Rangeland Management practices in changing environment: Implications for Land use and Climate Change in selected African countries

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Abstract
Rangeland Management entails rangeland resource management for improved animal production and other ecosystem services. While Africa is endowed with spectacular rangelands which support biodiversity, animal production and people's livelihoods, they face pressure from anthropogenic activities such as overgrazing which leads to land degradation and conversion of rangelands into other land uses. Furthermore, the quality of pastures fed to livestock has implications on feed efficiency and methane gas emission. Rangeland management interventions which enhance the carbon sequestration function of rangelands and reduce enteric methane emission from livestock have a potential of mitigating global warming and climate change. This paper reviews different rangeland management approaches for animal production and assesses their contribution to climate change in some African countries. Such approaches include (i) Community Based Natural Resource Management; (ii) Land and water use planning; (iii) marketing and alternative income; and(iv) wildlife and nature tourism. The findings suggest that, the adoption of SRM approaches is very low with less than 25 cases across Africa. This suggests that the existing SRM interventions have had little contribution to climate change mitigation. The

implementation of approaches such as village land use planning, legalization of the customary land right to grazing areas, establishment of mini ranches and the establishment of improved pasture species with low GHG emission will significantly contribute to sustainable range management and climate change mitigation in Africa.

***Keywords**: Environment, Land use, Climate change, African countries*

Introduction

Rangelands are natural landscapes dominated by grasses and grass-like plants, combined with various woody vegetation which support animal production and provides habitat to wildlife and other ecosystem services (Getabalew & Alemneh, 2019., Kumar et al, 2022). The characteristic features of rangelands include low rainfall, low soil fertility and poor drainage (Getabalew & Alemneh, 2019). Rangeland management entails a number of interventions aimed at maximizing rangeland productivity based on the management objective. In this paper, rangeland management refers to management operations with an objective of increasing livestock production in the manner that safeguards the integrity of the ecosystem.

Rangeland ecosystems in Africa play crucial roles in supporting economic and social development. For example, a large portion of land in Sub Saharan Africa (SSA) is covered by rangelands (62%) hosting about 38% and 56 % of African population and livestock respectively (Liniger et al., 2019). Rangeland ecosystems provide a wide range of ecosystem services including climate regulation (Millennium Ecosystem Assessment (MEA, 2005., Sala et al,

2017). This involves regulating processes related to the greenhouse effect, the ozone layer, precipitation, air quality and moderation of temperature and weather patterns at both global and local scales (Costanza et al., 1997). Such services can be sustained only if rangeland management is done sustainably.

The greenhouse effect is a natural phenomenon whereby the earth gains heat through gases which reflect back the solar radiation to the earth (IPCC, 1996). Such gases are referred to as greenhouse gases (GHGs) and the major ones include carbon dioxide, methane, and nitrous oxide (Cassia et al, 2018). When such gases are maintained in their natural concentrations in the atmosphere, they assist in maintaining the earth temperature through reflecting back the solar energy to the earth. However, due to anthropogenic activities such as industries and land degradation (due to conversions into different land uses), the atmospheric concentration of GHGs have increased since pre-industrial period leading to increased earth temperature thus leading to global warming and hence climate change (Crutzen & Bruhl, 1993). Increased earth temperature affects the hydrological cycle leading to erratic rainfall patterns, prolonged dry spells and floods in some parts of the world including Africa (Urama and Ozor, 2010., Ayugi el al, 2022).

Methane (CH_4), a GHG emitted from various sources including agriculture (paddy rice farming), ruminants, animal and domestic wastes has a global warming potential 21 times more than carbon dioxide (IPCC, 2007). It is a topical GHG in global climate change discourse. A large proportion of methane emissions in the Agriculture and Land use sector comes from livestock production (Knapp et al., 2014, Moumen et al., 2016). Methane is emitted

during the digestive action of microbes found in the stomach of the ruminants (the rumen). This rumen is located at the beginning of the digestive tract, contains different types of microbes mainly, bacteria, protozoa and fungi which plays a major role in the digestion of ingested feeds (Moumen et al., 2008). Many factors affect methane emissions from animal production. These include quality of feeds, level of feed intake, feed processing and changes in the ruminal microflora. Lack of good quality feeds coupled with weak rangeland management practices intensify methane emission from livestock production (Johnson & Johnson, 1995).

The combined global warming potential of both carbon dioxide and methane which are largely emitted from agriculture and land management sector, have compelled countries which signed the Paris Agreement to reduce emissions from that sector in their Nationally Determined Countries (NDCs) as required by the Agreement. For example, in East Africa Tanzania and Kenya have pledged to reduce emissions between 10 – 20% and 30% respectively relative to BAU scenario by 2030 (Kehbila et al, 2021., NDC 2021).

Rangeland Management approaches in selected African countries

Rangeland condition in various parts of Africa have changed, and are relentlessly changing albeit at different rates and in different ways (Liniger et al., 2019). While sustainable rangeland management practices exist to some extent, unsustainable practices are predominantly taking the lead. With the increasing human and livestock population and changes in political, economic and social landscapes across the countries in the region; achieving sustainable rangeland management (SRM) appears to be a daunting task. According to Flintan (2021) and Lininger et

al. (2019) there are four range management approaches common in Africa which are: (i) Community Based Natural Resource Management; (ii) Land and water use planning; (iii) marketing and alternative income; and(iv) wildlife and nature tourism. Such approaches whose cases are summarized in Figure 1, aim to improve land and forage management, reducing land use conflicts and improving livelihoods. Improved land and pasture management contribute to climate change mitigation as they increase carbon sequestration (below and above ground) and increases digestibility of forages hence lowering enteric methane emissions. As Figure 1 indicates, the adoption of SRM approaches is very low with less than 25 cases across Africa.

Rangeland management falls under agriculture and land use sector which accounts for 20% of global GHG emissions (IPCC, 2007). This is attributed to land degradation in developing countries including Africa. Conversions of rangelands into other land uses as a result of policy changes, poor land management practices, lack of comprehensive land use plans and land tenure rights in various countries in the region, have left many pastoral communities either without or with inadequate grazing lands. While some rangelands have been converted into croplands (Figure 2), a vast majority of rangelands in Africa host large investment projects such as mining, factories and urbanization (Bullock et al 2021). Such land use conversions are associated with significant carbon removals and hence contributing to GHG emission (Kim et al, 2016, Hawkins et al, 2018). Furthermore, the inadequacy of grazing lands suggests that the pastoralists have limited choices of pasture type for feeding the livestock, this is likely to reduce the feed efficiency and hence increasing enteric methane emission.

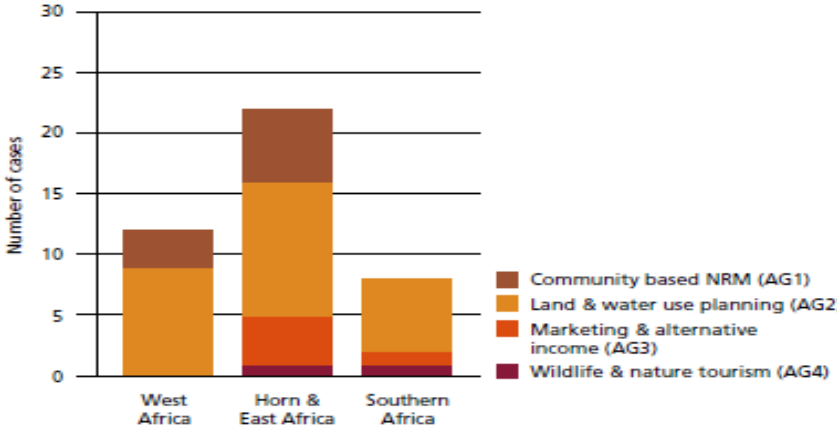

Figure 1: Distribution of SRM approach groups in Africa region (adopted from Liniger et al., 2019).

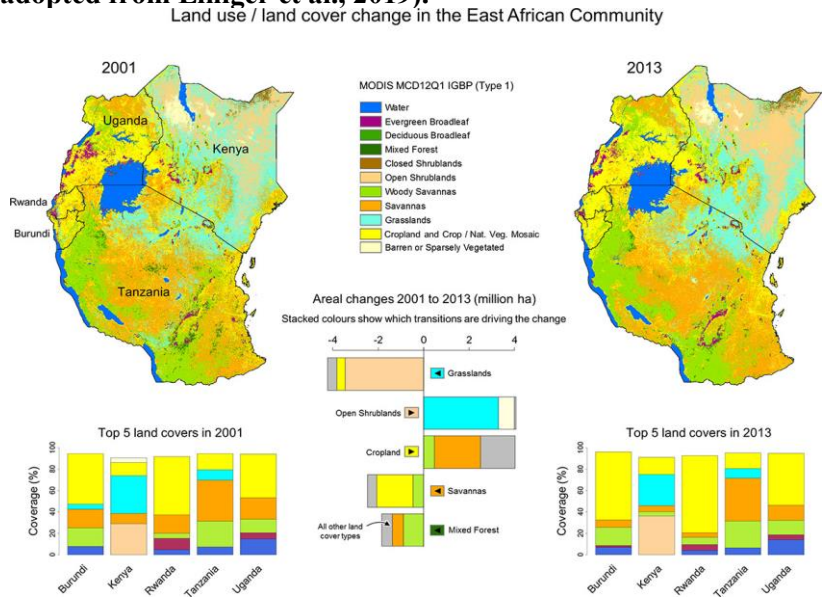

Figure 2: The map showing East Africa land use and land cover change from 2001 and 2013. the graphs show significant decrease of savanna and grassland cover and increase of cropland in 2013 when compared to 2001 (Adopted from Marchant et al, 2018).

The little adoption rate of SRM is attributed to many factors which are complex in nature as it is difficult to delineate where and when one factor ends and where and when the other factor begins. Such factors intertwined act on pastoralists, rangeland management practitioners and policy makers who are equally responsible for ensuring that SRM is achieved. Table 1 shows drivers and shocks affecting range management in Africa. They include ecological, economic, political/institutional and socio-cultural drivers which operate from global to national and local scales. Some drivers are considered as enabling while others are hindering the attainment of SRM. Global drivers and external shocks (e.g. drought, pests and diseases) can affect both rangelands and rangeland users at local level. The severity of impacts of such drivers to the rangelands will depend on the resilience status of the ecosystem and the ecosystem dependent pastoral communities. Policy and legal frameworks could be either enabling or hindering depending on the context. For example, a policy that promotes destocking and sedentarization may in one way appear to improve rangeland management and hence reduce GHG emission, but it may become unpleasant to pastoralists whose inherent social norms embrace nomadism. For example, in Uganda, the current rangeland policy promotes sedentarization of pastoralists and partitioning of communal grazing lands into small ranches (individualization of communal grazing lands). This left some pastoralists without grazing land and was displaced. They had to search for pasture outside their home territories as a result it led to conflicts with host communities (Byakagaba et al., 2018). Likewise, Tanzania land use policies and legislations support sedentarization and the grazing lands have declined as a result of agricultural expansion and establishment of protected areas which alienate livestock.

While rangelands account for about 60% of land in Africa, land designated for livestock production is a relatively small with much land being allocated to protected areas, agricultural expansion and other developmental uses.

Table 1: Key drivers and shocks affecting rangeland management (adopted from Liniger et al., 2019).

	Global/internati onal drivers	**Local- national drivers**	**Shocks/extreme events**
Ecological	- claims on water (within trans boundary watersheds) -claims for land (acquisition/ grab, nature protection)	- changes in pasture biomass and quality - changes in water resources: rainfall, surface, groundwater - climate change - climate variability and change observed locally - diseases/ pests - wildlife interaction	-droughts, water shortage, pollution, floods, extreme rainfall events, volcanic eruptions -outbreaks of pests and diseases - fires
Economic	-market for rangeland products - market for tourism	-market and access -alternative income (rangeland products, tourism/ wildlife) - access to financial resources and services	-market crashes
Political/ institutional	-transboundary policies - transboundary conflicts - land acquisition/ grab	-legal framework: tenure, rights and land fragmentation -authorities and institutional setting -multiple claims local – national governance: rules, regulations - conflicts and political unrest -infrastructure and services - interventions by development agencies	-political instability -insecurity, wars -new laws, agreements
Social-cultural	transboundary migration of people and livestock	-population change and migration - security and conflicts - livelihoods, poverty and market orientation -availability of manpower/ labour, and workload - norms and values - role of women, disadvantaged groups - knowledge, management capacity, and skills - collaboration and coordination of stakeholders	outbreaks of ethnic and other clashes

Rangeland Degradation

Rangeland degradation and poor pasture quality are also a characteristic feature of most rangelands in Africa (Selemani, 2014., Bolo et al, 2019). Degraded rangelands fail to provide the climate regulation services through carbon sequestration and become vulnerable to climate change impacts (Holechek et al, 2020). The degradation is largely due to policies that discourage pastoral mobility and promotes conversion of rangelands into other uses while failing to integrate the needs of pastoralists (Bolo et al, 2019).

Pastoral mobility (also known as transhumance) has been traditionally practiced by pastoral communities as a dry season coping strategy due to shortage of pasture and water (Adriansen, 2008). This practice is not only beneficial to pastoralists, but also it improves rangeland conditions as the pastures are not heavily grazed and hence given time to regenerate once the herders move to another location (Selemani 2014., Byakagaba et al., 2018). But there are critical questions to be answered to establish whether pastoral mobility is ecologically beneficial or not: (i) how are the site of origin and the destiny site spatially connected? (ii) are they in one ecosystem? (ii) what is the distance between the two sites? (iii) are there designated stock routes through which the herds will pass during migration to another site? And (iv) who will supervise the migration process making sure that the animals do not cause damage to other peoples' properties and the environment at large? Empirical evidence suggests that transhumance practice causes land degradation in the host locations and has led to several land use conflicts, notably between pastoralists and farmers (Channer, 2015., Heyman et al, 2020). In particular, during seasonal migration the herders move the animals across many different

landscapes before returning back to their home locations. Due to absence of clear stock routes, degradation of land and water resources occurs (Umutoni et al, 2018).

Despite the benefits of transhumance and other communal grazing management systems, the available natural pastures have low feed efficiency hence leading to high emission of methane gas due to low digestibility and less absorption (Meho-filho et al 2022). Many African countries are unable to support pastoralists to establish pasture farms for improved pasture. With pasture farms, the pastoralists are able to grow the selected list of pasture species which have both nutritive and environmental benefits (reduction in methane emission). The continued transhumance practice and grazing of the communal lands beyond the ecological carrying capacity of the area have led to the disappearance of some of palatable pasture species. These are replaced by unpalatable species which have low feed efficiency hence increasing the emission of methane (Løvendah et al., 2018).

Land degradation emanating from overgrazing and transhumance is exacerbated by increasingly high rate of conversion of grazing lands into other land uses such as agriculture, human settlements and industrial development (IPCC, 2019). This is largely due to absence of village land use plans with well-defined grazing areas (Bedunah & Angerer, 2012). Furthermore, even in areas with designated communal grazing lands, conversion into other land uses still occurs owing to lack of customary certificate of right of occupancy (CCRO). Areas with CCRO become legally protected hence making conversion into other land uses impossible.

Measures for improving range management and mitigating climate change

Destructive effects of pastoral mobility are the reasons for sedentarization policies in many counties in Africa (Fratkin et al, 2004). The pastoralists are encouraged to settle in one place and conduct animal grazing activities therein, notably the communal grazing lands. To avoid free-riding syndrome, a characteristic feature of common pool resources; the communal grazing lands ought to be subdivided and be distributed to individual pastoralists or groups of pastoralists (BurnSilver & Mwangi 2007). This is envisaged to improve the management of such grazing lands thus contributing to SRM.

For countries to achieve SRM which will lead to significant decline of GHG emissions from land use activities four issues must be addressed namely village land use planning, legalization of the customary land right to grazing areas, establishment of mini ranches and the establishment of improved pasture species with low GHG emission.

Village land use planning

While village land use planning aims to assess land and water to inform the decisions on best land use options in the village, it ought to be conducted in a participatory manner. Village land use planning, if properly done and by-laws effectively enforced, may contribute to the attainment of sustainable rangeland management (Zaid at et al, 2017).

Legalization of the customary land right to Grazing Areas

In Africa, many countries recognize customary or traditional land rights in their respective land legal frameworks. The customary right of occupancy is an effective tool for strengthening community land rights and securing communal land (Huggins, 2016). In Tanzania, the Village Land Act, 1999 stipulates the issuance of customary rights of occupancy (CCRO) to individuals or groups. The main purpose of CCRO is to secure community land for future use. The land that is secured is used for grazing, farming and other use. The CCROs provide the rights to individual or group of people to own a certain piece of land (Huggins, 2016). This encourage protection of land as it improves pasture availability to the pastoralists since everyone will be managing his/her areas. By doing so, pastoralists will be assured of grazing land thus improving grazing management. This is envisaged to reduce pressure on the grazing land hence greenhouse gas emission will be reduced due to increased carbon sequestration by sustainably managed rangelands.

The establishment of mini ranches

Unlike conventional ranches which require a relatively large track of land for keeping animals, mini ranches cover a relatively small area within a village or outside the village. Such mini ranches are privately owned by an individual or a group of few committed people. Literature review suggests that there is scant documented information on mini ranches in Africa. For example, in East Africa, the mini ranch concept is only reported in Uganda by Byakagaba et al. (2018). With mini ranches, pastoralists manage their animals in a confined area. Thus the mobility of animals is restricted leading to reduced rangeland degradation and improvement of rangeland management (Holechek et al., 2020).

Improvement in rangeland management by managing grazing intensity and improved forage production increases carbon sequestration and storage in the ecosystem, this contributes to climate change mitigation (O'Mara 2012., Mekuriaw, 2019).

Establishment of pasture species with low GHG emission

While enteric methane emission is influenced by many factors including the level of feed intake, feed digestibility and pasture type, it is important that the animal feeds contain pastures of low methane emission. *Brachiaria humidicola* and *Arachis pinto* grasses are among the pastures with high nutritive value, high feed digestibility and low GHG emission when properly managed (Peter et al, 2012). In particular, Brachiaria grasses are climate smart as they offer two important benefits. Firstly, they have high digestibility thus low methane emission from ruminant intestines; secondly, they have *biological nitrification inhibitor* that suppresses nitrification process in the soil (Byrnes et al., 2017). Nitrification is a biological process which converts nitrogen into nitrous oxide (N_2O) and releases it to the atmosphere. N_2O is a very dangerous GHG with a global warming potential of 300 times that of carbon dioxide. Thus, Brachiaria grasses abate N2O emissions from fertilizers and manures.

Conclusion

Rangeland management is key for mitigating climate change. Degraded rangelands contribute to emission of carbon dioxide from the soil. Furthermore, poor quality pastures increase enteric methane emission thus contributing to global warming and climate change. The implementation of interventions such as village land use planning, legalization of the customary land right to grazing areas, establishment of mini ranches and the

establishment of pasture species with low GHG emission will significantly contribute to climate change mitigation.

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