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Rangelands: Problems and management options

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Abstract
Man's relationship with his environment is a complex one. Primitive man managed to live as part of the natural ecosystem without altering its major characteristics. But now, man has modified ecosystems by directing energy and materials from the system to serve his personnel needs without due considerations to the overall sustainability of the ecosystem. Amongst the many ecosystems, rangeland is one of the most affected system, which is clearly evident by sharp decline in its productivity and species diversity. The Rangeland vegetation occupy about 52.5 million km^2 (40%) of the world's terrestrial surface area, 12.15 million ha (8.4%) of land in the country and in the Indian Himalaya occupies nearly 35% of the geographical area. Presently, rangelands all over the world are confronting many challenges in terms of degradation by soil erosion, drought, loss in productivity by GHG'S, wild and anthropogenic fires, collection of medicinal plants and fuelwood, invasion by weeds etc. The most prominent challenge across the globe is overgrazing which governs all other challenging factors. Thus, to meet the challenges of both protection/conservation and economy of our country, there is an immediate need to adapt the management options at national, regional and local level to eradicate the imbalances created by the man since time immemorial.

Keywords: Rangelands, extent, types, problems, management

Introduction
Rangeland (rakh) is an unimproved grassland in the sense that grasslands are vegetation types in which the woody plant canopy cover does not exceed 40%. Pandeya (1988) [6] referred the closely related terms in this context viz. grassland – a land with more than 80% occupied by grasses; rangeland-A piece of vegetation wherein grazing occurs or can occur; and pasture - a piece of land in which grasses are grown for feeding. This includes open woodlands (savannas), shrublands, heathlands, tundras (i.e. treeless) and pure grasslands (White *et al*., 2000) [14]. Amongst the many ecosystems, rangeland is one of the most affected systems, which is clearly evident by sharp decline in its productivity and species diversity. The pre-eminent causes, which induce the rangeland degradation include; overgrazing, soil erosion, nutrient depletion, salinization, pollution, disruption of hydrological systems, conversion of natural areas into croplands, monoculture plantations and ill-planned developmental activities. Primitive man managed to live as part of the natural ecosystem without altering its major characteristics. However, with the beginning of agriculture, man became increasingly sophisticated in his knowledge to modify an ecosystem in order to obtain the food, fodder or other eco-services he needed. In achieving this end, man has modified ecosystems by directing energy and materials from the system to serve his personnel needs without due considerations to the overall sustainability of the ecosystem. As a result, in many managed ecosystems signs of severe degradation and declining potentialities in supporting the life forms are becoming prominent.

Rangelands of India
The Rangeland vegetation in India is extended on 12.15 million ha of land area. Indian Himalaya occupies nearly 35% of the geographical area (Planning Commission, 2012). Like all other grasslands of the world, these formations support a large number of wild herbivores, domestic livestock and several agro-pastoral cultures. Different rangelands found in our country are:

1. **Sehima-Dichanthium Type:** These are spread over the Central Indian plateau, Choto-Nagpur plateau and Aravalli ranges, covering an area of about 17,40,000 km². This region has an elevation between 300 and 1200 m. There are 24 species of perennial grasses, 89 species of annual grasses and 129 species of dicots, including 56 legumes.

2. **Dichanthium-Cenchrus-Lasiurus Type:** These are spread over an area of about 436,000 km², including northern parts of Delhi, Aravalli ranges, parts of Punjab, almost whole Rajasthan, and Gujarat, and southern Uttar Pradesh. The elevation of this region is not high, between 150 to 300 m. There are 11 perennial grass species, 43 annual grass species, and 45 dicots including 19 legumes. This area has many protected areas, mainly in the hilly regions, but the *Lasiurus indicus* dry grassland of the Thar desert is under-represented in the Protected area system.
3. **Phragmites-Saccharum-Imperata Type:** These types of grasslands cover about 2,800,000 km² in the Gangetic Plains, the Brahmaputra Valley and the plains of Punjab and Haryana. The elevation of this region between 300 to 500 m. There are 10 perennial grasses, 26 annual grasses, and 56 herbaceous species, including 16 legumes.
4. **Themeda-Arundinella Type:** These grasslands cover about 230,000 km² and include the states of Assam, Himachal Pradesh, Jammu and Kashmir, Manipur, Uttar Pradesh and West Bengal. The elevations ranges between 350 and 1200 m. There are 37 major perennial grass species, 32 annual grass species, and 34 dicots including 9 legumes.
5. **Temperate Alpine Type:** These are spread across altitudes higher than 2100 m and include the temperate and cold desert areas of Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh, West Bengal and the north-eastern states. There are 47 perennial grasses, 5 annual grasses and 68 dicots, including 6 legumes. These high altitude grasslands harbour wildlife not generally found in other parts of the country. This area is also under-represented in the protected area system

Role of Rangelands

In addition to their roles as wildlife habitat, source of quality water, rich biodiversity and natural beauty, the high altitude areas of Himalayan rangelands provides food, fibre, fuel, timber, water, and shelter for the local people, in addition to fulfilling increasing new demands for recreation and tourism. The ability of the rangelands to meet the traditional and new demands would much depend on the way it is managed for any one purpose as this will invariably influence the ability to meet other demands.

Problems of Rangelands

1. Abiotic Causes (Ecological Implications of Climate Change)

The drivers of climate change, coupled with greater frequency and intensity of extreme weather events, will collectively affect soil water availability to influence many aspects of ecosystem structure and function, even though these drivers have unique and potentially counteracting effects (Morgan *et al*., 2011) [5]. Climate change impacts will vary regionally because the magnitude, decadal timing, or seasonal patterns of warming and precipitation modification will be expressed differently among regions and interactive effects among climate drivers are non - additive.

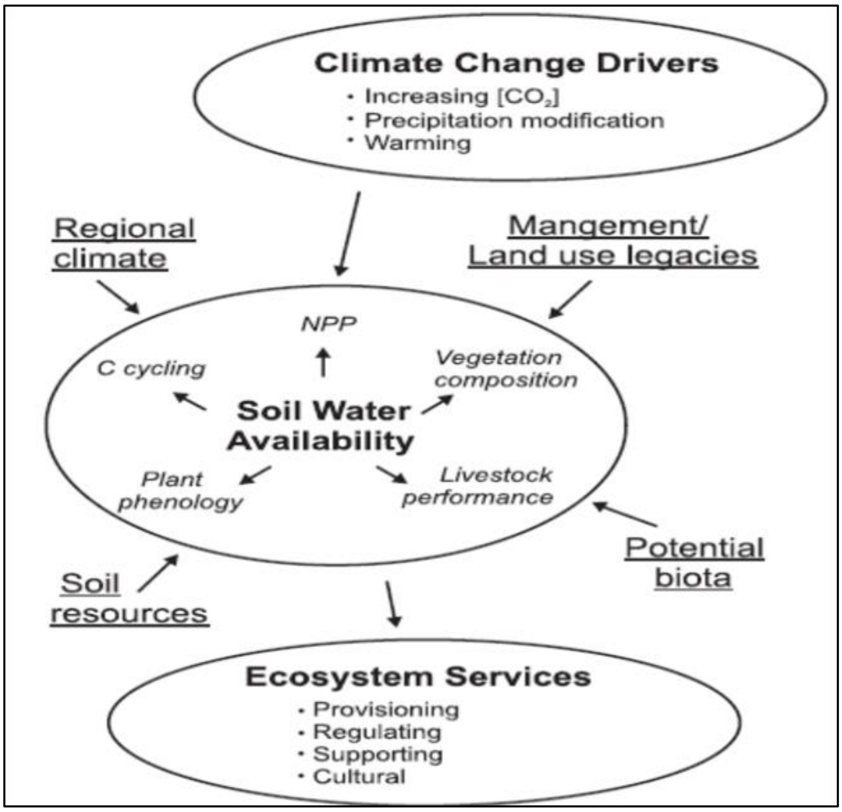

Fig: 1: A conceptual model illustrating the response of rangeland systems to climate change

1.1 Increased Concentration of CO_2: CO_2 enrichment will lead to a strong directional increase in woody vegetation in deserts, grasslands and savannas both because CO_2 enrichment enhances photosynthesis and growth among trees and shrubs, increased woody growth initiates a positive feedback involving light competition that favors trees over grasses (Higgins and Scheiter, 2012) [3]. In temperate regions, warming may enhance productivity by alleviating low temperature limits on plant growth (Lin *et al*., 2010) [4], extending the growing season, and increasing N mineralization rates provided that sufficient water is available (Dijkstra *et al*., 2008) [2]. Alternatively, warming may reduce ANPP by increasing the vapor pressure deficit of air, leading to greater evapo -transpiration and reduced soil water availability (Sherry *et al*., 2008) [11].

1.2 Drought: It is well established in both the historical (Breshears *et al*., 2009) [1] and the paleo-ecological records that severe multiyear drought can substantially modify species composition (Woodhouse *et al*., 2010) [15]. For example, the 1930s drought induced major shifts in community composition in the Great Plains (Weaver and Albertson, 1943) [13]. Cover of blue grama (*Bouteloua gracilis*) declined precipitously in eastern Colorado, where it had been the dominant perennial grass, whereas western wheatgrass (*Pascopyrum smithii*), a subordinant cool season grass, became a dominant species throughout much of the central Great Plains, apparently by taking advantage of limited water available early in the growing season. Most forbs succumbed to the drought, especially in the short grass steppe and mixed grass prairie, with the complete loss of shallowly rooting forbs early in the drought, later followed by deeper rooted forbs. Collectively, evidence from the 1930s drought illustrates that plant species with deep roots, high water use efficiency, or growth patterns that match the seasonality of precipitation likely will fare best during protracted droughts.

1.3 Erosion: Natural erosion is characterized by different forms of mass wasting such as mass movement of fractured rocks and other unconsolidated materials, rock failures, landslides, slumps, and riverbank cutting including soil movement from slopes and gullies. For example, In the Tarian valley which was subjected to flooding about 40 years ago by the rupture of the terminal moraine of one of the glacial lakes at the South-eastern base of the Tsendagang mountain (Nepal), the present vegetation consist primarily of low lying shrubs of Hippophae and Myricaria species, which are of little use of grazing but provide adequate ground cover (Gansser, 2006).

1.4 Natural / Wild Fires: Natural or wild fires have both positive as well as negative effects. In light of positive effect of fire aboveground biomass production in temperate, ungrazed grasslands generally increases because increased production has been attributed to release of readily available nitrogen and phosphorus from plant material and increased nitrogen mineralization rates and altered microclimatic conditions, including improved light availability (Hulbert, 2006). Fires negatively affect the availability of soil organic matter, cause changes in species composition, and long-term loss of nitrogen through volatilization and immobilization (Risser *et al.*, 2010). Also, firing event causes oxidizing of organic material, converts them into Co_2 and water, and releases energy as heat (Sarduo *et al*., 2012).

2. Biotic / Anthropogenic Use and Abuse

2.1 Pastoralism: Since the lower altitude grazing lands are limited in area and the livestock population in these areas far exceeds the carrying capacity, the practice of summer migration to the higher altitude alpine meadows has become necessary to sustain the number of livestock. It has been observed that agro-pastoralists in the western and central Himalaya generally keep more cattle than they really need because of easy access to free grazing areas and their inability to dispose or cull the population due to religious sentiments. Uncontrolled grazing on the steeper slopes reduces water holding capacity and compaction reduces the permeability of the soil. Continuous grazing also creates channels or paths on hill slopes which remove huge quantities of soil during rains. Over-grazed areas near mid- and high-elevation villages in Nepal shows a decrease in grasses and an increase in the unpalatable species such as *Rhododendron anthopogon*, *Berberis* spp. *Euphorbia wallichii*, *Euphorbia longifolia* and *Iris kumaonensis* (Rawat, 1998) [9].

2.2 Collection of medicinal herbs: Alpine meadows, besides being popular summer grazing grounds for a large number of migratory livestock, harbor numerous medicinal herbs which are extracted in large quantity by many local communities for their own consumption, as well as for sale. Over-exploitation of some of the herbs from high altitude areas has caused serious concern amongst conservationists (Tandon 1997) [12]. Most of the medicinal plants growing in the alpine meadows have tuberous or rhizomatous roots. Digging of fragile alpine soil for such medicinal herbs and subsequent trampling and grazing by livestock spreads weeds and causes soil erosion. In the western Himalayan meadows, exploitation pressure is particularly high on *Dactylorhiza hatagirea*, *Picrorhiza kurrooa*, *Jurinea macrocephala* and *Aconitum heterophyllum.* Of the total medicinal plants traded in India, 90% are wild collected in which 70% collections involve destructive harvesting (Raina *et al*., 2013) [8].

2.3 Collection of fuel wood: Livestock grazing and extraction of woody plants by the pastoral communities go together. Consumption of firewood is very high around treeline and sub-alpine zones of the greater Himalaya and thickly populated areas of trans-Himalaya. There are clear indications that the natural treeline in many parts of the Himalaya has lowered considerably as a result of regular camping and removal of woody vegetation. Selective removal of highly preferred species such as *Juniperus macropoda* and *J. communis* can also lead to local extinction of such species. Extraction of fuel wood, particularly from the low productive areas of Trans-Himalaya, is one of the burning issues in the conservation of steppe communities.

The possible way to reduce pressure on rangeland for firewood is adopting Silvipasture Systems, integrating woody perennials and pasture species, can serve the twin purpose of forage and firewood production and ecosystem conservation. It will be possible to increase land productivity from 0.5-1.5 t/ha/yr to about 10 t/ha/yr on a rotation of 10 years through such interventions (Rawat and Uniyal, 1993) [10].

Management options to improve rangeland conditions and reduction in ghg emissions

- Agroforestry in regions where woody species and *grasses* coexist management practices to enhance both woody and herbaceous productivity may increase carbon storage and reduce methane emissions per unit product from domestic and wild ruminants, by improving the quality of the diet.
- Increase in native species will enhance carbon sinks by improving vegetation cover and hence reduce methane emissions by diet quality improvements.
- Reduction of animal numbers can increase carbon storage & SOM through better plant cover and decrease methane emissions. Globally, ruminant livestock produce about 80

million tons of methane annually, accounting for about 22% of global methane emissions (Polley *et al*., 2013) [7].

- Agro-waste-use and fodder trees should be brought under one umbrella in form of a national fodder mission.
- Development of Common Property Resources (CPRs) available within village Panchyats through improved pasture/silvipasture systems should be undertaken by dairy /livestock cooperatives/associations.
- In undertaking large-scale range and pasture development programmes, poor availability of quality seeds of range species is often a critical problem. The focus should be on:

a) Research on forage seed standards and seed technology including emphasis on pure germinating seeds (PGS) in grasses.
b) Encouragement and incentives to farmers with small farm holding for forage seed production in a participatory mode.
c) Establishment of a nodal agency to coordinate production and marketing of quality range seeds, both at regional and national levels, involving commercial seed companies, NGOs and farmers' cooperatives etc.
d) Demonstration of range improvement and management technologies at different locations should receive higher priority and the feedback from the actual beneficiaries and the farmers in the vicinity should be properly accounted for further refinements in the technology.
e) Top fodder tree leaves (Willow, Poplus, Ailanthus etc) are good source of proteins and minerals and are traditionally fed to livestock during scarcity. Field crops viz, paddy, maize, oats, wheat are sown over 5 lac ha in J&K can provide a local source of fodder to the livestock during winters.

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