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RANGELAND DEGRADATION AND RESTORATION: A GLOBAL PERSPECTIVE

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Rangelands are lands on which the indigenous vegetation is predominantly grasses, grass-like plants, forbs, or shrubs and are managed as a natural ecosystem. They include grasslands, savannas, shrublands, deserts, tundras, marshes, and meadows. Globally, rangelands comprise the largest land use, estimated to cover about 25 % of Earth's land surface. This makes them an essential resource for both maintaining environmental services like biodiversity conservation and as a source of livelihood, especially for rural communities. Rangelands are used primarily as a source of feed for livestock. They, however, provide other secondary resources such as firewood, wild foods, medicinal plants, and water. Land degradation is the major challenge in the rangelands of the earth. Rangeland degradation is occurring as a result of no grazing management plans, removal of vegetation for fuel wood and no clear authority of rangeland ownership. The major indicators of rangelands degradation are shift in species composition, loss of range biodiversity, reduction in biomass production, less plant cover, low small ruminant productivity, and soil erosion. Major changes in rangeland surface morphology and soil characteristics have a drastic effect on the primary productivity of the rangeland ecosystem, and in turn on livestock production. The condition of the grazing area is influenced principally by herbivore species, densities and landscape structure. Population densities of grazing animals and intensity of their foraging can determine some rangeland dynamics. It determines whether herbivore increases nutrient cycling and plant productivity or affects plant communities by driving changes in successional pathways decreasing nutrient cycling, and influencing biodiversity of those communities. Management of rangeland degradation can be divided into preventative and restoration measures. Answers to preventative measures can often be found within the causes of land degradation. In view of the massive scale of land degradation, restoration is of significant importance to land owners.

Key words: Rangeland, Rangeland degradation, grazing animals, rangeland restoration

ACRONYMS

ACF	Action Contra la' Faim
AFD	Action for Development
ALRMP	Arid Lands Resource Management Project
ASALs	Arid and Semi-Arid Lands
ASE	Agri-Service Ethiopia
CBOs	Community-Based Organizations
CBNRM	Community based natural resource management
CECORE	Centre for Conflict Resolution
CORDAID	Catholic Organization for Relief and Development Aid
DVA	Dairy Development Agency
DPC	District Peace Committee
EAPDA	Ethiopian Agro-Pastoralist Development Association
ECHO	European Commission Humanitarian Aid Office
EPA	Environmental Protection Authority
FBOs	Faith-Based Organizations
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility

GPDI	Gayo Pastoral Development Initiative
HoA	Horn of Africa
IGC	International Grassland Congress
IRC	International Rangeland Congress
IPCC	Intergovernmental Panel on Climate Change
JIRDU	Jigjiga Rangeland Development Unit
LMB	Livestock and Meat Board
LVIA	Lay Volunteers International Association
MC	Mercy Corps
MEAs	Multilateral Environmental Agreements
NGOs	Non-Governmental Organizations
NAPs	National Action Programs
NERDU	Northeastern Rangeland Development Unit
OPA	Oromia Pastoral Association
OPaDC	Oromia Pastoral Areas Development Commission
PADP	Pastoral Areas Development Plan
PCDP	Pastoralist Community Development Project
PREMAP	Pastoralist Resource Management and Advocacy Programme
PWH&E	Pastoralist Women for Health and Education
SC-USA	Save the Children United States
SERP	Southeast Rangelands Project
SORDU	Southern Rangeland Development Unit
TLDP	Third Livestock Development Project
UNEP	United Nations Environmental Program
USAID	United States of Agency for International Development
WVE	World Vision Ethiopia

INTRODUCTION

Rangelands are lands on which the indigenous vegetation is predominantly grasses, grass-like plants, forbs, or shrubs and are managed as a natural ecosystem. They include grasslands, savannas, shrublands, deserts, tundras, marshes, and meadows. Globally, rangelands comprise the largest land use, estimated to cover about 25 % of Earth's land surface (Liebig et al., 2006). This makes them an essential resource for both maintaining environmental services like biodiversity conservation and as a source of livelihood, especially for rural communities (Asner et al., 2004). Rangelands are used primarily as a source of feed for livestock. They, however, provide other secondary resources such as firewood, wild foods, medicinal plants, and water. Land degradation is the major challenge in the rangelands of the earth (Palmer et al., 1997). The major indicators of rangelands degradation are shift in species composition, loss of range biodiversity, reduction in biomass production, less plant cover, low small ruminant productivity, and soil erosion. Rangeland degradation is occurring as a result of no grazing management plans, removal of vegetation for fuel wood and no clear authority of rangeland ownership. The major indicators of rangelands degradation are shift in species composition, loss of range biodiversity, reduction in biomass production, less plant cover, low small ruminant productivity, and soil erosion. Major changes in rangeland surface morphology and soil characteristics have a drastic effect on the primary productivity of the rangeland ecosystem, and in turn on livestock production (Payton et al., 1992). This suggests a need for interventions to halt degradation and improve the functional capacity of rangelands. Understanding of the causes, level, and nature of degradation should precede the intervention. There are a number of factors responsible for degradation; among others are climate, grazing (Arnalds and Barkarson, 2003), soil quality, and landform and its influence on rangeland ecosystem hydrology (Garcia-Aguirre et al., 2007). Degraded ecosystems characterized by low productivity, low diversity or both are often trapped in stable states, showing little or no improvement over time. Restoration can improve their utility. Identification of putative abiotic and biotic barriers to the natural regeneration of more desirable vegetation can lead to the implementation of appropriate restoration treatments (Whisenant, 1999). The potential for ecosystem restoration can be optimized if the functional status of ecosystems is defined beforehand and the relationship between ecosystem structure and functioning can be established (Cortina et al., 2006). In communal areas, community members influence management of rangelands; therefore, there is a need to engage them in the identification of degradation as a problem, vegetation restoration, and proper rangeland management as a solution and identification of a desirable state. Local communities and other stakeholders such as policy makers and researchers must play an important part in the process if sustainable rehabilitation is to be achieved (Everson et al., 2007). Community based natural resource management (CBNRM) is regarded as the best approach to encourage better resource management with the full participation of resource users in decision-making activities and the incorporation of local institutions, customary practices and knowledge systems in the management process (Armitage, 2005).

Kavana et al. (2005) suggest that there should be complementarities of modern scientific knowledge and traditional natural resource management for sustainable livestock productivity, biodiversity, and soil conservation in traditional agricultural systems. A scientific view might promote restoration goals derived from geomorphological and ecological imperatives (Kondolf, 1998). However, restoration is more of a process of modifying the biophysical environment and captures the interaction between scientific definitions and the goals of society as a whole (McDonald et al., 2004).

The international community has long realized the need to protect the global environment and has negotiated numerous agreements over the years in an effort to encourage countries to address problems facing the environment. At the Rio Earth Summit in 1992, the international community reached unprecedented agreements by negotiating and ratifying three global Conventions or Multilateral Environmental Agreements (MEA's) in the field of land degradation/desertification, climate change and biodiversity. These agreements were established in a world that already had a number of agreements regarding environment and natural resources management. However, despite the good intensions of the parties in negotiating the multilateral environmental agreements (MEA's), most if not all of them, especially in the developing world, lack the required capacity to implement such agreements.

This review paper explains the global rangeland degradation and restoration by integrating with MEAs (Multilateral Environmental Agreements. Trends of this particular resource degradation and restoration are also reviewed in Ethiopian cases by showing some agreements and project funds.

OBJECTIVES

The objectives of the study are:

- To explain about the causes of global rangeland degradation
- To see extent of global rangeland degradation
- To show indicators of rangeland degradation
- To highlight the need to ensure the restoration of rangelands at global perspective
- To see its trends and agreements/resolutions in Ethiopia

METHODOLOGY

To accomplish this paper, in-depth literature review is employed using various secondary sources from books, journals, and websites. The required informations are analyzed qualitatively using detail literature citations for each sub topics.

Causes of rangeland degradation

Livestock grazing patterns and location in different seasons within the rangelands

Cattle naturally form a herd when they are grazed in rangelands and the distance between individuals may be influenced by various factors. The spatial pattern formed by a cattle herd is usually aggregated and the area occupied by the herd does not infinitely increase (Shiyomi, 1995). The area occupied reaches equilibrium and attraction activities (desire to be in a group) are balanced in the herd, although the area they occupy is elastic within the grazing land (Shiyomi and Tsuiki, 1999). Animals exhibit certain foraging mechanisms during grazing; these mechanisms were divided into non-cognitive, cognitive, and foraging models based on rules and optimal foraging theory (Bailey et al., 1996). The non-cognitive mechanisms do not require herbivores to use memory during foraging and they require little judgement from animal. These include

(i) Foraging velocity-the rate at which herbivores transit different portions of the landscape could affect aggregate grazing patterns. Slower movement through areas of greater nutrient abundance would ensure that herbivores spend proportionally more time in nutrient-rich areas (Bailey et al., 1996);

(ii) Turning frequency and angles-if animals turn more often during grazing in nutrient-rich patches or feeding sites, their twisting grazing pathway would result in proportionally more time spent in the nutrient-rich area (Bailey et al., 1996).

(iii) Intake rate – there is an indirect relationship between intake rate and forage availability and that can explain the grazing pattern (Forbes, 1988). (iv) Neck angle – Changes in neck angle may provide a stimulus to initiate small-scale movements between feeding stations (Jiang and Hudson, 1993).

(v) Slope-slope gradient is an important determinant of grazing distribution of herbivores (Bailey et al., 1996).Cognitive mechanisms may affect behavior that occurs at small and large scales. Learning and memory affect diet selection and may be important in selecting feeding sites (Bailey et al., 1996). The cognitive mechanisms of animal grazing patterns are based on learning and memory. These include

(i) Learning model of diet selection-thus diets selected by herbivores are affected by post-ingestion feedback from nutrients and toxins (Provenza, 1995).

(ii) Momentary maximization-diet selection is maximized at each moment along the grazing pathway (Senft et al. 1987), momentary maximization assumes that animals select the best available alternative at any given time (Provenza and Cincotta 1993).

(iii) Frequency of patch and feeding site selection -herbivores may return to nutrient-rich productive patches and feeding sites.

Bailey (1995) reported that cattle in a heterogeneous grazing area did not return to a feeding site with lower forage quality for 21 consecutive days and alternated between the remaining two feeding sites with higher quality forage. Rule-based model-grazing mechanisms in some foraging models assume that the search for patches is random while other models use simplistic rules for locating patches and feeding sites within the animals' habitat (Bailey et al., 1996). Suitability, distance from other patches, presence of other animals and the time since the last visit were four rules to direct herbivore movements in a spatially explicit foraging model (Hyman et al., 1991). Optimal foraging theory provides a functional approach for examining grazing behavior, foraging behaviors are heritable, and that a currency (e.g. energy, protein) can be identified to link foraging behavior with fitness (Pyke, 1984). Sustainable use of rangelands for grazing depends on an understanding of how grazing interacts with the underlying environmental variables and ecological processes of these ecosystems (Solomon et al., 2006). Herbivores can influence or regulate forage quality and availability through influence on changes in production, plant species composition, and rates and pathways of nutrient cycling (Person et al., 2003). Grazing can increase palatability of forages by increasing nitrogen content of aboveground biomass or by shifting demographics of plants toward younger and more mitotically active individuals (Ritchie et al., 1998). The condition of the grazing area is influenced principally by herbivore species, densities and landscape structure (Person et al., 2003). Population densities of grazing animals and intensity of their foraging can determine some rangeland dynamics. It determines whether herbivore increases nutrient cycling and plant productivity or affects plant communities by driving changes in successional pathways decreasing nutrient cycling, and influencing biodiversity of those communities (Kieland et al., 1997; Pastor and Cohen, 1997; Olff and Ritchie, 1998; Harrison and Bardgett, 2004). When herbivores exhibit density-dependent reductions in physical condition and fecundity with increasing population size, a corresponding negative effect on the plant community is expected with reductions in plant productivity and nutrient cycling (Stewart et al., 2006). Such effects drive changes in successional pathways or lead to degradation of plant communities (Pastor and Cohen, 1997; Person et al., 2003). Most of the rangelands consist of a mixture of uplands and lowlands. The lowlands are grazed approximately three times more intensely than associated uplands due to easy access by animals (Senft et al., 1985). Because rangelands occur at heterogeneous topography, any activity on rangelands requires a spatial knowledge of soil physico-chemical properties (Corwin and Lesch, 2005). Severe grazing reduces litter cover and increases bare ground portion of land through reduced plant density and vigor; and this in turn reduces plant basal cover and exposes land to soil erosion (Milchunas et al., 1989). Long term grazing can have effects on soil water and nutrient cycling dynamics (McNaughton et al., 1988). Furthermore, long term grazing intensity can alter litter, plant basal and canopy cover characteristics, which can also affect soil water dynamics by altering microclimate and soil temperature (Day and Detling, 1994). Soil moisture, soil temperature, and soil organic matter are believed to be among the most important soil physicochemical properties influencing population dynamics, activity, and ecology of soil microbiota (Varnamkhasti et al., 1995). Overgrazing of rangelands has often been mentioned as one of the major causes of land degradation and desertification (Verburg and van Keulen, 1999). Grazing impacts on watershed properties vary naturally from area to area and over time due to the normal variability of climate, vegetation, intensity, and duration of livestock use (Blackburn, 1983). Many concerns with livestock grazing in arid rangelands are the results of uneven grazing distribution (Bailey, 2004). Typically, cattle graze areas with gentle terrain and near water more heavily than rugged terrain or areas far from water. Physiographically diverse rangelands will have areas of over utilization adjacent to areas with underutilization because the negative interaction between slope and distance to water promotes over concentration of use on areas adjacent to water sources (Pinchak et al., 1991). Livestock affect plant species composition directly by grazing and trampling; although impacts vary with animal density and distribution (Belsky and Blumenthal, 1997).There is an increasing awareness of the importance of grazing and grazing animals in the dynamics of ecological systems. There is also an increasing interest in the role played by large herbivores in shaping and maintaining vegetation formations. The interrelationships between herbivores and vegetation are more complex than many models recognize. They are influenced as much by the behaviour and ecology of the herbivores as by ecological responses of different plant species to trampling or defoliation (Pratt et al., 1986). The main objective of grazing management practices is to achieve an equitable distribution of livestock use among areas and plant communities within a pasture (Pinchak et al., 1991). Grazing-induced degradation often intensifies natural ecosystem change patterns and may largely include simple radial effects (Pickup, 1998). While grazing has been reported to be one of the factors causing degradation, especially species change, species loss has also been observed to occur in rangeland areas where there has never been domestic animals grazing (Curry and Hacker, 1990). This makes it difficult to separate the impact of natural declining land condition and biodiversity from that of introduced herbivory (Pickup, 1998). Livestock reduce plant cover, compact the soil and this in turn increase the volume of overland water flow (Blasky and Blumenthal, 1997). Animal grazing density and intensity is influenced by drinking water distribution within rangelands. Animals spend most of the grazing time around drinking points and that subjects the grazing areas adjacent to water points to severe grazing and subsequently to soil erosion. Van Rooyen et al. (1994), and Friedel (1997), suggested that the reasons for vegetation change along a distance gradient from livestock watering points, and in relation to land use are complex and dependent on the interaction of rainfall, landscape characteristics, and grazing. The effects of herbivore grazing pressure on plant species distribution patterns in the broader landscape are distinct from those affecting the environment of the heavily trampled sacrifice area immediately around a water-point (Friedel et al., 2003). Large mammalian herbivore density declines with increasing distance to drinking points. Water-points provide a focus for niche separation amongst grazing herbivores when forage is limited in quantity and quality (Fensham and Fairfax, 2008). Animal species vary with water dependency, browsing, and highly mobile animal species are the least dependent on water (Smit et al., 2007).

Climate Change: Impacts, And Vulnerability On Rangeland Degradation

Major effects of climate change on rangelands could be on vegetation biodiversity, land degradation, and water dynamics. Climate change and biodiversity loss are global problems, their causes are complex, frequently local and vary from one part of the world to another (Pickup, 1998). Climate change and climate variability have affected, and are projected to continue to affect, individuals, populations, species and ecosystem composition and function (Gitay, 2004). Climate change affects land degradation through changes in vegetation, soils, and the hydrological cycle. As the rangelands are affected by climate change, vegetation properties, soil properties, and rangeland water dynamics will change. That will lead to the farming and grazing systems, particularly in the arid, semi-arid, and sub-humid areas being altered as a response to higher rainfall variability, and to changes in the frequency and intensity of droughts and floods (Gitay, 2004).Multiple environmental changes will have positive or negative consequences for global vegetation. The consequences will vary in different areas, thus some areas will benefit from an increased rainfall while other areas suffer. This will affect crop and pasture yields and forest productivity (Reilly et al., 2007). It is further expected to bring about major change in freshwater availability, the productive capacity of soils, and in patterns of human settlement (Raleigh and Urdal, 2007). As the impacts of climate change intensify, this may have substantial impacts on rangeland ecosystems, agricultural crops, water resources, and in turn affect human health and livelihood (Lioubimtseva and Henebry, 2009). Increasing temperatures, precipitation anomalities, and extreme weather are expected to aggravate the processes of resource degradation that are already underway (Homer-Dixon and Blitt, 1998).

Meier et al. (2007) reported that decreased vegetation is associated with growth of pastoral conflict in the Horn of Africa. It is important to consider the potential impact of changing climates, especially with respect to rainfall distribution and quantity (Meadows and Hoffman, 2003). Although degradation is the result of interaction between natural and social dynamics, it is closely, but differently related to the spatial pattern of human activities (van der Leeuw and Archaeomedes Research Team, 2005). Climate change is likely to influence food-producing capacity in many areas. Thus, some areas may experience a reduction in production while other places are likely to benefit (Raleigh and Urdal, 2007).An increase in temperature of a few degrees is projected to increase crop yield in temperate areas. However, in tropical areas, where dry land agriculture dominates, even a minimal increase in temperature may be detrimental to food production (IPCC, 2001). Climate change affects land degradation through changes in vegetation and soils, and through changes to the hydrological cycle. Degradation of soil and water resources is likely to be intensified by adverse changes in temperature and precipitation, although adaptive behavior has the potential to mitigate these impacts as land use and management have been shown to have greater impact on soil conditions than the indirect effect of climate change (IPCC 2001; Raleigh and Urdal, 2007).Higher water temperatures are likely to lead to a degradation of water quality; however, non-climatic factors may influence freshwater availability and quality to a larger degree than climate change. Thus, water management may significantly reduce vulnerability (IPCC, 2001). Climate change also alters farming and grazing systems as a response to higher rainfall variability and to the shortening of fallow periods. Climate change presents multiple stresses to the rangeland ecosystems; these include low temperatures, high wind speeds, short growing seasons, low nutrient availability, and soil moisture. These may limit plant growth and primary production in rangelands (Walker et al., 1994).

Rainfall variability and uncertainty surrounding its annual reliability have prompted dry land communities to adapt to dynamic climatic, environmental, and weather conditions throughout history (Stringer et al., 2009). However, the speed of current climate change is feared to exceed the limits of adaptation in many parts of the world (Adger and Vincent, 2005). The African continent has low adaptive capacity and it is sensitive to many of the projected changes and therefore, highlighted as particularly vulnerable in the future (IPCC, 2007). Vulnerability of the African continent to land degradation due to the rapid climate change will be more emphasized in rangelands. A combination of rainfall and geomorphological factors coupled with the historical and political circumstances is likely to render the rangelands more susceptible to future intensification of the land degradation problem especially under the rapidly changing climatic conditions predicted under most global warming scenarios (Meadows and Hoffman, 2003).

The Extent Of Rangeland Degradation

The sustainable use of rangelands depends on the understanding of the extent of the rangelands deterioration, and how can these grazing areas be restored (Solomon et al., 2006). Most of the people working in rangeland areas have underestimated the degradation problems (Meadows and Hoffman, 2003). The biophysical and climatic environment appears crucial for any model of land degradation (Hoffman and Todd, 2000). Rangeland degradation is not a spatially uniform process; there are substantial off-site effects. Some landscapes are more prone to degradation than others because they have erodible soils and palatable species, which attract more grazing activity or both (Pickup, 1998). Land degradation has affected two billion hectares (22.5%) of world agricultural land, rangeland, forest, and woodland (Al Dousari et al., 2000). Severe degradation is blamed for the disappearance of about 5-10 million ha of agricultural land annually at global level. Dry land areas are environmentally fragile, and thus especially susceptible to degradation (Gao and Liu, 2010). The extent of rangeland degradation varies with the management history of the farming areas. Furthermore, the magnitude of rangeland degradation varies with land ownership and management. Thus, if soil and rangeland degradation are the main assessment criteria, largely communally farmed areas are perceived to be significantly more degraded than commercial areas. However, while there is the identification of a structural, socio-political foundation to the land degradation problem; the role of physical environmental factors on degradation should not be underestimated (Hoffman and Todd, 2000) Rural areas dominated by rangelands are subject to higher levels of land degradation susceptibility because they are Characterized by higher rainfall and steeper slopes (Meadows and Hoffman, 2003).

Dahlberg (2000) highlighted that the extent varies with different areas being affected by a number of biophysical and socio-economic factors. Land degradation affects primary productivity of rangelands and in turn affects ecosystem's biological and economic function. While there are general concerns about the impact of land degradation, especially with regard to ecosystem structure and function.

RANGELAND DEGRADATION INDICATORS

Rangeland Vegetation Condition

The composition of the plant communities will shift over time in response to different grazing intensities (Tainton, 1999). Certain plant species characterize different successional stages during grassland retrogression and they can be used as indicators of rangeland condition (Malan and Van Niekerk, 2005). High intensity grazing leads to excessive removal of the most palatable species, which are usually perennial grasses (Todd and Hoffman, 1999; Anderson and Hoffman, 2006). This opens the way for less palatable and faster establishing annual grasses and forbs to take hold. Constant diminishing of the highly desirable species can result in rangeland deterioration (Malan and Van Niekerk, 2005). On the other hand, heavy grazing depletes foliage of the palatable species, which results in reduced plant strength. Single animal species grazing systems can have dramatic, negative effects on vegetation Composition due to selective grazing (Morris and Kotze, 2006). Different animal species have different preferences for grazing material; this preference could be on plant species, plant parts, and on grazing location within the rangeland. Cattle prefer tall grass and their grazing behavior has a limited degree of selection, however, in the presence of many species; cattle will select certain species over others for grazing. Sheep prefer shorter grass and there is a higher degree of selection on softer plant parts with higher level of nutrition. Goats aregenerally browsers and they select softer leaves and twigs of the trees. The animals have some level of grazing and/or browsing selectivity, the most common in rangeland utilization is species and area selection. Because of area and/or species selective grazing, certain parts of the grazing area and some species will be utilized more than others. That will exert more grazing pressure on the preferred areas and species while others are not utilized. Vegetation species composition and cover vary between different vegetation types (O'Farrell et al., 2007).

The nutritive value of range forage is dependent among other factors on species composition, soil fertility, and physiological stages of grasses. Annual grasses and forbs are seldom considered as favorably as their perennial counterparts are (Arzani et al., 2006). Species and chemical composition of feed and season of growth affect digestibility of grasses. Grass species vary with feed chemical composition, thus some grasses have higher fiber content, and that renders them less digestible than species with less fiber content. The fiber content of grass species varies with their stages of growth; the younger fresh grass has less fiber and that makes it more digestible than mature grass (Dohme et al., 2006). Acceptable grasses lose their life because of repeated removal of leaves and constant draining of their nutrient reserves (Malan and Van Niekerk, 2005). When a plant is unable to replenish the stored resources, it will fail to produce new leaves and will eventually have reduced photosynthetic power (Morris and Kotze, 2006). As the desirable plants become weaker and die off, the number of roots in the upper layer of the soil decreases. Defoliation removes plant biomass, which changes the light regime in a plant stand (Tomlinson and O'Connor 2005) and this result in low photosynthetic rate of plants, which in turn reduces rangeland productivity. The bare areas between grasses become larger as the grass species are exhausted, causing a decline in the effective use of rainfall in the area. These are ideal conditions for woody plant establishment (Stuart and Tainton, 1989). According to Tainton (1996), environmental conditions play a role in changes in grass species composition. Perennial grasses produce more foliage than annual grass and thus provide more of forage yield than annuals (Peden, 2005). Perennial grasses have extensive root systems and protect the soil from erosion more effectively than annual species. The dominance of perennial grass species locally indicates that the rangeland has good protection against soil erosion (Morris and Kotze, 2006). When annual grasses die, the ground remains bare for a long time becoming susceptible to erosion (Malan and Van Niekerk, 2005). The excessive removal of perennial grass species reduces ground cover (Eccard et al., 2000). The stage of rangeland deterioration in grassland is characterized by increased rates of runoff (Svejcar et al., 1999). Water inputs may be intercepted by plants, infiltrate the soil, or runoff the surface depending on, among other factors, soil characteristics, topography and vegetation cover (Morris and Kotze, 2006). The most important single factor affecting water run-off is the amount and type of vegetative cover (Malan and Van Niekerk, 2005). Soil cover provided by vegetation to soil may be in aerial terms. The leaves provide the aerial cover and stems of the plants. The run-off rate depends on the spread of leaves and stems; it reduces raindrop impact on the soil, which normally causes soil particle detachment. Herbaceous plants provide more soil protection against raindrop impact and run-off than non-herbaceous ones (Tainton, 1999). This is because grasses provide a complex network of roots immediately below the ground surface, which hold the soil particles together unlike deep-rooted trees. Stands of perennial species are more stable than stands of annual species; and provide stable soil cover. (Fahnestock and Detling, 2000).

RANGELAND SOIL QUALITY

Soil organic matter has been identified as an indicator of soil fertility based on the rationale that it contributes significantly to soil physical, chemical, and biological properties that affect vital ecosystem processes of rangelands (Hopmans et al., 2005). Soil aggregate stability is widely recognized as a key indicator of soil and rangeland health (Herrick et al., 2001). It is related to a number of ecosystem properties, processes, and functions, including the quantity and composition of organic matter, soil biotic activity, infiltration capacity, and resistance to erosion. Soil aggregation has potential benefits on soil moisture status, nutrient dynamics, slope maintenance, and erosion reduction (Sainju, 2006). The amount of organic matter increases after the decomposition of litter and dead roots. Stable aggregates result from this process because soil biota produces material that binds particles together (Shrestha et al., 2007). Changes in aggregate stability may serve as early indicators of recovery or degradation of ecosystems (Amezketa, 1999). Soil aggregate stability indicates the ability of the soil to be detached by light rainfall (slow wetting), heavy rainfall (fast wetting) and mechanical disaggregation. Soil aggregate stability is one of the main factors controlling top soil hydrology, crustability, and erodibility (Caravaca et al., 2002). Stability of soil aggregates and pores between them affect the movement and storage of water, aeration, and soil erosion (Amezketa, 1999).Disturbance of the soil surface by grazing animals has both beneficial and detrimental effects on aggregate stability. It incorporates litter and standing dead vegetation into the soil, increasing the content of organic matter. However, it also breaks the soil apart, exposing the organic matter glues to degradation and loss by erosion (Caravaca et al., 2002). Heavy grazing that significantly reduces plant production disturbs the formation of aggregates by reducing the inputs of organic matter. Grazing is more likely to increase aggregate stability in areas where an unusually large amount of standing dead material is on the soil surface and the risk of erosion is not increased by removal of plant material and disturbance of the soil surface (Shrestha et al., 2007).The soil under rangeland management contains a high level of organic carbon and almost all organic constituents (Lu et al., 1998). The soil carbon balance is maintained by plant litter inputs, which enter the soil as particulate organic carbon. Rangeland sustainability is related to soil carbon and nutrient balance and the capability to maintain adequate soil conditions for water availability and root development (Noellemeyer et al., 2006). Soil under shade such as tree canopy, accumulates more soil organic carbon due to the influence of the tree canopy on the soil temperature regime. The different carbon dynamics are the result of a high proportion of woody debris under shade and different removal rates of aboveground biomass by grazing in the open communities (Simion et al., 2003).Changes in soil carbon can occur in response to a wide range of management and environmental factors. Rotational grazing management provides enough time between occupation periods and in turn stimulates growth of herbaceous species and improves nutrient cycling in grassland ecosystems. Disturbance of rangelands has a negative impact on soil structural properties and water holding capacity, which are related to losses of soil organic carbon pools. Deterioration of soil structural properties decreases soil infiltration and water holding capacity; and accelerates soil erosion. Soil texture is a fundamental property which largely determines the water balance and the potential biomass carbon production and in turn carbon input and stabilization. Soil moisture availability is determined by soil texture, which can influence the composition of the plant community (Scholes and Archer, 1997). Soil texture also has a strong effect on biomass production and soil organic carbon in rangeland soils. Standing biomass is lower in soils dominated by sand and not different in silt and clay dominated soils. Plant cover change and removal of biomass can decrease organic matter in soil, reduce important soil physical parameters, and, consequently, increase soil erosion. Soils that are dominated by sand are highly limited in nutrient and water holding capacity. The large proportion of gravel and stones in the soil due to limited root growth reduce soil productivity (Salako et al., 2006).

RANGELAND RESTORATION

The Role Of Management In Rangeland Restoration

Natural ecosystems have been severely destroyed because of anthropogenic disturbances, unreasonable utilization, and neglect of protection and restoration (Hai et al., 2007). These disturbed or degraded ecosystems are confronted with poor soil fertility, shortage of water and deteriorated microenvironment, which would severely restrict their productivity. How to comprehensively restore and harness the degraded ecosystem is a key issue in increasing productivity, improving environmental conditions and achieving sustainable development. When the disturbance is removed, the degraded ecosystems will initiate a succession to the primitive community, and restoration process is considered as the progressive succession (Peng, 2003).

Management of rangeland degradation can be divided into preventative and restoration measures. Answers to preventative measures can often be found within the causes of land degradation. In view of the massive scale of land degradation, restoration is of significant importance to land owners. The fast rate at which intact natural ecosystems are degraded and decline, has emphasized the importance of ecological restoration to maintain the earth's natural capital (Young, 2000). In order to restore degraded ecosystems, it is crucial to identify which ecosystem functions should be restored first. It is therefore, important to define the functional status of the ecosystem beforehand. It is also important to establish the relationship between ecosystem structure and functioning, and to assess the potential for ecosystem restoration (Cortina et al., 2006).

The Role Of Vegetation In Restoration Of Degraded Rangelands

Vegetation plays an important role in erosion control; it efficiently mitigates erosion by active and passive protection (Rey et al., 2004). Active protection against erosive agents consists of raindrop interception (Woo et al., 1997), and increase in water infiltration in soil, thermal regulation and soil fixation by root systems (Gyssels and Poesen 2003). Vegetation also has a passive action by trapping and retaining sediments inside the catchment due to its aerial parts (Abu-Zreig, 2001).A protective soil cover can be installed efficiently on eroded lands using bioengineering works based on common practices of ecological engineering. These structures favor artificial and natural vegetation dynamics so the vegetation predominates over erosive dynamics and controls it. The long-term goal of the degradation interventions is to restore ecosystems, in accordance with recent considerations about ecological engineering concepts and techniques (Gattie et al., 2003). Restoration is commonly considered as accelerated succession (Hilderbrand et al., 2005).

Planting vegetation as a restoration measure for degraded rangelands is preferred over structural measures since concrete, stonework, wood or any other building materials are subject to decay and liable to be avoided (Sarangi et al., 2004). Vegetation grows through different stages while it is improving the function of the ecosystem by providing physical soil protection against erosion by reducing the velocity of runoff and its decomposition contributes to nutrient cycling (Schwab et al., 1993).

Rangeland Restoration Techniques

In rangelands that have become degraded to the point that ecosystem functions cannot recover solely through-improved management strategies within practice-relevant time spans, active rehabilitation techniques are sought (Dregne, 2002). Most of these techniques aim at the improvement of soil water status by increasing infiltration or decreasing evaporative loss (Thurow, 2000). These restoration techniques include introducing transplants, application of brush packs or organic mulch and developing micro catchments to capture runoff (Anderson et al., 2004).

Revegetation and improvement of degraded land should be practiced after development of better techniques of seedbed preparation and planting methods (Gebremeskel and Pieterse, 2008). Seed germination and establishment of natural and artificial revegetation is a result of the number of seeds favorable in microsites or 'safe sites' in the seedbed rather than the total number of available seeds (Harper et al., 1965). Various techniques to improve microsites for sown seeds and to increase the seed germination rate and establishment have been introduced in the rangeland revegetation process (Gebremeskel and Pieterse, 2008). Some methods used for rangeland restoration consist of biological and mechanical approaches. The biological approach includes planting methods of seeds using manure, gravel, and grass. The mechanical approach includes use of farm implements to disturb the soil (van der Merwe, 1997). The use of organic mulch to improve establishment of over sown grass seeds in degraded rangelands has been emphasised (Ricket, 1970).The objective of the various methods of vegetation restoration among others is to create favorable microsites to enable seeds to germinate and establish more successfully (Gebremeskel and Pieterse, 2008). These revegetation techniques are normally practiced when insufficient desirable forage plants have remained on the rangelands and when sound rangeland management practices cannot restore it to its original grazing potential. Natural revegetation of perennial grasses is slow in many areas and therefore, species adapted to sowing are often desirable (Vallentine, 1989). Land use is governed by economics, technology, social issues, and environmental considerations, and is influenced by state, national, and international policies. However, the outcome is largely determined by the ways in which land managers respond to the policies (Teague, 1996). Management of rangeland ecosystems must be based on ecological theory; rangeland management planning should focus on developing an understanding of basic ecological processes, and answering specific ecological questions related to management problems (Walker et al., 1978).

Teague (1996) highlighted that the challenge is to understand how management influences ecosystem structure and function; and what management adjustments are required to achieve desired results of rangeland management. In coming up with the relevant rangeland management practices, the definitions of the rangeland problems and priorities have to be provided in consideration of the three spheres: objectives, research priorities, and extension roles.

Rangelands are a relevant renewable resource and the primary land type in the world. There are many important ecological functions such as nutrient cycling, decomposition of organic matter and infiltration performed by rangelands. Furthermore, a variety of goods and services including red meat, fiber, recreation, and wildlife viewing are provided by rangelands. Although range managers have attempted to provide a sustainable rangeland management, they have little control over stochastic environmental events such as drought and fire (Batabyal, 2004).

Batabyal (2002) further indicated that a range manager is unable to definitively determine the impacts of their actions on the condition of a rangeland. This is therefore, indicative of the fact that effective rangeland management is fundamentally an exercise in decision making under uncertainty. The question in providing a solution to rangeland degradation is driven from a point of view that overgrazing is the cause of rangeland degradation. Furthermore, the question would be, does over grazing depend on the number of animals or the time that the plants are exposed to herbivory or both? With regard to this uncertainty, Savory and Butterfield (1999) have argued that overgrazing bears little relationship to the number of animals but rather to the time that plants are exposed to the animals. According to Trollope et al. (1990), overgrazing is defined as excessive defoliation of the grass sward by animals to the detriment of the condition of the rangeland. Excessive defoliation could be due to both higher animal densities and a longer period of utilization of rangelands. In the same vein, Nelson (1997) has maintained that it is risky to oversimplify and argue merely that too many animals pursuing a limited grazing resource are destroying the dry land areas of the world. To understand what is occurring in rangeland production-based systems, it is valuable to contextualize current land management practices in terms of their production patterns (Richards and Lawrence, 2009).

Trends Of Rangeland Degradation And Restoration In Ethiopia

In Ethiopia, rangelands cover about 61 to 65% of the total area of the country and are characterized by arid and semi-arid agro-ecologies; experience a relatively harsh climate with low, unreliable, and erratic rainfall, and are home to 12%-15% of the human population, and 26% of the total livestock population. Pastoralism and agro-pastoralism are the dominant types of land use systems in these areas (PADP, 2004).

Some parts of Ethiopia have been experiencing heightened fragmentation of the rangelands since the 1970s. In particular the development of government and commercial irrigated schemes in the Awash River Basin to a total of approximately 68,000 hectares in 2011 (with another 90,000 hectares or so in construction) has caused significant ill effects on pastoral systems. Not only have key resources been removed but water sources have been polluted. In Somali region and Borana zone, there have been water/rangeland development schemes that have compromised pastoralism and opened up areas to in-migration of settlers (Flintan et al., 2011).

'New' challenges such as the invasion of Prosopis juliflora and other plants or shrubs have also had a significant impact: in Afar region alone it is possible that over 1 million hectares are now invaded by Prosopis. As access to land has become increasingly competitive, the fencing of remaining areas as private enclosures has grown and land/cropping arrangements have developed -often insecure in nature. The privatization of rangeland resources has occurred in many parts (Flintan and Cullis, 2010).

In 2009 the Government of Ethiopia launched plans for agricultural investment areas in several regions of the country to a total of 3.7 million hectares. Land already identified and secured in the government 'land bank' (or already allocated to investors) includes 409,678 hectares in the Awash River Basin, 180,625 hectares in South Omo, 444,150 hectares in Gambella and 691,984 hectares in Beni2gul-Gumuz. The evidence to date suggests that much of this will be in pastoral areas along rivers, and unless appropriate measures are taken risk, this will risk the restriction of access to (or the complete removal of) key-site grazing areas and water sources (Flintan, 2011a). The experiences of investments already underway suggest that the needs of pastoralists and other rangeland users may not be taken into account within the establishment and development of these schemes unless appropriate measures are taken. Future threats to pastoral livelihoods come from the development of oil and mineral extractions and large water development schemes, including the building of dams and the establishment of linked irrigated-agricultural schemes for commercial investors and sedentarised communities (including ex-pastoralists). Fortunately, there is a growing awareness of the value of pastoralism as an effective livestock production system and its current and potential contribution to national and regional economies. Pastoralists have been able to increase their voice in decision-making processes at all levels and such as marketing facilities have improved (Behnke and Kerven, 2011). The establishment of land policies and legislation by regional governments are hoped to offer opportunities for addressing many of the insecurities that pastoralists face and the securing of rangeland resources for them. In addition, the importance of planning across a rangeland rather than basing decisions on one or two key resources is being recognized. It remains to be seen to what degree government and communities can for example work with commercial investors to ensure that measures are taken to protect pastoral resources as well as take forward agricultural development (Flintan and Cullis, 2010).

The negative impacts of rangeland fragmentation including loss of grazing areas and restrictions on mobility were documented as early as the 1970s (Kloos, 1982): removal of Afar lands for large-scale agriculture and restrictions on their mobility had a direct result on their inability to deal with the drought experienced during that period where as many as 200,000 people died and three quarters of all livestock were lost. Yet, fragmentation of the rangelands continues (Behnke and Kerven, 2011).

The following project cases illustrate the various efforts tried over the last half century.

1. In 1964 USAID, the African Development Bank and the World Bank funded a project that helped establish a national authoritative body, known as the Livestock and Meat Board (LMB) to coordinate different livestock activities (livestock production, processing and marketing). The first project addressed was dairy development and was called the Dairy Development Agency (DVA).

2. The second project, initiated in 1973, focused on increasing off-take by developing markets, the stock route system, and establishing slaughter facilities in major towns and cities.

3. The Third Livestock Development Project (TLDP), launched in 1976, was the first large-scale pastoralist development intervention in Ethiopia. It was aimed at developing and rehabilitating three lowland areas: the Southern Rangeland Development Unit (SORDU), the Northeastern Rangeland Development Unit (NERDU), and the eastern area known as the Jigjiga Rangeland Development Unit (JIRDU).

4. The fourth Livestock Development project attempted to organize service cooperatives as an entry to a participatory approach. The programme was incorporated in the Southern Rangeland Development Unit (SORDU) and focused on a partnership with Borana social organizations by reorganizing the Borana traditional institutions into service cooperatives. The pilot programme was started in 1988 and ended in 1993.

5. The Southeast or Southeast Rangelands Project (SERP) was initiated in Somali region. The project began in 1990 and was based on the experience and lessons of various pilot projects. It adapted an integrated approach, which combined community based participatory extension and institutional development, land use and range management, animal production and health, livestock marketing and infrastructure development. These projects did not yield the desired results for a number of reasons.

- Too much emphasis was placed on the technical and technological aspects of the projects while neglecting the socio-cultural and ecological aspects of pastoral production systems.
- The projects did not integrate local participation and knowledge into their design.
- Little attention was paid to other "soft components" like institutional development and capacity building.

The failure of earlier projects has inspired a new approach. Based on lessons learned, the Pastoral Unit of the Ministry of Agriculture (MoA) drafted a pastoral and agro-pastoral extension strategy in 1999, which aimed to:

- Improve livestock quality by improving water points, forage production and breeds, expanding animal health services and developing market infrastructure.
- Integrate crop production and other agricultural activities where feasible side by side with livestock production through the introduction of small-scale irrigation.
- Provide appropriate infrastructure and social services including small-scale irrigation and drinking water.
- Tailor research and extension programs to the needs of dryland agriculture and livestock development.
- Put in place regulatory and quality assurance measures.

Under the new delivery system, institutions were established at various levels. The three most important for our purposes are the Kebele Extension Team, Community Development Teams, and Community Animal Health Workers (CAHWs).

Trends Of Conflict Resolution And Agreements Towards Rangelands In Ethiopia

Various efforts have been made to find lasting solutions to the conflicts in Ethiopia. During the time of the Emperor, a Tribal Convention was adopted to control grazing rights, and provide for the sharing of the rangelands between the Borana and neighboring communities. The Derg for its part used the threat of death penalty to maintain relative peace between the communities in Borana (Oba, 1998).The current government has taken various measures that include establishment of local level administrative frameworks mandated to resolve inter-ethnic conflict, and decentralization policy to empower citizens and devolve decision making. Although these efforts have resolved some problems, many conflicts still persist in Borana Zone and other places, most of them involving pastoral communities. Other efforts worthy of note include the Dukana/Makona community led cross border peace initiative that brought peace between the Borana and the Gabra in June 2006 and created stability along the Ethiopia/Kenya border, which has lasted for many years. The Halona Declaration has been widely adopted and applied in the wider Borana and its surroundings to resolve intermittent conflict among ethnic groups in the area. The Negelle Borana Peace Conventions were developed by representatives of ethnic groups residing in three pastoralist Zones of Borana, Guji and Liben of Somali and Oromia Region, with the active participation of representatives of Regional and the Federal government (Amsalu, 2010). Major actors involved in conflict resolution include government, Non-Government Organizations (NGOs), Community-Based Organizations (CBOs), Faith-Based Organizations (FBOs), and traditional institutions. They undertake peace building and conflict transformation interventions to enhance cooperation and peace dialogue among different conflicting ethnic groups in the Borana area (Abate, 2010). These institutions include; Action for Development (AFD), Action Contra la' Faim (ACF), Agri-Service Ethiopia (ASE), Catholic Organization for Relief and Development Aid (CORDAID), Ethiopian Agro-Pastoralist Development Association (EAPDA), European Commission Humanitarian Aid Office (ECHO), Food and Agriculture Organization of the United Nations (FAO), Gayo Pastoral Development Initiative (GPDI), Lay Volunteers International Association (LVIA), Mercy Corps (MC), Oromia Pastoral Association (OPA), Pastoralist Community Development Project (PCDP), and Save the Children United States (SC-USA) United States Agency for International Development (USAID), World Vision Ethiopia (WVE), and Oromia Pastoral Areas Development Commission (OPaDC). They provided training on participatory conflict prevention resolution and management, civic education and fostering exchange visits for local peace actors to learn from counterparts elsewhere in the country (PADP, 2004).

The interventions for conflict resolution and peace building are based on both traditional and modern approaches. It is however acknowledged that traditional mechanisms are the most appropriate in dealing with the root causes of conflict and establishing sustainable peace. Experience has shown that peace agreements founded on traditional systems and mediated by traditional institutions are the ones that have the most legitimacy and the highest chances of success. A number of challenges continue to undermine these efforts at conflict management and peace building, resulting in their failure to prevent reoccurrence of violent conflict and ensure sustainable peace and stability in the area. Interventions often focus on achieving temporarily cessation of hostility without addressing the underlying causes of conflict.

As a result, such interventions are no more than firefighting actions. They fail to establish mechanisms for monitoring and follow up. They also decried the absence appropriate permanent institutional frameworks for coordination of peace efforts to ensure harmony among peace actors to avoid duplications of efforts and pool resources for a process-oriented, integrated, and comprehensive intervention backed by well-established community based monitoring and evaluation mechanisms.

The following table shows rangeland projects with operational period, area, donors, and activities targeted which lasted nearly for 40 years.

Table 1 Rangeland/Pastoralism Projects in Ethiopia (1965-2013)

Project	Operational period	Operational area	Donors gov't agencies	Activities
Pilot Rangeland Development Project	1965-1970	Afar and Borana Plateau	USAID and Range Develop ment Unit,	Pond construction to relieve grazing pressure, range management
TLDP – Third livestock Development Project	1975-1987, Extended into early 1990s	Somali Region, Afar, Borana Plateau	World Bank and MoA	Water development, roads, animal fattening, ranch development, range management
JEPSS – Joint Ethiopian Pastoral Systems Study	1982-1985	Afar and Borana pastoral systems	TLDP and ILCA	Research on lowland development strategies and range management
SSRP – Southern Sidamo Rangelands Project	1985-1988	Southern rangelands	CARE-Ethiopia, MoA, Relief and Rehabilitation Commission, ILCA	Extension and research on pastoral development interventions
FLDP – Forth Livestock Development Project, Pilot Project	1988-1990	Southern Rangelands		Institution building and extension

Continuation of Table 1

SERP – South-east Rangelands Project	1990-2001	Southern rangelands	ADF	Infrastructure and institutional development, service co-ops
STI – Southern Tier Initiative	2001-2007	Borana Zone, Liben zones, Somali Reg.	USAID - MoARD	Health, education, improve pastoral incomes and dispute resolution
FOCUS – Focus on Newly Emerging Regions				Animal health, education, conflict mitigation and food security
PLI – Pastoralist Livelihood Initiative	2005-2008	Somali, Afar and Oromiya Regions	USAID-MoARD	Animal health, livestock marketing, drought cycle management, rangeland management, Water rehabilitation
RELPA – Regional Enhanced Livelihoods for Pastoral Regions	2007-2009	Ethiopia and Kenya	USAID-MoARD	Conflict mitigation, regional cross-border Cooperation, pastoral livelihoods
PCDP	2003-2008	Selected woredas- Afar, Somali , Oromiya	MoFA – World Bank	Decentralization, early warning, capacity building
PCDP II	2008-2013	Selected woredas- Afar, Somali and Oromiya Regions	MoFA – World Bank	Community education, risk management and livelihood enhancement
Pastoralists Communication Initiative	2006-2009	Horn of Africa	DFID, UN OCHA, MoFA	Advocacy and research

Source: PADP (Pastoral Areas Development Plan) (2004)

CONCLUSION

Rangelands play an important role in the global environmental issues of today and they are equally as deserving of international attention as rain forests. They are a major sink of carbon, which can be increased by reversing degradation and improving the production capacity, reducing the need for so many animals, at the same time reducing the methane emission per animal and increasing the livelihood chances of people in developing countries. Many of the important products and services that humans extract from rangeland ecosystems are linked to attributes at the watershed and regional scales. Fragmentation of rangeland habitats by changes in land use and management are a threat to many species and ecological processes. Rangeland degradation is the reduction in or loss of productivity and the ability to produce sustainable activities pertinent to the system of land use. An area is considered effectively degraded if the loss of production is beyond the bounds of resilience. Rangeland degradation is a phenomenon occurring mainly in arid, semiarid, and humid areas of the world. The causes of land degradation are many: the abuse of the environment through ignorance, injudicious management practices, climatic variability, as well as political, industrial and historical issues. Rangeland degradation starts with the formation of smaller areas of bare patches, which expand or join to form large, bare, and denuded areas in the long term. Owing to worldwide interest in nature, land restoration on degraded rangeland is becoming an increasingly popular topic for scientists, land managers and land users, especially in arid and semi-arid regions. This is due to the deteriorating condition of the environment, which leads to a loss in food security and to poverty and economic losses, especially in rural, communally managed and underdeveloped areas of the world.
The potential of rangeland improvement by natural or artificial re-vegetation depends upon the kinds and amounts of vegetation remaining, climatic conditions, the feasibility of using grazing management practices or range improvement practices to accelerate successional processes, the expected recovery rate and the cost of alternative approaches. These restoration procedures include active (browsing, burning, clearing, reseeding and cultivation) and passive methods (withdrawal of livestock/game). Natural re-vegetation implies improved management, particularly of grazing, to restore vigor and accelerate the spread of the remaining desirable plants. Although vegetation responses to improved management vary from site to site, a minimum of 15% of desirable perennial species in the vegetal cover is often used as an index to indicate the potential for successful natural improvement on semi-arid rangelands.Now there is no exit option for the governments since the complex and highly interdependent ecological challenges binds all nations and creates a new level of dependence among nation States. In seeking long-lasting solutions to the complex global environmental problems, the instrument of MEAs have proved an important mechanism by which States promise to each other to manage natural resources and protect the global environment. International legal instruments became central components of these sustained global efforts to save the humanity from environmental crises. By and large, the MEAs have grown from bilateral local regimes to multilateral global system. Similarly, over the years, the design of these agreements changed from a linear fashion to a multifaceted way.

RECOMMENDATIONS

Based on the findings in this review paper, the following recommendations are forwarded.

National governments should adopt policies for the conserved use of rangelands and where possible of rangeland improvement consisting of extension and aid programs, supported by the local community, with the help of international multilateral agreements and development programs.
Management flexibility should be a goal at all levels from individual ranch/allotment to multi-agency. The ability to detect changes and respond quickly offers the most promise for managing rangelands successfully in the face of global vulnerability. Decision-making and implementation at all levels should focus on developing a system that identifies the effects of rangeland degradation in the very early stages and implementing management responses.

Rangeland scientists and managers should collaborate to develop monitoring systems that track and predict how changes in land use and cover affect ecosystem function across spatial scales on rangelands.
There should be an increased research and development emphasis on managing rangelands to produce sustainable alternative products and ecosystem services. Sustainability in the face of global change will require quantitative knowledge of ecological thresholds, indicators of change and key decision points in the framework of comprehensive monitoring systems. Forward-thinking, manipulative field research provides a solid foundation for making predictions about the response of ecosystems to global change within the context of contemporary rangeland management.
There should be strong links among researchers, managers, and local land users to improve science, management, and rangeland ecosystems.

An integrated land use plan should be devised. This should cover all land uses from settlement and farmlands to communal rangelands and wildlife parks. It should include mechanisms to minimize expansion of area enclosures and depletion of communal rangelands.

The inadequate resource mobilization largely hampers the efforts made by the affected developing countries to fulfill their commitments towards MEAs. Therefore, the donors need to take a fresh look at ways and means to adjust the Convention to the new fundamentals of development cooperation to ensure sustainable development in the developing countries including in Africa.Experience has shown that peace agreements founded on traditional systems and mediated by traditional institutions are the ones that have the most legitimacy and the highest chances of success towards rangeland resource conflict management. A number of challenges continue to undermine these efforts at conflict management and peace building, resulting in their failure to prevent reoccurrence of violent conflict and ensure sustainable peace and stability in the areas. Strong interventions should be given by all stakeholders to sustain this indigenous mechanism.

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Totally degraded

Partially degraded

Restored