Journal of
Earth Science & Climatic Change

Hussein. J Earth Sci Clim Change 2021, 12:10

Review Article Open Access

Courses of Rangeland Degradation and Rehabilitation Techniques in the Rangelands of Ethiopia

Abdulbasit Hussein*

Department of Natural Resource Management, Haramaya University College of Agriculture and Environmental Science (HU CAES), P.O Box 138, Dire Dawa, Ethiopia

Abstract

Rangeland degradation continues to be a major hindrance to improving pastoral livelihoods in Ethiopia's lowlands. This review study examines the scope of rangeland deterioration, its drivers, and the potential consequences of rangeland degradation, as well as different rangeland restoration strategies. It is meant to be used as a starting point for more detailed quantitative assessments to support policy and investment strategies in Ethiopia to address rangeland degradation. Rangeland degradation worsens with time, and rangeland productivity suffers as a result if proper care is not taken. Climate change, overgrazing, bush encroachment, population pressure, drought, government policies, encroachment of rain-fed agriculture, and the demise of traditional resource management institutions are all key contributors of rangeland degradation. Rangeland degradation has led in significant losses in rangeland condition, water potential, soil status, and animal performance, as well as household livestock holdings and communal poverty. Rangeland degradation has led in significant losses in rangeland condition, water potential, soil status, and animal performance, as well as household livestock holdings and communal poverty. Food insecurity, poverty to the point of requiring food aid, aridity expansion, and the necessity for alternate livelihood and income diversification are all consequences of rangeland degradation. In addition, it has become a growing danger to pastoral production systems, contributing to rising poverty and tribal conflicts over grazing area and water resources. Despite these consequences, the country's adoption of alternative restoration strategies is woefully inadequate. There is an urgent need to significantly expand investments and strengthen policy support for sustainable land management in order to solve rangeland degradation issues.

Keywords: Ethiopia; Rangeland; Degradation; Rehabilitation

Introduction

Rangeland biomes, which occupy much of the area where pastoral livestock production is a dominant land use, account for 51% of the earth's land area yet support 78% of worldwide grazing (Asner et al., 2004). The majority of the 1.2 billion people living on less than $1 per day rely on livestock for food and income [1], While the demand for cattle is at an all-time high [2,3]. Rangelands in developing countries provide many commodities and services of enormous economic, social, cultural, and biological significance locally, nationally, and worldwide, in addition to securing livelihoods (Mortimore, 2009). Rangelands, on the other hand, have been subjected to opposing forces, such as increased demand for natural resources and animal products in order to meet the demands of growing human populations. According to conservative estimates, 10–20% of global rangelands have been badly degraded, with an additional 12 million hectares destroyed per year (Millennium Ecosystem Assessment, 2005; Reynolds et al., 2007).

Pastoralists who rely on degraded rangelands are frequently poor and food insecure [4]. As a result, rangeland deterioration and desertification have sparked global alarm. Rangeland degradation is a global issue that affects not only pastoralists who rely on healthy rangelands for existence, but also those who are affected by hydrological disruptions, dust storms, commodity scarcity, and the social implications of uprooted people. Because all native flora and fauna have adapted to the long-term evolutionary pressures that have molded these rangeland ecosystems, rangeland health has an impact on biodiversity both directly and indirectly [5].

Because of a lack of monitoring, it's difficult to estimate the level of deterioration in developing countries, but there's little doubt that the human population is putting enormous strain on rangeland ecosystems. It is also emphasized that there is no universally applicable definition of land degradation because the degraded factor must be defined [6]. Degraded rangelands, on the other hand, are characterized by long-term decreases in biological and economic productivity due to incorrect or unsustainable human land use, as well as the influence of this unsustainable usage on hydrology, soil processes, and vegetation composition [4].

Rangeland degradation is caused by interactions between pastoralists, governance and policy, and environmental elements that are complex in time and geography. Though a variety of variables are identified as important drivers of rangeland degradation in developing countries' arid and semi-arid regions, the leading ones are cultivation and overgrazing, both of which are driven by human and animal population pressures (Mannetje, 2002). Heavy grazing, frequent drought, rangeland cultivation, bush encroachment, human population pressures, rainfall shortages, incorrect use of land resources, and soil erosion are all probable causes of rangeland degradation, according to different research on different Ethiopian rangelands [7,8].

Despite the loss of many ecosystem services supplied by rangelands as a result of fast rangeland degradation and the urgent need for action to prevent and reverse land degradation, the problem has yet to be adequately addressed, particularly in developing countries such as Ethiopia. A comprehensive and evidence-based policy framework for action across all agro-ecological zones is inadequate, as is sufficiently

***Corresponding author:** Hussein A Department of Natural Resource Management, Haramaya University College of Agriculture and Environmental Science (HU CAES), P.O Box 138, Dire Dawa, Ethiopia; E-mail: abdulbasithussein111@gmail.com

Received September 01, 2021; **Accepted** September 17, 2021; **Published** September 30, 2021

Citation: Hussein A (2021) Courses of Rangeland Degradation and Rehabilitation Techniques in the Rangelands of Ethiopia. J Earth Sci Clim Change 12: 582.

strong policy action for sustainable rangeland management (Nkonya et al., 2013). There are no reliable assessments of the potential impact of rangeland degradation on pastoral and agro-pastoral livelihoods. Furthermore, one of the greatest hurdles to minimizing land degradation and boosting rangeland production, as well as encouraging the adoption of sustainable land management among pastoral and agro-pastoral communities, is a lack of information and expertise [9]. The major goal of this study was to look at the causes of rangeland degradation as well as rangeland restoration techniques in Ethiopia.

Litrature Review

Ethiopian Rangeland Degradation

Rangeland degradation is an issue that affects people all around the world. The combined effect of human and climatic forces on land degradation has resulted in lower rangeland output [10]. Rangeland degradation/deterioration encompasses both soil and vegetation, and is characterized as a decrease in a land's economic or biological productivity [11]. In the Ethiopian rangelands, loss of plant cover, undesirable changes in herbaceous species composition (e.g., annual grasses replacing perennials), various types of soil erosion associated with intensification of grazing, and woody encroachment have all been prominent features, all of which could have different implications for pastoral productivity [12].

Rangeland Degradation Causes

The degradation of Ethiopian rangelands was caused by a number of interconnected variables and processes. In general, natural and human-induced rangeland degradation are known to occur, with some overlap between the two, and the most typical ones are addressed below.

Climate change: Ethiopia is already showing indicators of climate change on a national level. Every decade, the annual average minimum and maximum temperatures over the country have risen by around 0.25 and 0.1°C, respectively, in the last 50 years [13]. Temperatures have risen and rainfall has decreased in southern and eastern Ethiopia since 1996, according to McSweeney et al. (2008) and FEWS NET (2009). As the temperature rises, so do the number of dry and windy days, and hence the number of erosion occurrences [14].

Climate change is expected to have a greater detrimental impact on rangelands, with implications such as changes in water supplies, rangeland productivity, land use patterns, and rangeland-based livelihoods. [15]. Climate change is viewed as a major ecological factor affecting the dynamics of sub-Saharan African rangelands. (Oba et al., 2000). As pastoral systems across national borders, they are likely to have an impact on migration trends both locally and globally. Since the last few decades, the country has also been subjected to unusually frequent and severe droughts (Kassahun, 2008). Ethiopia's dry regions, in particular, are vulnerable to climate change and variability, a concern that affects a wide range of sectors, including biodiversity (flora and fauna), agriculture, human health, and water. Climate change may hasten the spread of invasive species and exacerbate the degradation of rangeland ecosystems and the people who rely on them [16].

Over-grazing: Rangeland overgrazing is a global issue, and Ethiopia is no exception. In order to survive, a growth in human population demands an increase in animal population in rangelands. Animal populations are increasing in Ethiopian pastoral areas to fulfill the demands of growing human populations, whereas the pasture supply on which they rely is limited or deteriorating in terms of grazing area and range productivity [17]. Increased livestock populations are exacerbating lowland range system imbalances, which have already resulted in overgrazing and range degradation [18,19].

Decline of traditional knowledge: Rangeland degradation is exacerbated by the loss of traditional indigenous knowledge and a fall in elder participation in rangeland management. Despite global awareness of the conventional system of resource administration's relevance, policymakers, leaders, scholars, and development workers continue to place little emphasis on it [20]. Traditional rangeland and livestock management strategies described from East African countries included herd diversification and communal land free roaming (Oba and Kotile, 2001). The diversification of herd composition is a response to changing climatic conditions that improves the region's climate resilience.

In response to the spatial and temporal diversity of rangeland resources, herd mobility is an important strategy (Oba, 2011). Mobility is used for a variety of purposes, and decision-making is based on pastoralists' knowledge and local institutions (Oba, 2011). The pastoral production system was characterized by mobility and opportunistic resource consumption. Pastoralists used it as a method to exploit scarce flora and water supplies in dry places, as well as a practice to cope with the hard environment. Despite the benefits of mobility for pastoralists and the environment, Ethiopian pastoral development strategy prioritizes sedentarization as a means of escaping poverty, and this policy ignores mobility as a source of production in the arid plains.

Pressure from the population: The fundamental causes of rangeland degradation are demographic issues such as human population expansion resulting from a rise in the number of communities itself, settlements, and immigration from outside the pastoral region and from adjacent pastoral areas. In the early 1970's [21], the annual human population growth rate in the Borana rangelands was about 1-1.3%, about 2.5 percent in the 1980's [17], and about 3 percent in the late 1990's (Homann et al., 2008). However, more than natural increase, human migration (settlement or resettlement) to the lowlands (spontaneous and planned) is a big issue. Many people are relocating to the lowlands, where there is comparatively unpopulated land, while land access in the highlands becomes increasingly restricted and those that are available are degraded.

A number of government relocation programs have also targeted these areas, resulting in a significant increase in human population. Between 2000 and 2004, around 440,000 household heads, or 2.2 million people, were formally resettled in Ethiopia's four regional states: Amhara, Oromiya, SNNPR, and Tigray, with the majority of these resettlements taking place in dryland areas (Mulugeta et al., 2012b).

Due to geopolitical and domestic political events, regional boundaries between Somalia and Oromia have been redrawn, resulting in territorial loss for the latter and continued warfare between the Borana and the Somali-Garri. Oromo groups have relocated into nearby Oromo villages, bringing with them more Oromo people. In Dirre district, for example, the number of ollas (settlements) has doubled from 10 to 58 (Gemtessa et al., 2005). This, among other factors, has resulted in a significant increase in population, from 300,000 in the 1980's to over one million in 2007. [22]. Land degradation is a common outcome of rising population because more people mean more demand for forest products, settlement space, grazing and farming regions [23]. Increases in human population can exacerbate pressure on current rangeland resources, leading to land degradation, as a result of this.

Encroachment on agricultural lands: Traditional pastoral societies have lost relative significance in developing countries, particularly in Africa and the Middle East, within the new national governments of the dry lands, where political and economic power is concentrated in the urban and agricultural sectors (Thurow, 2000). Rain-fed cropping's recent incursion into better pasture land might be interpreted as a response to newly established national policies aimed at increasing food production and placing a greater emphasis on cash crops as a source of foreign exchange [24]. As a result, vital traditional exchange connections between pastoralists and farmers have broken down, and significant grazing grounds have been lost. Aside from the reasons stated above, the proliferation of large-scale commercial farms without proper consideration for the needs of local pastoralists is seen as a threat to the livestock production system. These interventions can be beneficial to the country in a variety of ways. However, the welfare of pastoralists and the environment of the rangelands must be prioritized.

In comparison to the past, there are no locations in pastoral areas where agricultural production is not practiced. According to a research conducted in Ethiopia's Rayitu district 30 years ago, 94 percent of the respondents were solely pastoralists. Only 36% are solely livestock herders, with the remaining 63% combining livestock and crop farming (Abate et al., 2010). Cropping in many dry land areas is risky, with crop failures occurring as frequently as 2 to 3 years out of every 5 years; however, it remains a popular diversification strategy, particularly among poor herders in SSA, despite the fact that smallholder crop producers find it exceedingly difficult to get an adequate return on investment to consistently lift them out of poverty (Harris and Orr, 2012). As more dry regions are cultivated, significant resource patches that are critical to pastoral production are often exploited, which can impede mobility and create conflicts between herders, farmers, and wildlife (Haan et al., 2014). The conversion of rangelands to cultivated lands, as well as the loss of high-potential rangelands for pastoralists, concentrates growing pastoralist and livestock populations on smaller areas of less productive rangelands, resulting in increased resource competition and rangeland overexploitation (such as overgrazing) [25].

Frequent Drought: Drought is a major factor that has contributed to range degradation in many sections of the world's lowlands, particularly in Africa. Drought, according to Pratt et al. (1977), occurs when rainfall falls below half of the long-term average or when rainfall falls 75 percent below average in two consecutive years. Drought is defined as 'two or more consecutive dry years in which the length of the growing period (LGP) is less than 75 percent of the mean, i.e., a drought is caused by several consecutive rainy seasons in which deficient rainfall has a determinant effect on the production system,' according to Coppock (1994).

When drought and overgrazing occur simultaneously, the impact on rangeland production is doubled (Herlocker, 1993). Droughts, for example, disrupt the pastoral rangelands on a regular basis, resulting in enormous cattle mortality (Oba and Kotile, 2001). Long-term drought, which includes water scarcity and irregular rainfall, may wreak havoc on ranges (Abate et al., 2012; Abate et al., 2016). During droughts, rainfall is insufficient to allow grasses to grow and to fill surface water ponds [26]. According to a report from the Borana rangelands, mean annual rainfall decreased by 14 percent, 35 percent, 18 percent, 17 percent, 52 percent, and 43 percent during the significant drought years of 1983–1984, 1992–1993 and 1999–2000, respectively.

Bush Encroachment: Rangeland degradation in Ethiopia has been widely recorded as a result of fast encroachment and invasion of plant species [7,8,19,20,25]. Bush encroachment is the spread of a plant species into an area where it did not previously exist. Invasion, on the other hand, is the introduction and spread of a foreign plant species into a previously uninhabited area. As a result, bush invasion can happen even with native species, and it is defined more by plant density than by species. Invasion, on the other hand, while focusing on plant density, concentrates on the exoticism of the species in question, making it more species specific. Furthermore, although encroachment concentrates on the species' woodiness, invasion includes alien herbaceous species; consequently, grasses are classified as invaders [27].

Several studies from southern Ethiopia's semi-arid rangelands have reported significant spread of bush invasion [8,23]. Assefa et al. (1986) [28] calculated that around 40% of the Borana rangelands were damaged by bush encroachment in the 1980's, whereas Gemado et al. (2006) assessed that bush cover had progressed to 52%. According to Abule (2009), the Borana rangelands have a shrub cover of more than 63 percent. For the Afar and Somali regions, there are no good data on the areas covered by invasive woody plant species. However, *P. julifolora*, *A. seyal*, *A. melifera* and *A. senegal* are of a major concern (Abule, 2003, Amaha, 2006). The spatial extension of *Prosopis juliflora* in Ethiopia, in particular, is difficult to measure because it is rapidly expanding, up to 18 percent every year [29]. *P. juliflora* has already covered one million hectares in Ethiopia (Ryan, 2011), with roughly 700,000 hectares in the Afar Region (Mueller et al., 2010). It's likely that the spread will accelerate even more. As a result, more work is required to restrict its spread and maintain sustainable resource use and management in Ethiopia's rangelands in general.

Rangeland rehabilitation techniques in Ethiopia

Throughout Sub-Saharan Africa, rangeland degradation is a major issue. Due to the combined effect of human and climatic forces on land degradation, rangeland output has decreased and environmental quality has deteriorated (Jama and Zeila, 2005). Though restoring damaged rangeland remains a difficult task, studies have shown that when protected, degraded vegetation can return in a very short period of time (Yayneshet et al., 2009). Range rehabilitation/restoration strategies include reseeding or allowing natural regeneration to proceed, soil and water conservation measures, water harvesting, and dryland forestry, among others. Rehabilitation must tackle the underlying causes of degradation and reverse the degradation process in order to be effective and successful (Li et al., 2011).

The implementation of suitable rangeland management rules, as well as successful restoration/rehabilitation of degraded rangelands, would go a long way toward slowing and reversing land degradation and increasing rangeland carrying capacity [30]. Management strategies incorporating prevention and rehabilitation are favored above restoration procedures, which are sometimes too expensive for broad use, for effective control of degradation (Puigdefabregas, 1998). In essence, rangeland degradation prevention is preferable over rehabilitation not only in terms of cost, but also because rangeland deterioration accelerates and reinforces itself once it reaches a certain point, with the risk of irreparable impacts [31]. With this in mind, it is vital to protect and boost the productivity of regions that have not yet degraded or are in fair shape.

Re-seeding techniques: Long-term severe grazing pressures, along with recurring drought, have reduced significant swaths of rangeland to bare soil in the pastoral areas of the country. Rangelands in such settings are vulnerable to wind and soil erosion, resulting in a loss of soil

fertility and seed [32]. The land degradation problem can be reversed through reseeding in severely degraded rangelands where the soil seed bank has entirely depleted or where the relative number of beneficial species has gone below threshold levels (10-15 percent) [33]. In order for restoration of degraded rangeland initiatives to be successful in the short term, seed must be introduced. Because of the high capital needs, reseeding technique has been effectively utilized to rehabilitate damaged rangelands in East Africa [34], but it is not widespread in pastoral settings. Tebaje et al. (2014) found that reseeding Rhodes grass (Chloris gayana Kunth) on degraded rangeland with simple tillage and manure application might restore degraded rangeland in south east Ethiopia.

Collecting seeds from existing grasses and spreading them on bare ground is known as reseeding. Ground preparation with fertilizers and continued nurturing would be part of the reseeding strategy, as would encourage pastoralists to collect enough seeds during the growing season to sow the land as needed. Native grasses have evolved to thrive in the tough conditions of semi-arid environments. Drought and barren soils are common causes of the extinction of many exotic species [35]. Native grasses not only provide home for many native animals, but they also serve as a good pasture base for livestock production and can perform well as exotic species in difficult environments (Oba and Kotile, 2001).

Prescribed fire: Fire is a common occurrence in East African savanna systems, and it has a significant impact on ecosystem structure and function [27]. The most visible effect of fire is the elimination of old, dead vegetation, which is replaced by new, healthy growth, resulting in a green-flush look. Herbivores are drawn to this regrowth [36], and feeding on it results in larger mass gains than grazing on unburned plants [27]. Several studies have found that during the post-fire growth season, post-burn savanna vegetation had a higher above ground nutrient concentration than unburned vegetation [27,36].

Managing woody vegetation, eliminating dead biomass, clearing, encouraging grass growth and palatability, hunting and controlling wildfires and pests are all common uses for fire [37]. An example data set from plots burned in the Dida Hara pastoral association in the Borana rangeland in Southern Ethiopia in 2005 showed that after burning, the cover of highly valued grass (Themeda tiandra) increased from 18% to 40% of the basal cover and the proportion of barren ground decreased [19]. Prescribed fire, if correctly administered and utilized in conjunction with other acceptable range management measures, can be used to reduce bush encroachment and boost fodder supply and quality for grazing animals, according to this study and observations. The importance of fire in grassland ecosystems cannot be overstated. It also plays a function in determining the structure and composition of rangeland vegetation from an ecological standpoint (e.g., Ayana and Oba, 2008). Without fire, organic matter and trash would build up, and tree densities would rise, eventually resulting in wooded areas. Changes in fire regimes, combined with grazing, are frequently linked to an increase in woody vegetation, resulting in considerable increases in carbon storage. Furthermore, many species of fauna and flora in rangeland ecosystems are fire-dependent, and eliminating fires will result in a loss of biodiversity [38].

Pastoralists have long utilized fire to limit the spread of shrub cover and ticks, as well as to improve pasture quality and ease livestock movement. However, in the early 1970s, the use of fire was outlawed [17]. As a result, shrub cover has expanded dramatically (Oba, 1998). The restriction of fire has resulted in an increase in bush encroachment over the previous four decades, with severe consequences for cattle production and community subsistence (Ayana and Oba, 2008), hastening rangeland degradation.

Bush's encroachment management: Bush encroachment control is a disturbance that minimizes the threat of bush encroachment by upsetting the invasive woody plant community structure through biotic environment and habitat conditions alterations in which colonization of the disturbed microhabitat occurs. Rangeland vegetation shifts from woody vegetation to herbaceous vegetation as a result of bush management strategies. The goal of this bush control is to provide grazers with a suitable habitat (Ayana and Oba, 2008). As a result, as the number of woody species decreases, herbaceous vegetation produces more fodder.

There are various strategies for controlling bush encroachment, but the most frequent include rangeland management, mechanical, biological, and chemical treatments. Most of the time, a single strategy is ineffective in achieving long-term rangeland weed control. As a result, employing more than one way to restore rangelands degraded by bush encroachment is necessary [39,40]. To address this issue, public awareness must be raised, and a participatory strategy to invasive weed removal must be implemented (Patel, 2011).

Bush encroachment is now often regarded as the most serious environmental issue confronting pastoralists in semi-arid and arid regions. Over the last century, these encroachers have grown their cover and density in grasslands and savanna systems all over the world, with a focus on African savannas [41]. These increases may cause a shift in biome from grassland to shrubland (Briggs et al., 2005). Pastoralists and their grazing animals are concerned about this because the thickening tree/shrub vegetation competes with herbaceous fodder and limits stock carrying capacity (Abule et al., 2007; Ayana and Oba, 2008).

With the technique of prescribed burning, Ayana (2007) argues that the use of bush or shrub clearing may be useful in the management and enhancement of rangelands. In terms of total dry matter (DM) yield, the grass component responded well to tree reduction, whereas forbs were negatively affected (Smit, 2005). According to Abule et al. (2007) and Bikila et al. (2014) [42], grass diversity decreases considerably when woody plant cover or density increases. Except in some low rainfall zones or where grazing or previous land use has limited the availability of perennial grass propagules or favors exotic plants and shrubs, herbaceous output normally improves after trees are removed (Abule et al., 2007). Nutrients generated from decomposing tree remains may help to boost grass growth following removal. According to Samuel (2009), if a rangeland encroached by acacia species is thinned at a specific intensity, the under-storey vegetation production and soil fertility improve. As a result, landscapes with a heavy cover of mature, massive woody plants may experience the highest release of herbaceous production after tree removal.

Area enclosures: Enclosures, in which grazing is prohibited for a set length of time, are a typical strategy that has been successfully tried in rehabilitating degraded rangelands. Enclosures can be successful systems for restoring degraded land if they have clearly defined users, resource boundaries, and realistic norms developed locally, according to experience from various parts of Ethiopia [43]. However, as compared to more regularly grazed rangelands, a study of the long-term repercussions of managing land this manner indicated that the spread of bush encroachment is a major problem in these enclosures over time (Ayana, 2007). To avoid unfavorable outcomes, particular effort should be taken to include scientific and indigenous knowledge into rangeland enclosure management [44].

Grazing management: The basic concepts of range management include maintaining livestock numbers with available fodder, consistent animal distribution within the range, vegetation upkeep through alternating periods of grazing and rest, and the employment of the most suitable livestock. In arid and semi-arid settings, the link between land degradation and livestock management is well-known, necessitating changes in livestock management practices and, as a result, strengthening grazing management best practice is critical for sustaining rangeland productivity and health (Illius et al., 1998; and Ash et al., 2011). Reduced animal numbers and managed grazing have been advocated in degraded rangeland to reduce grazing pressure and allow rehabilitation [45]. As Woodfine (2009) points out, the goal of sustainable land management in pasture and range management is to maximize the capture, infiltration, and storage of rainwater into soils, which promotes favorable conditions for increased vegetation cover, soil organic carbon, and the long-term use of above and below ground biodiversity [46].

In conditions of insufficient vegetation cover, overgrazing, and degraded soils, controlled grazing management is regarded the most promising SLM strategy for restoring degraded rangelands because it increases the strength of mature perennial grasses (Woodfine, 2009). The use of grazing as a management strategy for boosting range productivity and restoration must take into account the degraded rangeland's grazing history. This is especially critical if the degraded grazing lands have a history of attracting large herbivores, such as livestock (Papanastasis, 2009). In the case of rotational and postponed grazing, it is advised that land partitioning be based on ecological variation, and that grazing timing and duration be calculated independently for each land type and grazing region to account for biophysical differences, primarily soils and vegetation (Abel and Blaikie, 1989).

Aside from its importance in range restoration, better grazing management will improve the functioning of dryland hydrological systems and contribute to biodiversity conservation and restoration (Woodfine, 2009). Indeed, according to International Union for Conservation of Nature, inappropriate livestock management has been identified as a serious danger to biodiversity of a high number of threatened species [47].

Conclusion

Rangeland degradation has become a growing threat to pastoral production systems, resulting in significant declines in rangeland condition, water potential, soil status, and animal performance, as well as livestock holding at the household level, resulting in food insecurity, poverty to the point of requiring food aid, and the need for alternative livelihood income and diversification. Despite the detrimental consequences of rangeland degradation, Ethiopia faces a difficulty in achieving sustainable rangeland ecosystems; rangeland degradation has not been stopped, and the ecosystem services offered by rangelands are undervalued. Rangelands are degrading at an alarming rate, giving the impression that restoration would be difficult in the future. As a result, research and development should be focused on developing sustainable rangeland industries and policies that reduce rangeland disturbance and allow for the repair of stressed and dysfunctional rangelands.

References

1. FAO (2008) Livestock policy and poverty reduction. Rome, Italy: Food and Agricultural Organization. Livestock policy brief 4: P: 8.
2. Delgado C, Rosegrant M, Steinfeld H, Ehui S, Courbois C (1999) Livestock to 2020: the next food revolution. Washington, DC, USA: International Food Policy Research Institute. Food, Agric Environ Discuss Pap Pp: 28.83.
3. De haan C, Schillhorn van veen T, Brandenburg B, Gauthier JE, Le gall F, et al (2001) Livestock development: implications for rural poverty, the environment, and global food security. Washington, DC, USA: The World Bank.
4. Donald JB, Jay PA (2012) Rangeland Degradation, Poverty, and Conflict: How Can Rangeland Scientists Contribute to Effective Responses and Solutions? Rangeland Ecol Manage 65: 606-612.
5. Fiona F, Worku C, Dida W, Andrew R (2008) Livestock and livestock systems in the Bale Mountains Eco-Region. A report for the Bale EcoRegion Sustainable Management Project, SOS Sahel Ethiopia and FARM Africa June 2008 Addis Ababa.
6. Abule Ebro (2003) Rangeland evaluation in relation to pastoralist's perceptions in the Mid Awash rift valley of Ethiopia. A PhD. Dissertation submitted to University of Free State, Bloemfontein, South Africa.
7. Ayana A, Oba G (2008) Herder perceptions on impacts of range enclosures, crop farming, fire ban and bush encroachment on the rangelands of Borana, southern Ethiopia. Hum Ecol 36:201-215.
8. Gemedo D, Maass BL, Isselstein J (2006) Encroachment of Woody Plants and Its Impact on Pastoral Livestock Production in the Borana Lowlands Southern Oromia, Ethiopia. Afr J Ecol 44: 113-299.
9. Flintan F, Tache B, Eid A (2011) Rangeland fragmentation in traditional grazing areas and its impact on drought resilience of pastoral communities: lessons from Borana, Oromia and Harshin, Somali Regional States, Ethiopia. Reg Learn Advocacy Programme.
10. Briggs JM, Knapp AK, Blair JM, Hilster JL, Hoch GA (2005) An ecosystem in transition: causes and consequences of the conversion of mesic grassland to shrub land. Bio Sci 55: 243-254.
11. FAO (2011) World Census of Agriculture: analysis and international comparison of the results (1996-2005). FAO Statistical Development Series No. 13. (Columns 3 and 4). Rome.
12. Alima, Cai P (2002) The prevention of degraded grassland and enhancement of grassland animal grazing productivity in Xilinguole League. Grassland of China 24: 75–77.
13. INCE (2001) Initial National Communication of Ethiopia to the United Nations Framework Convention on Climate Change (UNFCCC). Federal Democratic Republic of Ethiopia Ministry of Water Resources, National Meteorological Services Agency. Addis Ababa.
14. Chen ZZ, Wang SP, Wang YF (2003) Update progress on grassland ecosystem research in Inner Mongolia steppe. Chin Bull Bot 20: 423–429.
15. Hoffman T, Todd S (2000) National review of land degradation in South Africa: The influence of biophysical and socio-economic factors. J South Afr Stud 26: 743-758.
16. Alemayehu M (2004) Pasture and Forage Resource Profiles of Ethiopia. Alemayehu Mengistu and Associates, Addis Ababa, Ethiopia.
17. Coppock D (1994) The Borana Plateau of Southern Ethiopia: Synthesis of Pastoral Research, Development and Change, 1980-91. ILCA, Addis Ababa.
18. Amaha K (2006) Characterization of rangeland resources and dynamics of the pastoral production system in the Somali region of Eastern Ethiopia. PhD Thesis. University of the Free State, Bloemfontein, South Africa.
19. Gebru G, Desta S, Coppock DL, Gizachew L, Amosha D et al. (2007) Stakeholder alliance Facilitates Re-Introduction of Prescribed Fire on the Borana Plateau of Southern Ethiopia. GL-CRSP research brief 07-02-PARIMA.
20. Abule E, Snyman HA, Smit GN (2005a) Comparisons of pastoralists' perceptions about rangeland resource utilization in the middle Awash valley of Ethiopia. J Environ Manage 75: 21-35.
21. Homann S, Rischkowsky B, Steinbach J (2008) The effect of development interventions on the use of indigenous range management strategies in the Borana lowlands in Ethiopia. Land Degrad Dev 19: 368–387.
22. CSA (Central Statistical Authority) (2007) Report of the 2006 Population and Housing Census. CSA, Addis Ababa, Ethiopia.
23. Haile G, Assen M, Ebro A (2010) Land use/cover dynamics and its implications since the 1960s in the Borana rangelands of Southern Ethiopia. Livest Res Rural Dev.
24. FAO (1993) Land Degradation in Arid, Semi-Arid and Dry Sub-Humid Areas: Rainfed and Irrigated Lands, Rangelands and Woodlands. Inter-Governmental Negotiating Committee for the Preparation of a Convention to Combat Desertification and Drought (INCD). Kenya Nairobi.

25. Ayana A (2007) The Dynamics of Savanna Ecosystems and Management in Borana, Southern Ethiopia. PhD Thesis in Environment and Development Studies Department of International Environment and Development Studies, NORAGRIC, Norwegian University of Life Sciences (UMB).

26. Abule E (2009) Rangeland suitability evaluation for livestock production in Laga-Wata/Laga- Sura, Dawa and rift valley basins of the Borana Zone of Oromia, Southern Ethiopia Pp: 441.

27. Higgins SI, Bond WJ, Trollope WSW (2000) Fire, re-sprouting and variability: a recipe for grass–tree coexistence in savanna. J Ecol 88: 213–229.

28. Assefa E, Bille JC, Corra M (1986) Ecological map of Southern Sidamo. JEPSS (Joint Ethiopian Pastoral System Study). Research report. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

29. Felker P, Flintan, F (2008) Prosopis juliflora control and/ or utilization.

30. AU-IBAR, UNEP (2009) Experiences and Lessons from Livestock-Wildlife-Environment Interface Management in Kenya and Burkina Faso. The Dryland Livestock Wildlife Environment Interface Project. UNEP, Nairobi.

31. Jaap WA (1990) Economic Policies and Rangeland degradation in Botswana. J Int Dev 2: 471-499.

32. Diress T, Stein R, Moe PV, Aynekulu E (2010) Land use/ cover dynamics in northern afar rangelands, Ethiopia. Agric Ecosyst Environ 139:174–180.

33. Abule E, Snyman HA, Smit GN (2007) Rangeland evaluation in the middle Awash valley of Ethiopia: II. Woody vegetation. J Arid Environ 70: 272-292.

34. Belachew K, Tessema T (2015) Assessment of weed flora composition in Parthenium (Parthenium hysterophorus L.) infested area of East Shewa zone, Ethiopia. Malays J Med Biol Res 2: 63-70.

35. Bassett TJ, Zuéli KB (2000) Environmental discourses and the Ivorian Savanna. Ann of the Assoc of Am Geogr 90:67-95.

36. Frank, van L, Claudius ADM, van de V, Lalit K, et al (2003) Effects of fire and herbivory on the stability of savanna ecosystems. Ecol 84:337-350.

37. Blench R, Florian S (1999) Understanding Rangeland Biodiversity. Chameleon Press, London.

38. Bedasa ET, Bikila NG, Samuel TK, Jaldessa DL, (2014) Effect of reseeding of Rhodes Grass on the Restoration of Degraded Rangeland of Borana, Southern Ethiopia. Direct Res J Agric Food Sci 2: 102-106.

39. Abel NOJ, Blaikie PM (1989) Land Degradation, Stocking Rates and Conservation Policies in the Communal Rangelands of Botswana and Zimbabwe. Land Degrad Rehabil 1:101- 123.

40. Belay K, (2004) Resettlement of peasants in Ethiopia. J Rural Dev 27: 223-253.

41. Berisso T (2002) Modernist dreams and human suffering: Villagization among the Guji Oromo. Remapping Ethiopia: socialism and after P: 117-32.

42. Bikila N, Bedasa E, Samuel T, Barecha B, Jaldesa D, et al. (2014) Control of bush encroachment in Borana zone of southern Ethiopia: effects of different control techniques on rangeland vegetation and tick populations Pastoralism: Research, Policy.

43. Bossio D, Erkossa T, Dile Y. McCartney M, Killiches F, et al. (2012) Water implications of foreign direct investment in Ethiopia's agricultural sector. Water Altern 5: 223-242.

44. Ellis JE, Swift DM (1988) Stability of African pastoral ecosystem: alternate paradigms and implications for development. J Range Manage 41: 450–459.

45. Eswaran H, Lal R, Riech PF (2001) Land degradation: an overview. In: E. M. Bridges,

46. Homann S, Rischkowsky B, Steinbach J (2008) The effect of development interventions on the use of indigenous range management strategies in the Borana lowlands in Ethiopia. Land Degrad Dev 19: 368–387.

47. Jackson L, Lopoukhine N, Hillyard D (1995) Commentary ecological restoration: a definition and comments. Restoration Ecol 3: 71-75.