

PRACTICE PAPER

Weather Forecasts for Pastoralism in a Changing Climate: Navigating the Data Space in North Eastern Uganda

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Efforts to support the building of resilient pastoralism have been stepped up in Uganda through a number of activities. One of the activity is the provision of seasonal and medium-range climate forecasts to enable decisions concerning livestock herding. Seasonal weather forecasts are critical but there are challenges of timeliness and usability of the forecasts. The challenges are associated with the multiplicity of information sources, methods for data integration and dissemination channels. Institutions including public and Civil Society Organizations usually invest in collecting weather and other data which should be accessible. Often times this data remains hoarded necessitating other organizations to collect similar data. The inter-institutional relations notwithstanding, the lack of data sharing leads to minimal data available for open access. This paper illustrates that this challenge can be addressed by using combined multiple methods to elicit data on weather and other biophysical conditions for pastoralism in Karamoja. In this paper we additionally analyse the opportunities and challenges of using multiple sources of pastoral-relevant data to couple with weather information in support of herding decisions. Building resilient pastoralism that utilizes pasture and water availability will have to utilize available data. It is evident that more robust approaches for data sharing at global, regional and local levels are needed to understand how pastoralists can respond to climate shocks and changes. The paper illustrates the use of a multifaceted-methods approach including open data to develop climate forecast information for risk-reduction oriented information for decision-making. Integration of this data provides insights on how pastoralists have long adapted to a variable and changing climate, the methods and processes of adaptation to losses and damages from the climate shocks.

Keywords: pastoralism; climate shocks; weather forecasts; resilience; traditional systems

1 Introduction

It is argued that pastoralism is one of the human activities in African Savannas that has for long demonstrated resilience to a variable climate (Dietz, 1987; Lind et al., 2016). The arid and semi-arid savannah regions in Africa have historically experienced a variable climate where pastoralism has coped with droughts, excessive floods and famine (Egeru, 2014; Kandagor, 2005). National meteorological services have always provided daily forecasts but more recently on seasonal basis to enable livelihood decisions that are dependent on weather conditions including pastoralism (Luseno et al., 2003; Ngugi et al., 2011). Seasonal forecasts are recent, partly because slow-onset hydro-meteorological hazards evolve over time. Thus information on possibilities for the performance and intensity of rains to be received is useful in enabling micro-level planning such as grazing (Ngugi et al., 2011). Seasonal forecasts are an improvement in weather services because they provide warning alerts about possible hazards or possibly a good season that would enable timely planning for optimum productivity. Data collection and its sharing on weather and pastoral activities by resilience building agencies becomes important. One of the challenges of shared data and information regarding

seasonal weather forecasts by Uganda National Meteorological Authority is the format, level of detail and usability of the information disseminated (Luseno et al., 2003). In Uganda these seasonal forecasts are in form of a policy Ministerial press release that is qualitatively summarized. The briefings usually provide policy advice and recommendations on what users of the information can do (Patt and Gwata, 2002; Vogel and O'Brien, 2006). The challenge with this kind of information is that it does not specifically give details at a more defined spatial scale to enable micro-level adjustments and planning. Thus users including pastoralists take the information but the usability of such information is minimal. Reliance is based on other sources of weather information, which have been amplified by the Non-for-profit organizations providing support for adaptation and resilience building in the region (Vogel and O'Brien, 2006). This amplified information onto which decision makers in the region rely is often times unreliable. Comprehensive data access regarding weather forecasts is thus a big challenge even for the NGO's that often have plans to integrate it with applied data on economic activity to advise users at regional level. Karamoja region in Uganda is characterized by these problems of data access, format and usability and there isn't any foreseeable transition to sharing data which is in various formats that can support programming in institutions but also pastoralists for grazing planning and access to water. The legal mandates of public organizations managing data simply plays to the disadvantage of data accessibility and support for adaptation and resilience building. For the pastoralists, traditional methods of data capture and sharing remain important for their decisions but are also constrained by dissemination procedures and rules that gives mandate to the National Meteorological Authority (Vogel and O'Brien, 2006). In this paper we illustrate these challenges and examine how traditional methods of data capture and access can be integrated with national service forecasts to enable decision making up to the farmer or pastoralist level. The objective of the paper is twofold; *a*) to analyze the challenges of data collection, access and dissemination in pastoralist communities; *b*) to examine how multiple sources of data with an extended list transcending seasonal weather forecasts provides improved information for decision making at small geographical scales.

2 Framing data sharing principles and rules

Data on different aspects for multiple users is valuable and when analyzed to generate knowledge can also have a social power dimension. In the current globalization of knowledge and emergence of a knowledge economy, the value in data compels owners and generators to keep to it for cost and economic value recovery (Tallon, 2013). Data is usually owned by organizations, individuals and companies that generate it at primary level. These agencies of data generation collect it through observation devices or conduct extensive field studies following predetermined questions and observation variables. The primary investment in collecting this data whether from the field or use of satellite imagery or secondary data that is collated to suite the purposes of the data generator is a cost that many data generators have to incur. This cost coupled with copyrights give the data generators a natural ownership and claims for cost recovery (Sawyer, 2008). The cost and desire to recover the value sets the principles of data sharing in many countries including Uganda and particularly the region of Karamoja. Adhoc systems exist for sharing of data, which occur when institutions have arrangements for the sharing of data (Cragin et al., 2010). However many institutions involved in collecting and using data for resilience building do not manage for open access, leading to duplication and low data quality that all translate into complexities in data sharing (Takizawa et al., 1978). There are some existing inter-agency coordinating mechanisms especially in regard to weather seasonal forecasts which can be built upon. But the mechanisms are also largely constrained by the mainstream Government agency of Uganda National Meteorological Authority (UNMA), which is mandated to issue daily and seasonal forecasts (Hansen et al., 2011). Thus UNMA controls and owns the weather data in addition to setting principles of how this data is shared and disseminated. The synthesis of weather data comes in form of a seasonal forecast bulletin that is released by the Minister in charge. But data needed for adaptation and resilience building is not only weather related. Data on livestock, disease outbreaks, grazing areas, and water availability is part of the holistic data needs for pastoralism, which in this paper we call the extended list of data needs. There are different players in respect to these other types of data. For example geospatial data in form of satellite imagery needed at temporal and spatial scales that enable planning for grazing at seasonal level is owned and held by research institutions as well as regional agencies such as the Regional Center for Mapping of Resources for Development (RCMRD). This centre serves the Eastern and Southern African Region. While statistical data at national level is held and owned by Uganda Bureau of Statistics (UBOS), in addition to numerous NGO's operating in the region of Karamoja that have for long collected and stored data on pastoralist activities disaggregated to household level, which is yet to be shared (Azzarri and Cross, 2016). Institutional

relations for sharing this data are still weak for the data to be optimally utilized for several interventions including resilience building. It emerges that there is lack of direction in regard to data copyright issues, data sharing although there is voluntary cooperation amongst institutions operating in the Karamoja region. These relations are based on partnership and trust rather than principles that would streamline cost recovery and pricing of data where necessary (Arzberger et al., 2004). The public sector including government, its agencies and ministries has not streamlined access of the data it generates neither the data held by other generators that would be beneficial to all in implementing resilience work in Karamoja. Instead what is common is to regulate the dissemination of weather information by UNMA yet the information like seasonal weather forecasts is not detailed enough to help pastoralists at more small geographical scales to plan for the grazing and resource utilization. Thus the discrete rules of data generation, management, dissemination and access set by the data-owning agencies lead to challenges of meaningful sharing of data that can support several interventions including resilience building. This paper refers to the spatial data infrastructure model that sets the ownership, management, clearing houses and principles as well as standards to illustrate how multiple sources of weather forecasts and other types of data can be integrated for decision making among pastoralists (Groot and McLaughlin, 2000; Kok and Van Loenen, 2005).

3 Understanding data needs for pastoralists

With the grim situation in regard to data ownership, access and dissemination in Karamoja, region, pastoralists have continued to navigate the data access space using various methods in order to make grazing decisions, determining routes for migration and water resource utilization (Egeru, 2012; Nyambura, 2003). The most important data needs for pastoralists is information regarding water and pasture so that they can plan for livestock grazing, where to graze and by which herding groups. Weather information and particularly seasonal forecasts provide the basis for livestock herding because pastoralists would anticipate where pastures and water would be in abundance. The pastoralists have traditional institutions with a hierarchy that includes, herders at the lowest level supervised by Kraal leaders, who in turn are supervised by elders that form an elders' council that determines the routes, grazing patterns and decision to migrate or not. The actors regularly meet to use traditionally predicted weather and decide on how the grazing will be managed. In case of an anticipated drought, elders from different groups of the Pokot, Bokora, Dodoth, Jie, Labwor and Matheniko, which are the tribal groups with slightly differing cultures, language, meet to dialogue about the forecasted drought or rains and how grazing lands can be shared to minimize loss of livestock. In the grazing areas of the Dodoth, a trans-boundary issue with Turkana from Kenya exists and thus these are often incorporated into the discussions (Dietz, 1987). Traditional system for predicting seasonal weather is based on four traditionally known weather seasons, which differ from the two conventional UNMA seasons. The seasons include, the dry season (Akamu) (mid November, December January, February), post-dry season of (Akiceret), (Mid February, March April), pre-wet season of (Akiporo) (months of May, June, July August and September) and the wet rainy season (Atieth) (September, October and mid November). In addition to knowing their grazing fields, pastoralists rely on data from the traditional system for these detailed seasons, which illustrate needs for information that is of higher temporal resolution and spatially detailed as opposed to the UNMA seasonal forecasts. The information regarding forecasts from UNMA does not align with these seasons and is not detailed enough at small spatial scales. But the pastoralists also use the information from government and other institutions operating in the region. Pastoralist data needs include sub-regional weather forecasts as opposed to the summarized regional forecasts that don't tell much on how the rains will be distributed. The pastoralists also require information on water availability beyond the known valley dams that have been constructed in the region for watering animals and wildlife (Chow, 2014). Pastoralists also need to estimate the livestock from different herders in order to plan for the available pasture and water. But there are serious data gaps in regard to all data needs related to the multiple data generators and mechanisms for sharing the data. These data gaps are created by data hoarding on the part of data generators but also the lack of standards, principles and mechanisms for data sharing constraining decision making at herder level. This paper addresses the data gaps by illustrating how multiple sources of data can be leveraged to provide data at a scale where it can be readily synthesized and applied.

4 Materials and method

We utilized a multifaceted approach in this study to understand the weather data challenges as well as other data needs beyond seasonal weather forecasts. In regard to weather forecasts, we collected seasonal forecasts from Uganda National Meteorological Authority (UNMA) and Inter-Governmental Authority on

Development (IGAD), two agencies with national and regional mandate to release forecasts. These forecast releases were analysed in respect to format, detail and usability of the information. The reason for using the two sources of forecast data is because the UNMA provides data within the boundaries of Uganda and summarized for the region whereas the IGAD early warning forecasts provide data for the region extending as far as the Horn of Africa. We collected releases of four seasonal forecasts for the years 2015 and 2016. Since herding in this region is sometimes trans-boundary, it was important to integrate the regional forecast with other data in order to analyse what data is provided and how it can support herder level decisions.

Consultations in all the 7 districts in Karamoja region also covered seasonal forecasts and user satisfaction of the information. The consultations also involved collecting data on herding decisions, through Focus Group Consultations. This method generated the narratives about various aspects of conflicts, historical accounts that could not be adequately represented on the maps. FGD's were formed at each consultation taking into account stakeholder representation and gender. The qualitative data on grazing fields, migration decisions, water and pasture resource mapping was collected through these participatory methods. We also consulted existing electronic databases on livestock statistics and baselines. Data on water and pasture planning, grazing patterns, routes of grazing and institutions that influence the herding decisions were collected through the participatory GIS. In mapping we generally visualized the different actors, identified their sphere of influence and relations between each other contextualized around four themes of a) access to grazing areas as shown in **Figure 1**; b) access to water resources; c) conflict resolution and d) access to livestock services. The consultations targeted representatives from Herders, Kraal Leaders, Water User committees /Community, Uganda People's Defense Forces (UPDF), Local, governments, Non Governmental Organizations, Administrative staff and Office of Prime Minister.

In addition to general mapping, we also applied participatory GIS mapping (PGIS) that integrated participatory Learning and Action (PLA) methods with Geographic Information Technologies (GIT). Participants for

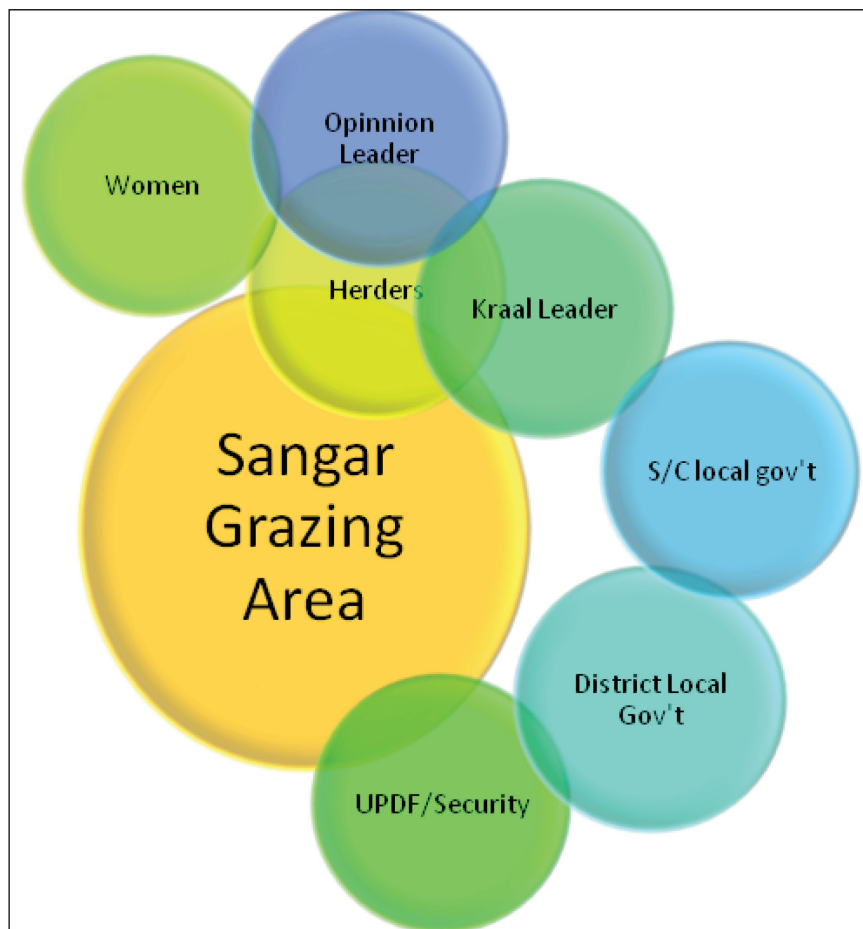


Figure 1: Location of the study sites.

each of the consultation were trained on how to draw maps basing on the thematic areas of access to grazing areas, access to water sources and conflict resolution. The same categories of representatives worked to map these thematic topics on a base map. A two-day training workshop provided the skills and insights to the participants in generating the maps. The sketch maps were georeferenced in a GIS environment and simulated planning at a smaller geographic scale combined with seasonal forecast. In addition a sample of kraal leaders were given GPS's for logging while grazing to get insight into the patterns in the grazing fields. The method involved training and giving herders the GPS loggers to track herders' movements on a daily basis such that data can be downloaded and input into the GIS system for various analyses and visualization. In addition to mapping and GPS data logging, semi-structured consultations of the stakeholders were conducted.

4.1 Studysite

Karamoja region, located in North Eastern Uganda lies between latitudes $10^{\circ} 30'$ and $40^{\circ} N$, and longitudes $30^{\circ} 30'$ and $35^{\circ} 0'E$ and covers an area of over 27,200 Km² as shown in **Figure 2** below. The region is composed of seven districts namely: Kaabong, Abim, Kotido, Moroto, Napak, Nakapiripirit and Amudat. The region is home to a cluster of different pastoralist and agro-pastoralist groups including the Karimojong, Jie, Dodoth, Pokot and Ethur. It's characterized by a harsh climate as the area is arid and semi-arid agro-ecological zones with rainfall ranging between 350–1000 mm per annum, variable in space and time. Precipitation is usually intermittent received between June and October, characterized by the desert winds and the hot dry season from November to March (FAO, 2010). The vegetation of Karamoja consists of open savannah grasslands, woodlands, thickets and shrublands. Karamoja's vegetation can be described as consisting of Acacia–Combretum–Terminalia species associations, with a grass layer of Hyparrhenia, Setaria, Themeda, Chrysopogon and Sporobolus species (Egeru et al 2014). The region essentially consists of a plain sloping west wards. Karamoja's border with Kenya is raised and to the extreme northeast is Mt. Zulia dropping to the eastern rift valley. There are isolated highlands interspersed in the plains including: Mt. Kadam (Debasien) 3200 m; Mt. Napak (Kamalinga) 2,500 m; and Mt. Moroto 3,050m. Several momentary streams and rivers originate in the hills and mountains on the east of Karamoja and flow towards the south and west. (Egeru et al 2012).

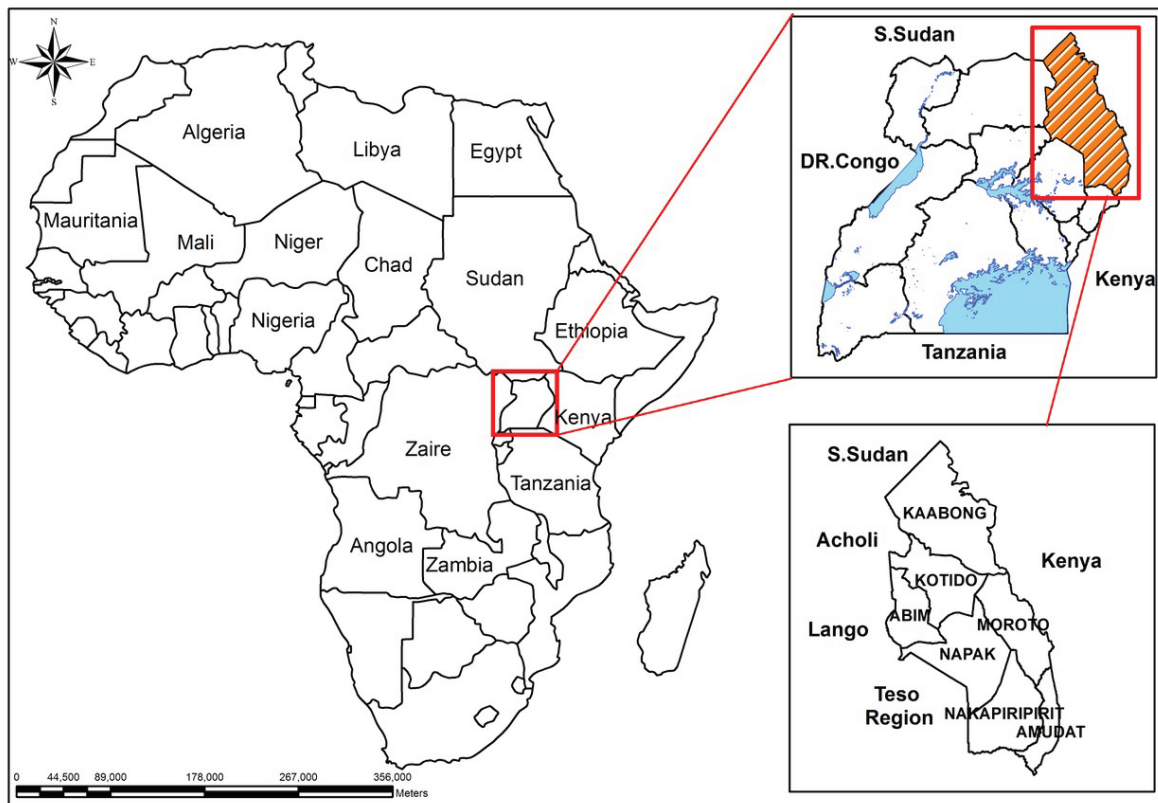


Figure 2: Showing actors in grazing decision around a specific grazing field of Sangar.

5 Results

5.1 Seasonal Forecasts and Grazing decisions

As noted, officially released forecasts for the four seasons in the last two years were analyzed, from IGAD and UNMA. According to UNMA, Karamoja region has one long season of rainfall from April to October followed by the dry period. The average annual rainfall is about 620 mm. But according to the traditional system, there are four seasons as described from the traditional pastoralist calendar. These include, the dry season of (Akamu) (mid November, December January, February) characterized by drying up of water sources, the post-dry season of (Akiceret) (late February, March, April), when first rains start and the animals are herded towards home direction expecting heavy rain, the pre-wet season of (Akiporo) (months of May, June, July, August and September) and the wet rainy season (Atieth) (September, October and mid November). This is the season in which planning to migrate is undertaken to ensure adequate pasture for the animals. The neighbouring regions of Teso, Lango Acholi are the targeted grazing fields during this temporal migration. As mentioned earlier, the signals that trigger decisions to migrate depend on how the rainy season performs. Elders discuss forecasts from traditional system and how the period is likely to perform with pasture productivity. When the performance of rains is considered poor and temperatures are high, the Atieth period is when pastoralists are ready for migration (Stites et al., 2007). Decisions regarding grazing are tied to these four seasons which are locally and traditionally understood (Egeru, 2012). We compared the seasons with the official forecasts from UNMA and IGAD and found that the later are based on the generic climate seasons in the region as influenced by the Inter tropical Convergence Zone (ITCZ). The ITCZ brings rainfall in March April May and later in September, October November. What seems clear with the official forecast is that the summary forecast statements are disseminated through the website and government entities which takes time to get to the pastoralists due to administrative hierarchy. Secondly the forecasts are too generic for decisions regarding grazing. But the organizations operating in the region have stepped this up by often disseminating the accessible information on the IGAD and UNMA websites direct to the pastoralists. For example, as noted above, the season of Atieth, is always expected to be followed by the dry season of Akamu, the decisions to migrate are made as early as Mid-November yet the seasonal forecast by UNMA are provided at the end of November. Likewise the decisions to migrate back to grazing fields within the districts are made in early April when the following months are expected to perform well on rains but also return home to cultivate some crops. Thus it can be observed that seasonal forecasts are sometimes not very appropriate for the region. This is because of two reasons. First is that they tend to be generic and thus inappropriate at local level for herders and elders to make decisions. Second is because these forecasts don't align with the traditional seasons thus information coming either too early or too late for useful decision making as shown in **Table 1**.

5.2 Data access and cultural information systems

Pastoralist decisions occur at the herding level and not necessarily at household level perse. Herding is organized in kraals which are located distances away from the household. There is separation of grazing roles in Karamoja where households are for most times of the year occupied by women, children and elderly while the young able-bodied graze distances from the household locations. Herders in the kraals traversing the region in advance search of water and pasture. Herders can stay away from the households for a number of seasons depending on pasture performance. The council of Elders hold the responsibility to guide grazing decisions and all other issues associated with grazing such as conflict resolution (Barnabas, 2012; Chapman and Kagaha, 2009; Inselman, 2003; Mkutu, 2008). Elders determine the plan for grazing which among other strategies include location for grazing fields for a block period of two weeks and the transects along which animals should be grazed or migrate (Otim, 2002). The Kraal leaders collect data on availability of water and pastures which they pass on to the elders. This traditional system involves traversing large tracts of land in search of the resources that involves cross-border treks. The elders' work in conjunction with the kraal leaders, is to synthesize data and information collected traditionally and integrate it with forecasts from the UNMA and IGAD agencies. Traditional systems involve shrines where traditional forecasts are made and information is disseminated through open community meetings (Egeru, 2012; Ejoku-Oonyu, 2009). The shrine leaders use various artefacts to foretell weather. The leaders then communicate what the diviners tell about the performance of rains, water and pastures providing advice to elders. The elders meet with kraal leaders and give orders on where and when the animals can graze. This information is also shared with other agencies including security organizations to ensure safety of the animals and people. Elders also sanction or gazette certain areas to be grazed in certain periods of the year depending on the rain performance as forecasted to ensure quality and availability of pasture (Egeru et al., 2015, 2014). The forecasted information may or not be collated with the seasonal forecasts from UNMA or IGAD. Inherent

Table 1: A synthesis of the regional and national seasonal forecasts from bulletins by IGAD-ICPAC and UNMA.

Season	Inter-Governmental Authority on Development (IGAD) Forecast	Uganda National Meteorological Authority (UNMA) forecast	Synthesis
November 2014–February 2015	Near normal to warmer Sea Surface Temperatures of Indian Ocean. Rains outlook above normal to below in Karamoja region	Elnino warning as a build up in Indian Ocean and farmers advised to take advantage of above normal rains	Forecast very abstract and on refers to crop farming and other sectors but not pastoralism
March–May 2015	Above near rainfall in the region	Near normal rainfall across the country with influence of local features particularly Lake Victoria	Rainfall intensity, small spatial scale indicative patterns of irregular light rains provided in country forecast. No supportive map
June–August 2015	Increased likelihood of above normal rains and warmer temperatures	Near normal rainfall and tendency to below normal. Karamoja region chances of below normal rainfall	Disjuncture between the forecasts with greater horn forecast predicting above normal while country predicting below normal for Karamoja region
September–November 2015	Seasonal outlook sustained forecasted above normal rainfall	Specially Karamoja region forecast below normal rainfall with intermittent dry spells	Inconsistent forecasts but potentially useful forecast at country level
December 2015–February 2016	Seasonal outlook sustained forecasted near normal rainfall	Country forecast of near normal rainfall and normal temperatures	Consistent forecasts
March–May 2016	Increased likelihood of near normal to above normal rainfall and near normal temperatures	Start of rains with possible peaks in October November	Rainfall intensity, small spatial scale indicative patterns of irregular light rains provided in country forecast. Supportive map but still generic
June–August 2016	Increased likelihood above normal rainfall and near normal temperatures	Country forecast of near normal rainfall and normal temperatures	Forecast very abstract and on refers to crop farming and other sectors but not pastoralism

Sources: http://www.icpac.net/wp-content/uploads/2016Seasonal-bulletinJJAS_2016.pdf; <https://www.unma.go.ug/index.php/alerts/disaster-warnings>.

in these decisions is health status and security of both animals and herders. The herders implement the orders and coordinate with other kraal leaders of the other districts including trans-boundary communities to plan where the animals can graze when and how (Dietz, 1987; Mieth, 2012; Wasonga et al., 2003). Peace meetings with neighbours around water and pasture resources are an integral part of the role of herders, Kraal leaders and elders for conflict resolution (Otim, 2002). It emerges from the forgoing that there is a disjuncture between the traditional system in respect to the seasons as compared to UNMA and IGAD. The traditional system often integrates their divine forecasts with the forecasts provided by UNMA and IGAD if the later are released and disseminated on time. The NGO's operating in the region have established Resilience Adaptation Committees (RAC's) at village level through which this information is disseminated though coverage is yet to improve.

5.3 Managing Livestock and pasture data for grazing densities

As mentioned earlier, conventional forecast data is not enough for grazing decisions. The number of livestock and estimates for pasture and water is critical to the elders. There are also recent changes in land use within the region that have transformed the grazing patterns (Houdet et al., 2014; Rugadya and Kamusiime, 2013). The conservation areas of one National Park and two wildlife reserves have claimed huge chunks of land. Although the boundaries around these conservancies are relatively soft, access is often restricted by Uganda wild Life Authority. The National Park of Kidepo and two game reserves of Bokora and Matheniko act as water reservoirs with large valley water dams as well as wild life corridors. These extend to the nearby

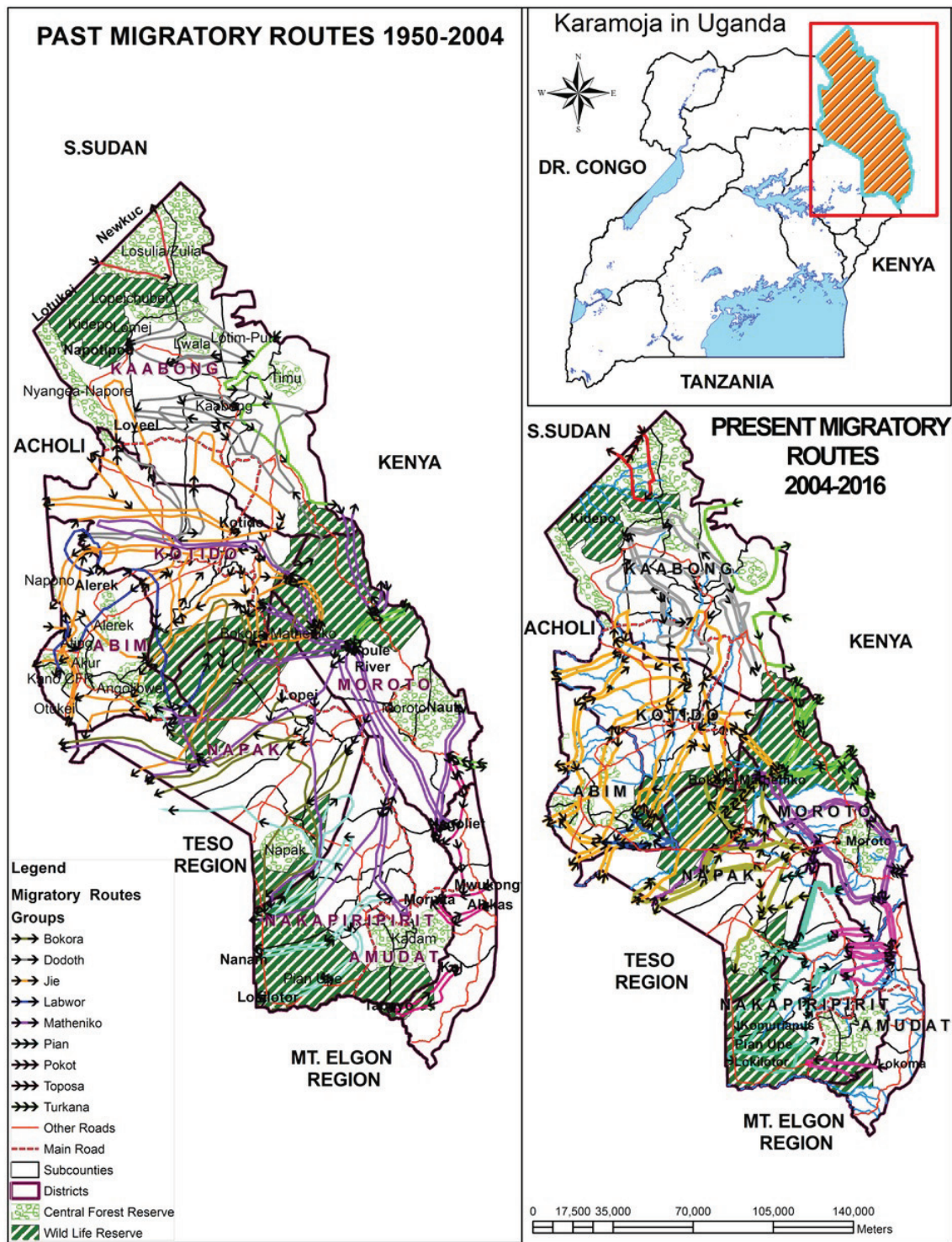


Figure 3: Showing past and present migratory routes in Karamoja.

districts of Teso and Acholi in Uganda while the National Park borders South Sudan. There are controlled 'hard' boundaries around the conservancies for controlled grazing by pastoralists in the corridors while watering is allowed occasionally. This has often sparked conflicts that are sometimes violent due to water resource scarcity during the Akamu season. Conservation area boundaries have coupled with increase in livestock, other land uses most prominent mining and agriculture, leading to reduction in grazing land size. In some of the neighboring districts like Teso and Kitgum the land that was used for grazing is used for agriculture (Ezaga, 2010; Hansen et al., 2011; Mubiru, 2010), sealing off and changing migration routes. The promotion of agriculture in Karamoja first as a strategy for improving food security and second as a measure for adapting to a changing climate has been supported by numerous agencies (Ezaga, 2010; Wang, 2013). But the investment in agriculture has not been supported adequately by data and information on the moisture availability for crop growing (Muleke and Nalule, 2013; Nakalembe, 2013). Agriculture is putting pressure on the carrying capacity for pastoralism. As a result pastoralists have been advised by government agencies to reconsider the number of livestock that can be supported by the resources in the region (Murphy et al., 2017). This change in pastoralism practice extends data needs in terms of satellite imagery and livestock data to determine the pasture availability to analyze carrying capacity. But data are not readily available and where it exists, constraints for access are enormous (Bemigisha, 1991; Harvey and Tulloch, 2006). Carrying capacities for the landscape requires data that supports separation of grazing fields from conservation areas, urban areas, the agricultural or mining land. The use of multiple sources of data is critical in analyzing carrying capacity. In view of the changing climate with the uncertainties of rainfall, it is important that the geographic scale at which data should be available for grazing decisions is sub region. Results of the analysis of carrying capacities indicate that livestock numbers will increase as health is improved but this will lead to more competition for water and pastures. Thus the outcome of this competition is likely to be temporal migration of livestock as has been traditionally. For example in the map for present migratory routes, it is noticeable that the eastern route was diverted to southeast which implies that the Dodoth now migrate towards Pokot areas as shown in **Figure 3**. This should always be preceded by dialogue meetings and agreements through the elders' council. This has been illustrated by increasing migratory routes as shown on the map.

5.4 Pastoralist Data Conflicts

Due to unavailable data sharing mechanisms, there are data conflicts in Karamoja region. There are several organizations public and private which are involved in development activities and particularly pastoralism improvement (Catley, 1997; Oloka-Onyango et al., 1993). More recently, there are programs that are targeting adaptation and building resilience to climate change (Venton, 2014). One of the data conflicts emerging is the issue regarding livestock and agricultural baselines. Each institution is conducting a baseline and most if not all on the same issues at the same level of household. The continuous baselines by different organizations have created fatigue among the households and also created elitist field research assistants with high monetary expectations. In addition, the disparate baselines are hoarded for ownership and cost recovery. A cultural issue regarding data on livestock that prevents pastoralists to divulge actual numbers punctuates the hoarding. Divulging data on number of livestock at household level is considered a taboo and thus differing figures have emerged from public agencies just as private organizations operating in the region. Data conflicts have also emerged in respect with the disaggregated livestock data collected by the UBOS, which has not been disseminated. The summaries of the livestock census only give statistics at district level and not village level where planning for grazing occurs. Interventions around adaptation to climate change and building resilience requires disaggregated data at a small geographic scale to be meaningful for decision making especially in regard to carrying capacities for pasture and water although as known, pastoralists can herd the livestock for longer distances to access resources. Hoarding has created data owners who generate and don't share for integration and reintegration. Using some examples, this paper illustrates an approach that would be useful in dealing with data access to support interventions in a changing climate.

6 Discussion

We argue that climate related interventions need seasonal weather forecasts but this data is just but one category needed for decision making around adaptation and resilience building (Hansen et al., 2011; Luseno et al., 2003; Ngugi et al., 2011; Patt and Gwata, 2002; Vogel and O'Brien, 2006). The extended list of data on livestock, water availability, land for grazing and pastures, pastoralist migratory routes and systems of conflict resolution is equally important (Bainomugisha and Okello, 2017; Barnabas, 2012; Ocan and Ocan, 1994; Otim, 2002). The data list changes with time due to changes in land use, land ownership, security reasons and

political reasons (Anderson, 1993; Dyer et al., 2008; Kandel, 2016; Oloka-Onyango et al., 1993). Response to climate shocks should be appropriately targeted and thus the integration of the data from multiple sources is important because adaptation and resilience building are both long term in nature while comparatively, forecasts seem to be on shorter term basis (Patt and Gwata, 2002; Vogel and O'Brien, 2006). It emerges that herding decisions are made at herder and kraal level and thus targeting the actors at this level is critical as illustrated by the mapping in this paper (Ejoku-Onyuu, 2009). It is also important that traditional systems of forecasting can supplement the modern systems of forecast instead of negating such data that comes from the traditional systems. This is due to the geographic scale at which traditional forecasts are produced. The four seasons which breakdown the two major seasons by UNMA are more detailed and meaningful to the pastoralists because they enable planning for temporal migration but also grazing patterns and access to water and pasture resources (Egeru et al., 2015). The use of information based on four seasons also emphasizes the importance of temporal migration, which is not only a tradition but also as adaptation measure for the pastoralists (Wiese et al., 2003). This issue makes it imperative for unlearning to learn about which data is used for the kind of decisions that influence resilience building. This is because pastoralists have for long adapted, adopted new strategies to a variable climate (Busby et al., 2011; Kandagor, 2005; Stites and Huisman, 2010). Multiple sources of data and information on weather and climate is thus an unavoidable strategy for improving the data access among pastoralist communities (Arzberger et al., 2004; Takizawa et al., 1978; Zimmerman, 2003). Motivation for this integration is related to the fact that traditional information is worth integrating into the forecasts and climate projections if adaptation interventions are to be meaningful. For example, pastoralists in Karamoja use the traditional seasons information to plan on where and how often the livestock would have to be watered. This is similar to processes and decisions by pastoralists in Ethiopia (Hughes, 2013; Kandagor, 2005; Luseno et al., 2003). Livestock access to water is determined according to analyzed availability which may be watering once in a day as water sources tend to be far from the kraals. As they migrate to access other districts the pastoralists also dialogue with other communities often non-pastoralists to reduce conflicts for purposes of ensuring access to water and pastures for the livestock. In periods of onset of rains, it was also reported that they target particular areas due to the quality of pastures that are traditionally known to be "salty" and nutritious. This special pasture is related to the intensification of rains and is available in particular areas and not the entire fields grazed by the different tribal groups. Some of these areas with nutritious pastures overlap with the conservancies thus potentially causing grazing conflicts. Once again these detailed accounts on season to determine the quality of pastures illustrates the importance of improving integrating the data for improved information access by pastoralists. Thus the need for a system for acquisition, integrating and disseminating the information is critical (Egeru, 2016, 2012, Egeru et al., 2015). For future climate shocks and change, the dominant top-down approach in dissemination of seasonal weather forecasts would have to be adapted to the four traditional seasons, pastoralists-led systems of dissemination and targeting the right actors for the weather information. Integrating such weather information with the extended list of data needs, is also critical for enabling adaptation and resilience among the pastoralists (Arzberger et al., 2004; Cragin et al., 2010; Gardner et al., 2003; Groot and McLaughlin, 2000; Harris et al., 2007; Zimmerman, 2003).

7 Conclusion

In conclusion, traditional systems of weather forecast may be for shorter periods compared to the meteorological seasons and therefore may appear unconventional, but the forecasts are a solid basis for determining the grazing patterns, carrying capacity for watering points, migratory routes and reducing conflicts over the key resources needed by pastoralism. In this paper, it emerges that the data access for pastoralism particularly in Karamoja region seems to be characterized by dominance of UNMA seasonal weather forecast but the pastoralists largely use the traditional forecasts, which are at a more detailed spatial-temporal scale. The disjuncture between the two sources of forecasts has thus led to mixed decisions in respect to grazing and migration. Since the region has historically experienced a variable climate, we conclude that data on seasonal weather needs to be coupled with traditional forecasts in addition to other data and information needs for the appropriate decisions regarding adaptation and resilience building. It also emerges that the data issues in respect to access and generation notwithstanding, other factors are also intervening to influence the decisions about grazing. The promotion of conservation, mining, and agriculture are good in diversifying the production base of the region. But these have interfered with the traditional migratory routes, grazing patterns and accentuated conflicts. Agriculture in particular and its promotion as a strategy for diversification of the region's economic base may actually lead to negative impacts on pastoralism and thus needs to be rethought through careful land use planning. Coordination in data generation as well as

data sharing is important but would have to consider the fact that each organization needs a different set of baseline data. Data generation principles and standards supported by a data infrastructure platform may help in this regard such that basic information of livestock, household data, productivity, value chains can be updated regularly by the planned baselines rather than completely new baselines. This would require a repository of data and standards for sharing this data. This paper illustrates that there are multiple sources of data all of which can provide useful information to enable grazing decisions. A system for integrating this data would be useful for the region especially given that there is already ample momentum by the organizations operating in the region to co-generate the data. If data sharing is improved, streamlined and enhanced, the resources going into data collection would be rechanneled to systems of sharing, standards and access mechanisms that would spur design of adaptation and resilience building interventions.

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Competing Interests

The authors have no competing interests to declare.

References

- Anderson, D M** 1993 Cow power: Livestock and the pastoralist in Africa. *Afr. Aff.*, 92: 121–133. DOI: <https://doi.org/10.1093/oxfordjournals.afraf.a098585>
- Arzberger, P, Schroeder, P, Beaulieu, A, Bowker, G, Casey, K, Laaksonen, L, Moorman, D, Uhlir, P and Wouters, P** 2004 Promoting access to public research data for scientific, economic, and social development. *Data Sci. J.*, 3: 135–152. DOI: <https://doi.org/10.2481/dsj.3.135>
- Azzarri, C and Cross, E** 2016 Improved Spatially Disaggregated Livestock Measures for Uganda. *Rev. Reg. Stud.*, 46: 37.
- Bainomugisha, A and Okello, J** 2017 The Tragedy of Natural Resources Dependent Pastoral Communities.
- Barnabas, O D** 2012 Climate Change, Pastoral Livelihoods and Environmental Resource Conflict in Uganda. *Pastor. Livelihoods Environ. Resour. Confl.* Uganda July 15 2012.
- Bemigisha, J** 1991 The Karamoja Database (Uganda).
- Busby, J W, Smith, T G and White, K** 2011 Climate Security and East Africa: A GIS-Based Analysis of Vulnerability. *Clim. Change Pastor. Tradit. Coping Mech. Confl. Horn Afr.*
- Catley, A** 1997 A Review of the Oxfam UK/Ireland Kotido Livestock Development Project (Animal Health Component), Kotido District, Karamoja. *Consult. Rep. Renew. Nat. Resour. Sect. Overseas Dev. Adm.* UK Uganda.
- Chapman, C and Kagaha, A** 2009 Resolving conflicts using traditional mechanisms in the Karamoja and Teso regions of Uganda. *Minor. Rights Group Brief.*
- Chow, J T** 2014 Karamoja Productive Asset Program (KPAP) Small Earth Dam Technical Assessment Report.
- Cragin, M H, Palmer, C L, Carlson, J R and Witt, M** 2010 Data sharing, small science and institutional repositories. *Philos. Trans. R. Soc. Lond. Math. Phys. Eng. Sci.*, 368: 4023–4038. DOI: <https://doi.org/10.1098/rsta.2010.0165>
- Dietz, A J** 1987 *Pastoralists in dire straits: survival strategies and external interventions in a semi-arid region at the Kenya/Uganda border: Western Pokot, 1900–1986.*
- Dyer, N, Omondi, S and Wantsusi, M** 2008 *Securing Pastoralism in East and West Africa.*
- Egeru, A** 2012 Role of indigenous knowledge in climate change adaptation: A case study of the Teso Sub-Region, Eastern Uganda. *Indian J. Tradit. Knowl.*, 11: 217–224.
- Egeru, A** 2014 *Assessment of forage dynamics under variable climate in Karamoja sub-region of Uganda.*
- Egeru, A** 2016 Climate risk management information, sources and responses in a pastoral region in East Africa. *Clim. Risk Manag.*, 11: 1–14. DOI: <https://doi.org/10.1016/j.crm.2015.12.001>
- Egeru, A, MacOpiyo, L and Majaliwa Mwanjololo, G** 2012 *The effect of climate variability and change on forage availability and productivity in Uganda's cattle corridor: A case study of Karamoja sub-region.*
- Egeru, A, Wasonga, O, Kyagulanyi, J, Majaliwa, G M, MacOpiyo, L and Mburu, J** 2014 Spatio-temporal dynamics of forage and land cover changes in Karamoja sub-region, Uganda. *Pastoralism*, 4, 1–21. DOI: <https://doi.org/10.1186/2041-7136-4-6>


- Egeru, A, Wasonga, O, Majaliwa Mwanjalolo, G, MacOpiyo, L and Mburu, J** 2014 *Dynamics of land use and land cover change in semi-arid Karamoja sub-region, Uganda.*
- Egeru, A, Wasonga, O, Mburu, J, Yazan, E, Majaliwa, M G, MacOpiyo, L and Bamutaze, Y** 2015 Drivers of forage availability: An integration of remote sensing and traditional ecological knowledge in Karamoja sub-region, Uganda. *Pastoralism*, 5: 1. DOI: <https://doi.org/10.1186/s13570-015-0037-6>
- Ejoku-Oonyu, S** 2009 Indigenous justice systems and the administration of justice in Uganda: a study of Karamoja region.
- Ezaga, O** 2010 Markets for livestock and food crops in Karamoja subregion. *Food Agric. Organ.*
- Gardner, D, Toga, A W, Ascoli, G A, Beatty, J, Brinkley, J F, Dale, A M, Fox, P T, Gardner, E P, George, J S and Goddard, N** 2003 Towards effective and rewarding data sharing [Editorial].
- Groot, R and McLaughlin, J D** 2000 *Geospatial data infrastructure: concepts, cases, and good practice.* Oxford university press: Oxford.
- Hansen, J W, Mason, S J, Sun, L and Tall, A** 2011 Review of seasonal climate forecasting for agriculture in sub-Saharan Africa. *Exp. Agric.*, 47: 205–240. DOI: <https://doi.org/10.1017/S0014479710000876>
- Harris, D, Khan, L, Paul, R and Thuraisingham, B** 2007 Standards for secure data sharing across organizations. *Comput. Stand. Interfaces*, 29: 86–96. DOI: <https://doi.org/10.1016/j.csi.2006.01.004>
- Harvey, F and Tulloch, D** 2006 Local-government data sharing: Evaluating the foundations of spatial data infrastructures. *Int. J. Geogr. Inf. Sci.*, 20: 743–768. DOI: <https://doi.org/10.1080/13658810600661607>
- Houdet, J, Muloopa, H, Ochieng, C, Kutegeka, S and Nakangu, B** 2014 Cost Benefit Analysis of the Mining Sector in Karamoja, Uganda. *Kampala Uganda IUCN Uganda Ctry. Off.*, ix: 82p.
- Hughes, K** 2013 *Effectiveness Review: Disaster Risk Reduction Programming in Ethiopia's Somali Region.*
- Inselman, A D** 2003 Environmental degradation and conflict in Karamoja, Uganda: the decline of a pastoral society. *Int. J. Glob. Environ.*, Issues 3: 168–187. DOI: <https://doi.org/10.1504/IJGENVI.2003.003863>
- Kandagor, D R** 2005 Rethinking pastoralism and African development: A case study of the Horn of Africa. *Proc. Lect. Egerton Univ. Njoro.*
- Kandel, M** 2016 Struggling over land in post-conflict Uganda. *Afr. Aff.*: adw001. DOI: <https://doi.org/10.1093/afraf/adw001>
- Kok, B and Van Loenen, B** 2005 How to assess the success of National Spatial Data Infrastructures? *Comput. Environ. Urban Syst.*, 29: 699–717. DOI: <https://doi.org/10.1016/j.compenurbysys.2004.02.001>
- Lind, J, Sabates-Wheeler, R, Kohnstamm, S, Caravani, M, Eid, A, Nightingale, D M and Oringa, C** 2016 Changes in the drylands of eastern Africa: case studies of pastoralist systems in the region.
- Luseno, W K, McPeak, J G, Barrett, C B, Little, P D and Gebru, G** 2003 Assessing the value of climate forecast information for pastoralists: Evidence from Southern Ethiopia and Northern Kenya. *World Dev.*, 31: 1477–1494. DOI: [https://doi.org/10.1016/S0305-750X\(03\)00113-X](https://doi.org/10.1016/S0305-750X(03)00113-X)
- Mieth, F** 2012 In between cattle raids and peace meetings: Voices from the Kenya/Ugandan border region. *Spaces Insecurity*, 63.
- Mkutu, K A** 2008 Uganda: Pastoral conflict & gender relations. *Rev. Afr. Polit. Econ.*, 35: 237–254. DOI: <https://doi.org/10.1080/03056240802194133>
- Mubiru, D** 2010 Climate change and adaptation options in Karamoja. *Food Agric. Organ.*
- Muleke, P P S and Nalule, R** 2013 The impact of commercial agricultural investments on the pastoral communities in Uganda: a case of Karamoja sub-region.
- Murphy, S, Carmody, P and Okawakol, J** 2017 When rights collide: land grabbing, force and injustice in Uganda. *J. Peasant Stud.*, 44: 677–696. DOI: <https://doi.org/10.1080/03066150.2016.1259616>
- Nakalembe, C** 2013 Estimating agricultural land use change in Karamoja, NE. Uganda using very high resolution satellite data. *Presented at the AGU Fall Meeting Abstracts*, p. 0369.
- Ngugi, R K, Mureithi, S M and Kamande, P N** 2011 Climate forecast information: the status, needs and expectations among smallholder agro-pastoralists in Machakos District, Kenya. *Int. J. Curr. Res.*, 3: 6–12.
- Nyambura, S K** 2003 *Traditional conflict early warning systems: a case study of Turkana among Karamoja cluster pastoral communities.*
- Ocan, C E and Ocan, C** 1994 Pastoral resources and conflicts in north-eastern Uganda: the Karimojong case. *Nomadic Peoples*: 123–135.
- Oloka-Onyango, J, Zie, G and Muhereza, E F** 1993 *Pastoralism, crisis, and transformation in Karamoja.* International Institute for Environment and Development, Centre for Basic Research.
- Otim, O** 2002 Scarcity and Conflict in Pastoral Areas: A look at the other Side of the Coin. *Resour. Alienation Mil. Dev. Case Stud. East Afr. Drylands OSSREA Addis Ababa*: 105–117.

- Patt, A** and **Gwata, C** 2002 Effective seasonal climate forecast applications: examining constraints for subsistence farmers in Zimbabwe. *Glob. Environ. Change*, 12: 185–195. DOI: [https://doi.org/10.1016/S0959-3780\(02\)00013-4](https://doi.org/10.1016/S0959-3780(02)00013-4)
- Rugadya, M A** and **Kamusiime, H** 2013 Tenure in Mystery: the Status of Land Under Wildlife, Forestry and Mining Concessions in Karamoja Region, Uganda. *Nomadic Peoples*, 17: 33–65. DOI: <https://doi.org/10.3167/np.2013.170103>
- Sawyer, S** 2008 Data Wealth, Data Poverty, Science and Cyberinfrastructure 1. *Prometheus*, 26: 355–371. DOI: <https://doi.org/10.1080/08109020802459348>
- Stites, E** and **Huisman, C S** 2010 Adaptation and Resilience: Responses to Changing Dynamics in Northern Karamoja, Uganda. *Brief. Note Feinstein Int. Cent.*
- Stites, E, Mazurana, D** and **Akabwai, D** 2007 Out-migration, return, and resettlement in Karamoja, Uganda: The case of Kobulin, Bokora County. *Medford MA Feinstein Int. Cent.*
- Takizawa, M, Hamanaka, E** and **Ito, T** 1978 Resource Integration and Data Sharing on Heterogeneous Resource Sharing System. *Evol. Comput. Commun.*: 253–258.
- Tallon, P P** 2013 Corporate governance of big data: Perspectives on value, risk, and cost. *Computer*, 46: 32–38. DOI: <https://doi.org/10.1109/MC.2013.155>
- Venton, C C** 2014 *Understanding community resilience: findings from community-based resilience analysis (CoBRA) assessments: Marsabit, Turkana and Kajiado counties, Kenya and Karamoja sub-region, Uganda.*
- Vogel, C** and **O'Brien, K** 2006 Who can eat information? Examining the effectiveness of seasonal climate forecasts and regional climate-risk management strategies. *Clim. Res.*, 33: 111–122. DOI: <https://doi.org/10.3354/cr033111>
- Wang, V** 2013 *Karamoja, Uganda: A Region Capable of Developing an Agricultural Food Source.*
- Wasonga, V O, Ngugi, R K** and **Kitalyi, A** 2003 Traditional range condition and trend assessment: lessons from Pokot and Il Chamus pastoralists of Kenya. *Anthropologist*, 5: 79–88.
- Wiese, M, Yosko, I** and **Donnat, M** 2003 Participatory mapping as a tool for public health decision-making in nomadic settings. A case study among Dazagada pastoralists of the Bahr-el-Ghazal region in Chad. *Med. Trop. Rev. Corps Sante Colon.*, 64: 452–463.
- Zimmerman, A S** 2003 Data sharing and secondary use of scientific data: Experiences of ecologists.

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