Monitoring of pastoral landuse systems in East African rangelands using GPS data and a hidden Markov model

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Abstract

Pastoral mobility is an important adaptive strategy for managing seasonal variability and resource availability in arid and semi-arid regions. However, accurate and consistent data on pastoral mobility remains limited, posing a challenge for understanding and supporting sustainable land use in these environments. In this study, we use GPS-based behavioural models to analyse and document pastoral mobility in northern Kenya. For one full year, GPS data was continuously collected from pastoralists herding livestock in the rangelands of northern Kenya. The herders were equipped with GPS trackers that recorded their position, speed, time, date, and direction at 5-minute intervals. This dataset represents the first continuous collection of GPS points intended specifically to develop algorithms and analyse basic movement patterns of herders in this region.

The movement patterns were classified and predicted using a Hidden Markov Model (HMM), which enabled the identification of distinct behavioural states and transitions between them. These transitions were analysed in response to changes in the Normalised Difference Vegetation Index (NDVI), a key indicator of forage availability. By integrating the GPS data with satellite-derived vegetation maps, we were able to map the spatial and temporal distribution of herding activity across different landscapes, seasons, and times of day. The approach effectively captured critical dimensions of herd mobility, offering new insights into patterns of seasonal pasture use and decision-making in mobile livestock systems. The increasing prevalence of smartphones, even in remote rural areas, provides a valuable opportunity to continue data collection using mobile applications. These findings highlight the potential of GPS-based modelling to support sustainable rangeland management and the broader digitalisation of pastoralism in East Africa.

Keywords: GPS tracking, Kenya, pastoral land use, rangeland management

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