la température montre une hausse générale en minimum (0,9 ° C), en maximale (1,6 ° C), et la moyenne (1,3 ° C) de la température de 1979 à 2009. MAM, JJA, SON et DJF minimale, maximale et la température moyenne aussi a montré une augmentation progressive à des degrés divers. Cette étude réfute l'idée que Karamoja est une région homogène semi-aride. Par conséquent, il est essentiel pour les planificateurs et les décideurs de prendre en compte l'hétérogénéité lors de l'exécution des programmes d'adaptation au changement climatique.

Mots clés: variabilité du climat, du fourrage, de l'intensité, de l'élevage, de la saisonnalité

Introduction

Considerable climate variability and change have been recorded in Africa over the last century (Trenberth *et al*., 2007). In the Sahel for example, rainfall declined by 20-30% (Dai *et al*., 2004) while temperatures rose by 1.3°C (Trenberth *et al*., 2007). Meanwhile significant increase in rainfall variability and seasonality, intensification of aridity conditions during the start and end of the wet seasons have been reported in eastern Sudan (Sulieman and Elagib, 2012). These have had wide ranging impacts including: decline in vegetation cover (Gonzalez *et al.*, 2012), changes in land use and degradation of grazing areas (Sulieman and Elagib, 2012). Climate projections show that there will be marked variability in the African climate system. Within the East African region, climatic variability is a fact (Thornton *et al*., 2010) and nowhere in the region is this most felt than in the vast dryland areas that span 83% of Kenya (Nyariki *et al*., 2009), 40% of Uganda (NEMA, 2007) and 50-80% of Tanzania (Mbwambo, 2004). In Uganda, in particular, variability in climate is most pronounced in the "cattle corridor". In the cattle corridor, Karamoja sub-region is considered as variability hot spot. Despite this assertion, limited effort has been geared towards providing evidence of climate variability intensity in the region as well as linking this variation to key livestock production resources that is water and forage.

Figure 1. Location of Karamoja Sub-region.

Materials and methods

This study was conducted in Karamoja sub-region, Uganda (Fig. 1). Karamoja is a semi-arid area with a variable climate regime. It is inhabited by the Karamoja people-a pastoral and agro-pastoral community. This study utilized two rainfall data sets. Historical data for Namalu station in southern Karamoja covering 1947-1976 periods was used. Correlation and regression method of the near next neighbor station was used to fill missing data, a fit $y = 0.8947x$ and $R^2 = 0.8348$ (Fig. 2) was obtained. The Global daily climate data (1979-2009) provided by the National Centers for Environmental Prediction (NCEP) which is part of the broader NOAA reanalysis programmes was also utilized. This was obtained due to the limitations existing with on station data including; wide ranging gaps and missing data, unavailability of daily rainfall and temperature data. Data analysis was conducted in Excel spread sheet, Instat and Combined drought Index Calculator software.

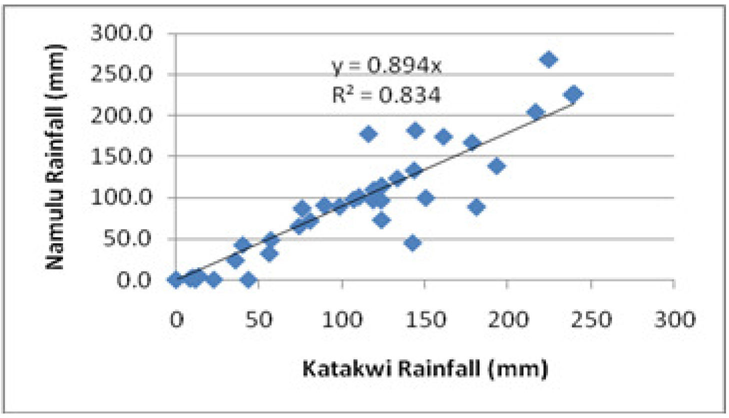

Figure 2. Namalu-Katakwi rainfall regression coefficient.

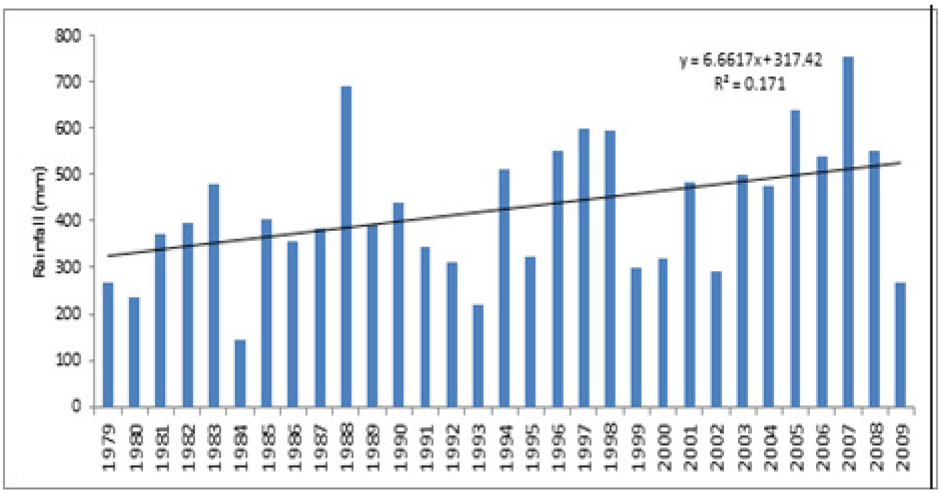

Figure 3. Long term rainfall total for Karamoja.

Results

Rainfall trend and variability in Karamoja. A positive trend in rainfall over the Karamoja sub-region has is observable despite the existence of below normal rainfall (Figs. 3 and 4). The trend in rainfall depressions (lows) is non-uniform but generally the return period of lows ranges from 4-7 years for the period 1979-2009 compared to 1-3 years for 1947-1976 period (Fig. 5). Generally, between 1947-1953 and 1971-1976 the region experienced poor rainfall. This trend continued until 1984, where a major depression was experienced. Thereafter, rainfall in the sub-region picked up progressively with intermittent lows and highs. The intensity of rainfall variability is depicted by the very high coefficient of variation at 35.01 percent. Variability in the sub-region is heterogeneous with some locations such as Pian Upe (CV > 58%), Namalu (CV>50%), Lolachat, Okere, Abim, Kokeris, Kotido-Panyangara (CV> 40%) experiencing higher variability than locations such as Komuria, Nga-Moru and Dopeth (CV< 30%).

MAM, JJA, SON and DJF rainfall season trends in Karamoja. In the last 31 year period of analysis, rainfall in Karamoja sub-region increased by 0.7 mm. This overall increase followed an increase in the MAM, SON and DJF rainfall by 66.7 mm, 31.7 mm and 45.7 mm respectively. Conversely, JJA rainfall decreased by 148.4 mm over 1979-2009 periods.

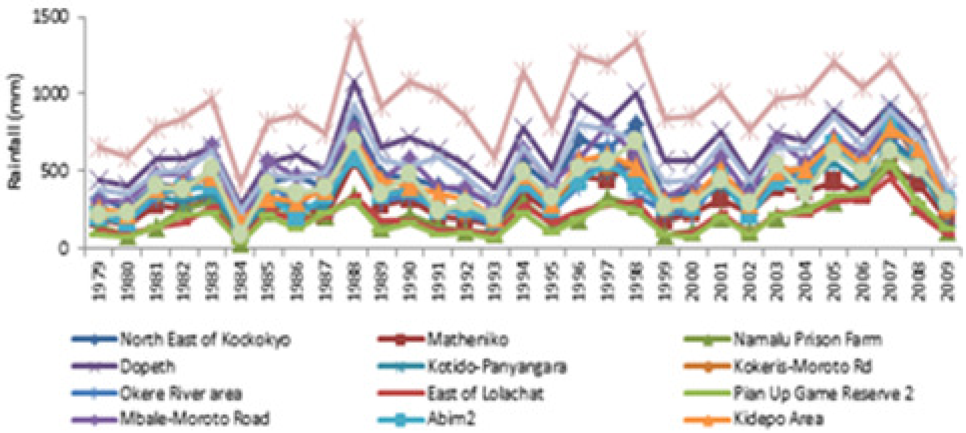

Figure 4. Long term rainfall total by station.

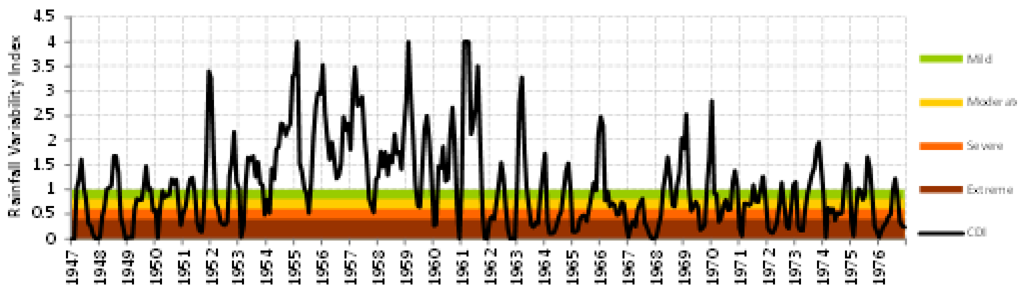

Figure 5. Rainfall variability index for Namalu station, Karamoja.

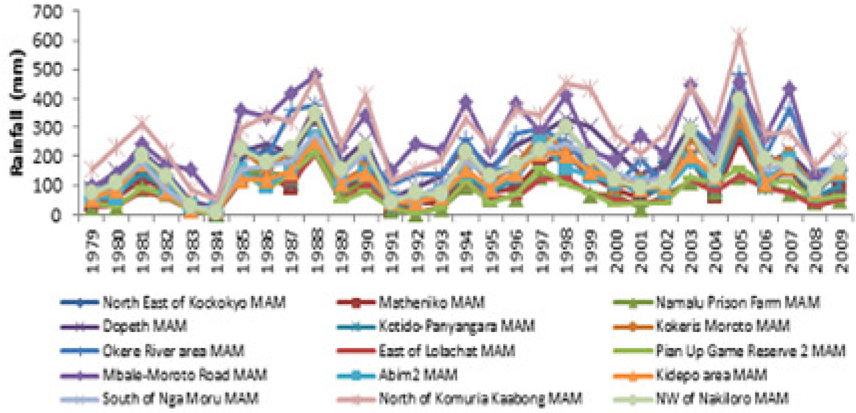

Figure 6. MAM rainfall trend.

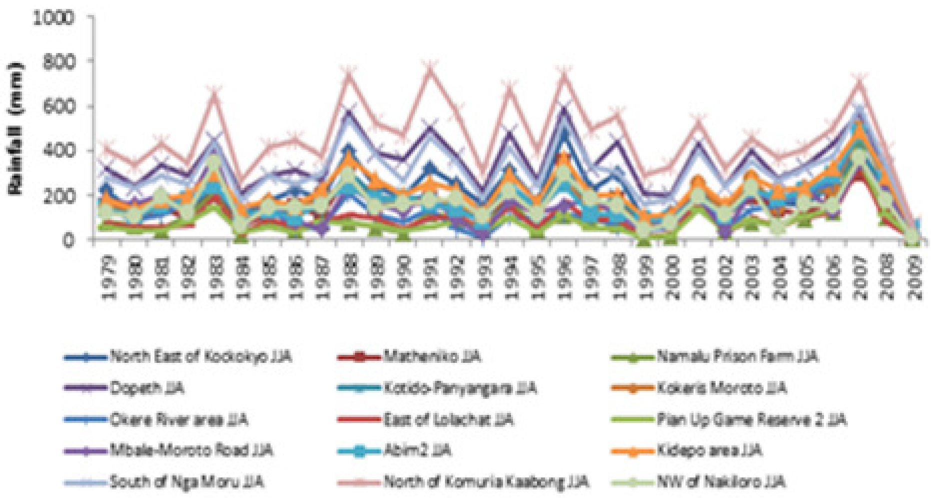

Figure 7. JJA rainfall trend.

Despite experiencing a negative long term trend, the JJA rainfalls have remained generally higher across the region. This is against the traditional belief that the MAM rainfalls are the most important rains. The variability in this period is far greater than that of MAM, SON and DJF periods (Figs. 6, 7, 8, and 9).

Onset and cessation of rainfall in Karamoja. Rainfall onset in Karamoja occurs around the 20th pentad with the first peak level quickly approaching around the 25th pentad with a temporary withdrawal around the 31st pentad (Fig. 10). The first withdrawal is short-lived that a second peak is observed around the 36th and 38th pentad. The cessation marking the beginning of the long dry season in the region occurs around the 62nd pentad (Figure 10). Therefore, the first rains are very short, lasting approximately 20 days to the peak and 25 days to withdrawal. The rise is rapid and so is the withdrawal. Observably, rainfall onset may delay but cessation is timely. Comparatively, the second rains rise rapidly, takes nearly a normality curvature and decline gradually making this period's rains more prolonged.

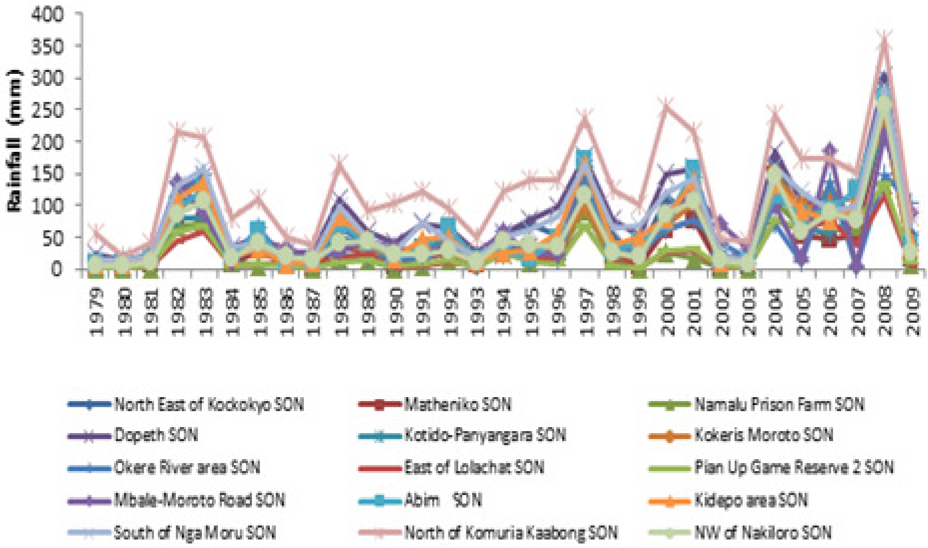

Figure 8. SON rainfall trend.

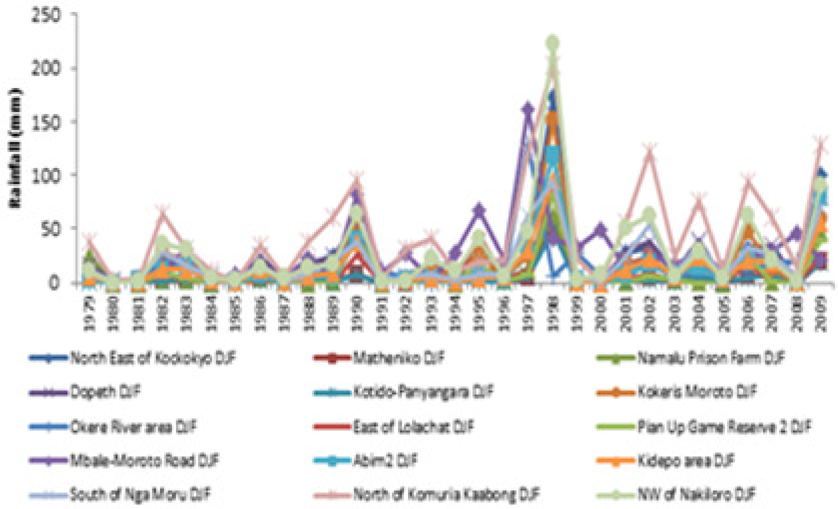

Figure 9. DJF rainfall trend.

Temperature trends in Karamoja. Evidence available confirms that there is a general rise in all temperature categories. During 1979-2009 period, minimum temperature has increased by 0.9°C (R^2 0.67), maximum temperature by 1.6°C (R^2 0.35) and mean temperature by 1.3°C (R^2 0.56). Temperature in Karamoja (1979-2009) has undergone three phase rise and decline scenario although rising. A general crest emerging from the 1970s breaks down around 1985 to create the first trough, this is subsequently followed by a rise that peaks around 1991-1993 but drops to a 1997 trough. This was then followed by a sharper rise whose peak occurs around 2000-2002. This momentous rise breaks down in 2007 period. From 2008 a further progressive rise in temperatures (minimum, maximum and mean) across all stations in the sub-region was experienced.

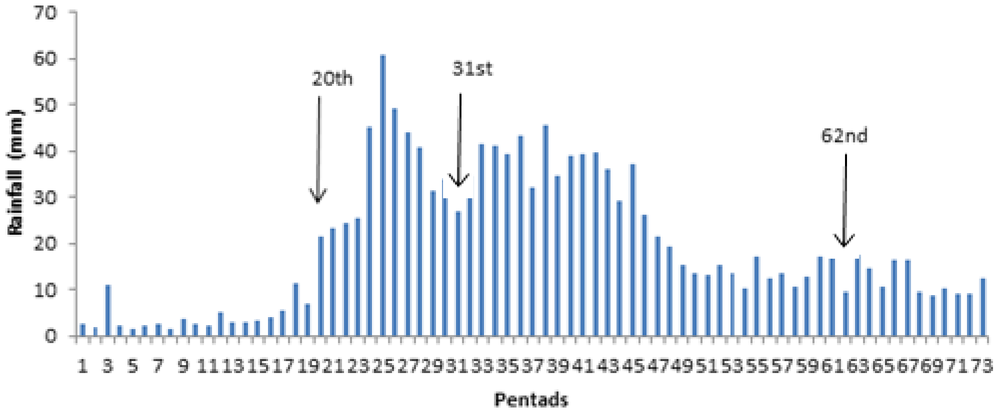

Figure 10. Pentads for Karamoja sub-region (>10 mm is a wet pentad and marks onset and <10mm marks cessation. 1 = 5 day total).

Discussion

This study has shown that rainfall in Karamoja is progressively rising and so are the temperatures. We have also shown that Karamoja sub-region experiences periods of drought with cycles of above average rainfall that often lead to sporadic floods. This trend is consistent with patterns observed by Sarr (2012) in semi-arid region of West Africa. However, the rise in rainfall in Karamoja should be approached with a cautious notch. This is because even within similar sub-locations in southern, central and northern Karamoja, some areas have indicated a rise in rainfall total while others have indicated a decline in rainfall. The rise in temperatures experienced in Karamoja is consistent to that reported by Trenberth *et al.* (2007) in the Sahel. Rainfall onset and cessation reflect rather a positive trend for forage availability. This is because a progressive growth in biomass can be supported by the available rainfall. However, it may also cause a challenge by favoring the growth and expansion bush lands thereby affecting the availability of herbage for cattle but supporting shrubs and Acacias that can be consumed by small stock and camels.

Acknowledgement

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