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Thesis Title

ASSESSMENT OF FORAGE DYNAMICS UNDER VARIABLE CLIMATE IN KARAMOJA SUB-REGION OF UGANDA

Thesis Abstract

Livestock herding is an important undertaking in rangeland areas of East Africa. These regions are characterized by climate variability that affects the availability of key livestock production resources especially forage and water. This study sought to assess the dynamics of forage under variable climate conditions of Karamoja sub-region. The study adopted a mixed methods approach utilising both primary and secondary data obtained through herbaceous biomass survey, cross-sectional survey, key informant interviews, focus group discussions, remote sensing and archived climate data. Data was analysed using descriptive statistics, correlations, standard soil processing procedures, analysis of variance (ANOVA), Ordinary least squares (OLS) and Log-linear regression, and statistical downscaling using the delta method.

The results showed that there is a spatio-temporal variability of forage production leading to the existence of heterogeneity that supports transhumant livestock herding in the sub-region. The sub-region has a high diversity of herbaceous forage species (65) whose abundance is dominated by a few species (9), these include: *Hyparrhenia rufa*, *Sporobolus stafianus*, *Chloris pychnothrix*, *Setaria sphaceolata*, *Pennisetum unisetum*, *Aristida adscensiones*, *Hyparrhenia diplandra* and *Panicum maximum* that vary across

space and time. The pastoralists and agro-pastoralists possessed detailed knowledge of forage species type, location, growth periods and forms, perceived quality and preferences by livestock species. However, land use and land cover change orchestrated by a tenfold increase in croplands and a 10% increase in woody vegetation cover over the last decade (2000-2013) is threatening forage resources particularly in the grasslands.

Land use and cover type, and seasonality ($P \leq 0.05$) were identified to significantly influence forage dynamics in the sub-region. Further, the perceived determinants of forage dynamics included: length of residence by livestock keepers at a location, frequency of grazing, number of kraals in a location, presence of governing rules, and presence of conflicts, knowledge of pasture locations, restricted movement and ease of access to grazing areas ($P \leq 0.05$). The results also showed that soil nutrients such as: N, P, K, and SOM significantly influenced forage dynamics ($P \leq 0.05$). In addition, development interventions in form of piospheres had a significant influence on forage dynamics by influencing species composition and abundance leading to the observance of increaser and decreaser forage species around the piosphere zones.

The results of climate analysis showed that the sub-region's climate is highly variable (Coefficient of variation $> 35.0\%$) with spatio-temporal oddities in rainfall and temperature. Over the historical time step (1979-2009), there was a progressive rise in minimum, maximum and mean temperature by 0.9°C , 1.6°C and 1.3°C respectively. In the same period, there were more dry months (< 1.0 threshold) from 1979 to 1994 than between 1995 to 2009, with wetness intensity (> 2.5 threshold) increasingly common after the year 2000. It is projected that rainfall will increase in total however the increase will be non-significant and inter and intra-annual variability will remain pronounced. A significant increase in minimum temperature will be expected such that by mid-century (2040-2069) it will have increased by 1.8°C (RCP 4.5) and 2.1°C (RCP 8.5) and by 2.2°C (RCP 4.5) and 4.0°C (RCP8.5) during end-century (2070-2099). The projected patterns in rainfall and temperature are expected to lead to a relatively high but variable forage production under both RCP 4.5 and RCP 8.5. Continued increase in temperature to RCP 8.5 level will be expected to induce a significant decline in forage production; thus indicating that higher temperatures in the future compared to the present level will become a limiting factor to vegetation production in the sub-region. Given the above findings, it is vital to; undertake community based land use planning so as to better manage land use transformations occurring in the sub-region. It is also essential that any efforts geared towards rangeland resources and biodiversity management in the sub-region should tap into the detailed cultural knowledge of the pastoral communities in Karamoja. In addition there is need to continuously monitor socio-ecological conditions perceived to influence forage dynamics as they have

potential of creating 'artificial forage shortages'. In-light of observed and projected climate variability and change; there is need to use location specific and sub-regional climate information for timely adjustment to extreme climate events and early warning in the sub-region.

Key words: *Grazing, pastoralists, pro-active planning, remote sensing, variability*