

Rangeland Ecosystem Services in the Hindu Kush Himalayan Region

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There are rangelands in most parts of the world, and wherever they exist, they are important for the national economy, environment, and cultural heritage. Globally, more than 120 million pastoralists rely on more than 5 billion hectares of rangelands for their livelihoods. The geographic extent and resources of the rangelands make their proper use and management essential. While traditional management practices were sustainable, increasing pressure on land and inappropriate management and development policies are now causing degradation.

Rangelands produce a wide variety of goods such as forage for livestock grazing, wildlife habitat, mineral resources, and other products. Many of these tangible benefits are well known. Other services of rangeland ecosystems, such as carbon sequestration and storage, storage and regulation of water, maintaining landscape beauty, and maintaining biodiversity, are less known. This paper discusses the key ecosystem services provided by rangelands in the Hindu Kush Himalayan (HKH) region, their benefits, and their economic value to in situ and downstream communities. Based on a review of the literature and selected case studies, we discuss major constraints and opportunities in the management of the rangelands in the region. Recommendations are made in relation to the valuation of rangeland ecosystem services, a PES (payment for ecosystem services) approach, transboundary collaboration, policy support, capacity building, and knowledge sharing.

Keywords: biodiversity; carbon; climate change; HKH; mountain ecosystem; valuation;

Introduction

Rangelands and their distribution

Rangelands are land areas on which the indigenous vegetation (climax or natural potential) consist predominantly of grasses, grass-like plants, forbs, and shrubs. They include natural grasslands, savannas, shrub land, many deserts, tundras, alpine communities, marshes, and meadows (Society for Range Management 2001). Rangelands are managed principally with extensive practices such as managed livestock grazing and prescribed fire. Grazing is an important use, although the term rangeland is not synonymous with grazing land. Rangelands exist in all parts of the world except Antarctica. Rangelands cover about 75% of the total land area of Australia (Taylor 2004), 36% of the USA (Department of Rangeland Ecology and

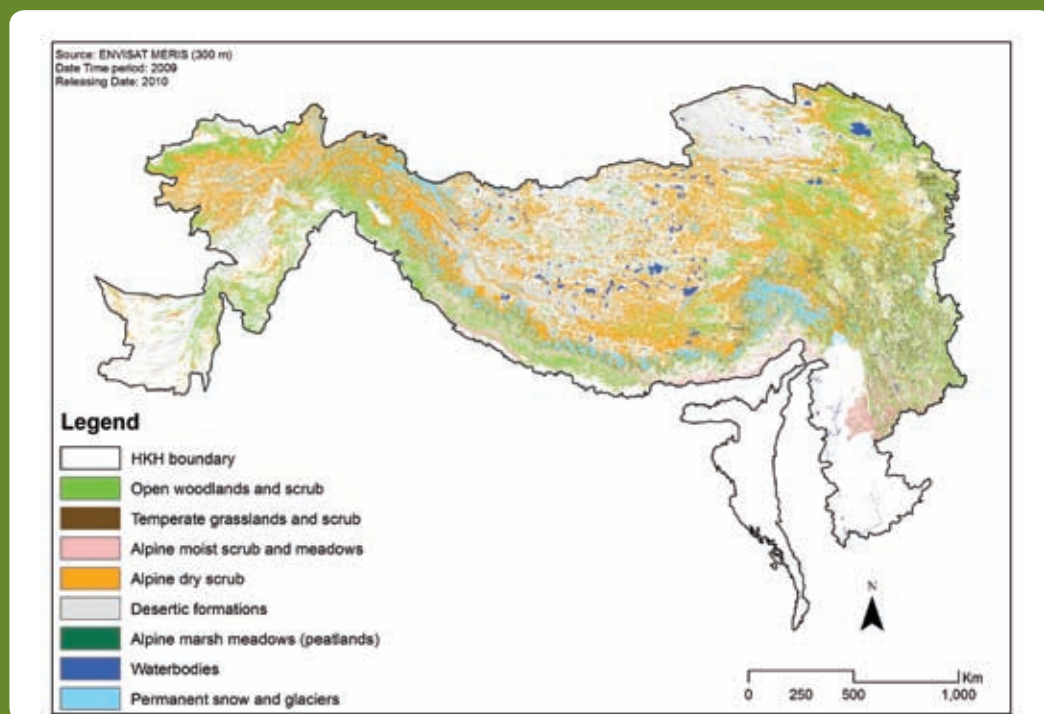
Management 2009), 33% of South America (Yahdjian and Sala 2008), 84% of Kenya (Barrow and Mogako 2007), and nearly 60% of the Hindu Kush Himalayan region (Miller 1996). They are important for national economies, the environment, and cultural heritage.

Most pastoralists are poor and dependent on rangeland resources. The traditional management practices were sustainable, but increasing pressure on land and inappropriate management and development policies are causing degradation of large areas of rangeland. For example, it has been reported that nearly 50% of the Tibetan Plateau grasslands are degraded (Wilkes 2008). The geographic extent and many important resources of rangelands make their proper use and management vitally important.

Importance of the HKH Rangelands

The Hindu Kush Himalayan (HKH) region is the largest and most diverse mountain region in the world, comprising a 3,500 km long complex landscape of mountains, plateaus, river gorges, and plains). Politically, the region comprises all or part of eight countries: Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. Rangelands form the largest land use system (60%) in the HKH region (Miller 1996). The distribution of different rangeland types in the region is shown in Figure 22; the country-wise distribution is summarized in Table 23.

Figure 22: Map showing major cover classes in rangelands of the HKH region



Source: ICIMOD

The largest area of rangelands within the Hindu Kush Himalayan region is located within China. More than half of the Tibetan Plateau's total land area of 2.5 million km² is covered by grasslands; these play an important role in regulating ecosystem services of national, regional, and global importance (Long 2003) and are the basis of livelihoods for 5 million pastoralists, most of whom are poor (Wilkes 2008).

Table 23: Extent of rangelands within the HKH portion of the countries of the HKH region

Country name	Area (km ²)	Area %
Afghanistan	291,880.87	7.57
Bhutan	17,419.636	0.45
China	1,545,542.4	40.09
India	169,381.09	4.39
Nepal	77,826.664	2.02
Pakistan	188,118.4	4.88
Total area (%)	2,290,169	59.41

The ecological richness of the HKH rangelands make them unrivalled in terms of diversity; they extend from subtropical savannas in the Siwalik foothills to abundant alpine meadows in the mountains, and from the spacious steppes of the Tibetan Plateau in the east to the cold, dry deserts of the Hindu Kush mountains in the west. The rangelands contain a diverse collection of plant communities, wildlife species, and human cultural groups.

Pastoralism is a major adaptation to local conditions in the HKH region and contributes significantly to the subsistence livelihood of the mountain people (Bhasin 2011). Over centuries, pastoralists have developed a remarkable resilience through their experience-based migratory patterns. Despite contrasting ecological zones they face similar problems, as shown, for example, in a study of different groups of pastoralists in India (Sharma et al. 2003). The 25 to 30 million pastoralists and agropastoralists in the region tend to be socioeconomically disadvantaged and are faced with serious threats to their livelihoods due to severe rangeland degradation and desertification problems throughout the region (Shaoliang and Sharma 2009). Outmigration is used as a livelihood support strategy and rates within the mountain communities in the HKH countries are strikingly high (Hoermann 2009).

Pastoralism in the HKH is under immense pressure from increasing human and animal populations. Over the last 50 years, the number of people has doubled and the livestock population has quadrupled. Transboundary issues between HKH countries concerning resource use and conservation are also affecting migratory pastoralism and the use of the historical grazing corridors (Chettri 2009). Effective planning and use of the HKH rangeland resources is further complicated by the limited understanding of various factors including

- rangeland productivity causing shifts in the temporal and spatial distribution of resources;
- current and potential future use of rangeland resources for pastoral livelihood diversification and improvement;
- value of rangeland ecosystem services;
- links between rangelands and other ecosystems like forests and wetlands;
- innovative climate change adaptation strategies; and
- gaps in knowledge and local capacity for developing rangeland resources.

These heterogeneous rangeland ecosystems and their integrity are very important for the provision of services that benefit communities far away. The ten main rivers of Asia, namely the Amu Darya, Brahmaputra, Ganges, Indus, Irrawaddy, Mekong, Salween, Tarim, Yellow River, and Yangtze, originate in the HKH mountains and flow through the rangelands. The rangeland ecosystems make up the environment for the headwaters of these river systems, and what takes place in these upper watersheds has a far-reaching effect on downstream areas (Miller 1997). The water that flows from the rangelands is also critical for hydropower development and for irrigated agriculture at lower elevations.

Crop cultivation at high altitudes is restricted by physiographic factors, and grazing by domestic animals enables herding communities to convert otherwise unusable plant biomass into valuable animal products that are either consumed by the pastoralists themselves or sold for income (Miller 1997). Livestock raising forms a part of the livelihood system of the majority of people in the HKH. In the grazing land areas it contributes close to 100% of household income; where agropastoralism is the main farming activity, it contributes 50 to 70%, and in mixed crop livestock farming systems, 10 to 30% (Tulachan and Partap 1997).

The HKH rangelands are also becoming increasingly popular as tourist destinations. Tourism in mountain rangeland environments has the potential not only to improve the livelihoods of the local people, but also to contribute to overall economic development of the countries.

HKH Rangelands and Climate Change

Climate variability affects the amount and distribution of pastures and water points. Although the long-term impacts of climate change are difficult to predict, the most important predictions made by climate change models are of rising temperatures and changes in precipitation with an increased number of extreme events (Mortimore et al. 2009). Erratic and unpredictable rainfall along with extreme weather conditions and longer and more frequent droughts would affect the sustainability and efficient use of rangeland resources. The availability and productivity of grazing areas, and existence of water points, which are critical for livestock survival during the dry season, are bound to decline with marked consequences for mountain livelihoods. The pressures associated with human population growth, economic development, land use change, and climate change are major challenges facing rangeland development professionals and practitioners. Climate change in the rangelands is likely to affect glaciers, temperature, precipitation, water availability, length of seasons, livestock number, and availability of animal feed.

The rangeland herders are among the poorest and most vulnerable communities in the HKH. To cope with the harsh and changing environment, herders move their livestock to areas where water is available and the conditions more favourable according to season. Surveys of pastoral communities conducted recently in Afghanistan, Bhutan, China, India, Nepal, and Pakistan revealed the extent of their hardship and vulnerability. Livestock rearing contributed more than 80% of household income in Afghanistan, Bhutan, and China. Average household

size was around six to eight (Figure 23a) and food deficit was an annual phenomenon and persistent reality for the vast majority of respondents across the region. The majority of households in Pakistan (64%) and Afghanistan (59%) and 42% in Nepal reported that food shortages were worse now than previously. To cope with the increasing food shortages and other problems, at least one adult family member had outmigrated in more than half of the sample households in Nepal and a large proportion of the households in other countries (Figure 23b). The average annual household income ranged from USD 78 to 402 in Afghanistan and USD 536 to 2,781 in India. More than 97% of respondents in China and Nepal, and 42% in Bhutan and Pakistan, depended heavily on animal dung as a source of energy. The respondents called for immediate conservation activities to reverse the deteriorating condition of key plant species in the rangelands (Jasra et al. 2012).

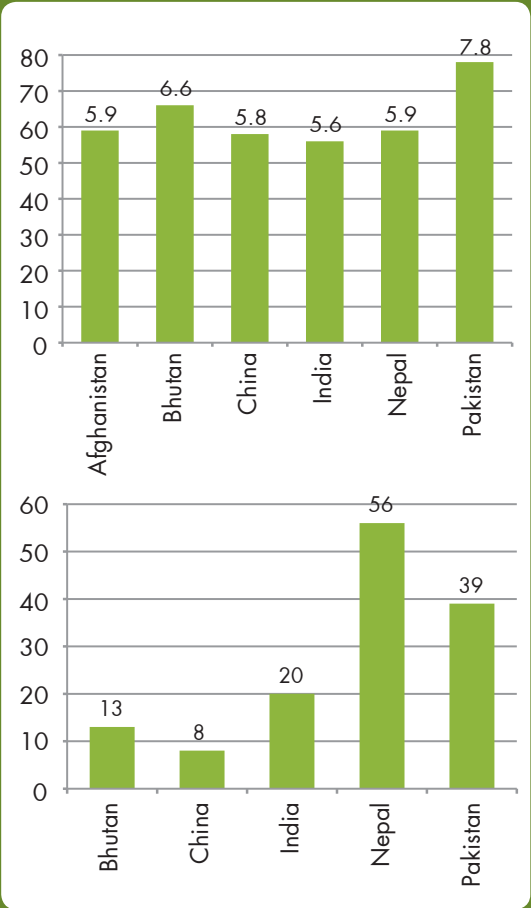
While changes in temperature and precipitation are not uniform across the Tibetan Plateau (Wilkes 2008), or

elsewhere in the region, climate change is nevertheless expected to shift the location of climate belts and the distribution of vegetation types. The permafrost that currently covers half of the Tibetan Plateau is predicted to shrink, or even disappear, due to climate change, which will have a direct impact on water resources and the local ecosystem. The lack of knowledge about the impacts of climate change in the rangelands is a limitation for development planning.

Rangeland Ecosystem Services

Rangelands in the HKH provide ecological, economic, and cultural and spiritual services to communities living in and outside these systems (Table 24). Among others, they produce forage for livestock grazing; wildlife habitat that sustains the flora and fauna necessary to support human wellbeing; water storage and supply; maintenance of stable and productive

Figure 23: (a) Household size and (b) outmigration (seasonal and longer-term) among herders in HKH countries



soils; mineral resources and products; sequestering and storage of carbon; and natural beauty. The rangeland ecosystem services provide a link between economic and ecological systems as shown in Figure 24. Biodiversity habitat maintenance, carbon storage, and water regulation are considered primary ecosystem services from rangelands to human beings.

Table 24: Key functions of rangelands

Biological	Hydrological/Atmospheric	Miscellaneous
Domestic livestock	Drinking water	Views and scenes (aesthetics), recreation and tourism
Other food for humans	Water for economic benefit	Cultural, spiritual, and ceremonial
Forage for livestock	Floods for channel and riparian area rejuvenation	Historical/archaeological sites
Fibre	Flood mitigation	Scientific study
Biofuels	Water bodies for recreation/tourism	
Fishing, hunting	Carbon sequestration	
Biochemicals and genetic materials	Clean energy – wind and hydropower	

Figure 24: Rangeland ecosystem services provide a link between economic and ecological systems



Biodiversity

Rangelands are home to significant concentrations of large mammals and plants with an ecological and economic value. Biodiversity provides many direct benefits to people and the economy such as food, fibre, and forage for grazing animals, medicines, fuel, building materials and industrial products, recreation, and hunting. Most rangelands are not 'natural', they have developed as a result of human modification, especially where the dominant subsistence strategy is pastoralism, and this presents a paradox to conservationists. Historically, when the human population was relatively low, the human exploitation of rangelands was not problematic. But this is changing with the increase in human populations and demand for land for other uses, which are having a significant impact on the flora and fauna of the rangelands. Fragmentation, for example, represents a major threat to biodiversity in rangelands.

Species diversity can be affected by livestock grazing and fire. Livestock can also enhance the conservation of particular species or plant communities and structures. Grazers influence diversity by selective grazing and trampling of plant species. Moderate grazing and trampling can increase the diversity of plants by decreasing the dominance of a single species. Grazing can also create gaps in the plant community, making light, moisture, and nutrients more available to other species. The effects of grazing on plant community diversity depend on the grazing intensity, evolutionary history of the site, and climate. It is also known that if grazing is excluded, the number of species may increase in the short term, but may decline over the long term.

Carbon

Global warming is a major concern and is predicted to affect all ecosystems and human livelihoods, particularly in the developing world. It is estimated that average global temperatures will be 2°C higher than pre-industrial levels by 2035-2050 (Stern 2007). In the rangelands, this may change the length and timing of the growing season and the amount and seasonal pattern of precipitation. Although pastoral societies have made a minimal contribution to the global warming process, they are likely to be seriously affected by it.

In most rangelands and grasslands, soil carbon is by far the largest carbon pool. Above-ground vegetation is normally small and consumed by grazing livestock. Litter pools are also a very small percentage of total carbon stocks. An unpublished report by Feng et al. (n.d.) indicates that there is a significant difference in carbon stocks between degraded and non-degraded grasslands on the Tibetan Plateau (Table 25). Degraded grasslands often have low vegetation cover and low biomass. Practices that increase vegetation cover will increase inputs of organic matter into grassland soils, and reduce soil respiration, thus sequestering carbon in the soil. Overgrazing increases the amount of biomass removed from the system. Trampling can also increase the soil temperature increasing respiration and carbon emission.

Table 25: Soil carbon stocks of alpine grasslands at different levels of degradation (t C ha⁻¹)

	Above-ground C (incl. litter)	Below ground biomass C	Soil C	Total C
Lightly degraded	1.61 (1.20–2.05)	5.01 (4.52–5.29)	115.09 (107.01–123.16)	121.71 (112.73–130.48)
Medium degraded	1.09 (0.70–1.67)	4.31 (3.02–5.34)	44.65 (40.14–49.15)	50.05 (43.86–56.16)
Severely degraded (black beach)	0.96 (0.35–1.53)	3.23 (1.35–4.89)	40.31 (32.11–48.54)	44.50 (33.81–54.96)

Source: Feng et al. (n.d.)

Management practices can increase or decrease organic matter input to soils. Rangelands vary greatly in their climatic characteristics, vegetation, and soil types. Research results indicate that some types of rangeland may respond positively to a certain practice with increased rates of sequestration, while the same practice may reduce sequestration rates elsewhere. Hence, rangeland soil carbon management practices need to be site-specific and designed with care.

Considering that rangelands cover about 40% of the world’s land area (White et al. 2000), and that the majority of the world’s rangelands are degraded to some degree (Dregne and Chou 1992), the carbon sequestration potential of sustainable land management in rangeland areas appears to be huge. A report from FAO (2009) highlights the potential of increased financial benefits from enhanced carbon:

“Typical population densities in pastoral areas are 10 people per km² or 1 person per 10 ha. If carbon is valued at USD 10 per tonne and modest improvements in management can gain 0.5 tonnes C/ha/yr, individuals might earn USD 50 a year for sequestering carbon (Tennigkeit and Wilkes 2008). About half of the pastoralists in Africa earn less than USD 1 per day, or about USD 360 per year. Thus, modest changes in management could augment individual incomes by 15%, a substantial improvement. Carbon improvements might also be associated with increases in production creating a double benefit.

Water storage and flow regulation

The HKH rangelands are also primary catchment areas for annual precipitation. There is little information in the literature about the role of rangelands in storing water and snow and regulating the flow of water in rivers. Nevertheless, it is clear that changes in water storage and regulation in the rangelands may have serious consequences for the water in the rivers flowing from the mountains, and the more than 1.3 billion people who live in the downstream areas. The impact on hydropower generation may also be extensive. Degraded grasslands are typically less able to hold moisture in the soil than non-degraded grasslands, and thus are more susceptible to the impacts of drought and heavy rainfall events. Productivity of grass also depends on soil moisture availability.

Landscape beauty

The beauty of the landscape in the Himalayas attracts hundreds of thousands of tourists and pilgrims to the mountains, including the rangelands. The mountain ranges represent some of the most beautiful landscapes in the world and have immense aesthetic value. The mountain rangelands are significant assets for the tourism industry. With their fresh air and cool climates, breathtaking landscapes and peaks, and prosperous natural and cultural heritage, mountain rangelands are attractive places to enjoy nature and escape from the urban world (Kruk 2011). The demand for trekking, hiking, camping, mountaineering, rock climbing, mountain biking, wildlife viewing, and other forms of non-consumptive mountain tourism activities is ever-increasing, leading to rapid development of the mountain tourism and recreation market (Kruk and Banskota 2007).

Rangeland Ecosystem Services in the HKH Countries

Afghanistan

The rangelands of Afghanistan occupy about 30 million hectares, roughly 45% of the country's territory. The total grazeable area (including marginal lands) is estimated at 70–85% of the total land area; it provides habitat and forage for nearly 35 million livestock as well as numerous wild animals. Over the last 30 years, the population of sheep and goats in Afghanistan has gone down from more than 30 million to approximately 16 million, although livestock production remains the 'backbone of Afghanistan agriculture' and 'crucial for socioeconomic development of the country'. The rangelands are essential for the Kuchi pastoralists, estimated to comprise 20% of the rural population. People in the rangelands gather biomass for fuel and forage, and the rangelands are used by livestock and wildlife for foraging and habitat. The natural resources of the rangelands and woodlands are vital to the survival of communities and nomads as well as to the national economy. However, the many years of war, drought, and migration have devastated both the human and natural resources of Afghanistan, and led to a loss of the traditional ways of using natural resources. Other socioeconomic productivity functions of Afghanistan's rangelands include a range of natural products from fuel and building materials, to fruits and nuts, meat from wild animals, and medicinal plants. The biophysical functions of Afghanistan's rangelands include its critical role as a watershed (and associated regulatory effect on irrigation), in providing a natural soil erosion control mechanism, as a carbon sink, and as a habitat for wildlife.

Bhutan

More than 10% of Bhutan's population are yak herders who reside in the high-elevation rangeland area where they rely mainly on extensive pastoralism for subsistence. These people are entirely dependent on livestock and livestock products. Integrating socioeconomic development of the herder communities with the rangeland ecosystems has been a challenge to all the stakeholders involved. In recent years, the multiple values of the high-elevation landscape (such as for recreation and water conservancy) have gained increasing recognition,

which has unfolded new opportunities for local communities to gain livelihoods. Many world-class trekking routes exist in Bhutan, most passing through rangeland areas, and they have attracted tourists from around the world. Cordyceps (*Cordyceps sinensis*) harvest was legalized in 2004 to provide another avenue of income to mountain communities (Royal Government of Bhutan 2005), with a designated period for collection from May 15 to June 15. Cordyceps are sold through an auction coordinated by the Agriculture Marketing Services of the Ministry of Agriculture. It is estimated that an average household may collect about 100 g, which provides yak herders with 50% of their cash income.

China

China has extensive areas of rangeland; including vast areas within the Hindu Kush Himalayan region on the Qinghai-Tibetan Plateau, the highest and largest plateau in the world (Zhang et al. 2005). The Tibetan Plateau, with its unique ecosystems and extremely rich rangeland resources, has provided some of the most important grazing lands in the region since ancient times (Boxes 2 and 3). The plateau modulates the climate in the region, thus changes in its climate are likely to have a marked effect on the climate of eastern and southwestern China, and further to the whole northern hemisphere and even the entire globe. Environmental changes in the region also influence lowland China, especially in terms of water supply and modulation of the hydrological regime. The high-frigid meadow ecosystem has immense biodiversity resources including many breeds of domestic animals unique in the world. The Qinghai-Tibetan Plateau has attracted the attention of meteorologists, soil experts, environmental specialists, and ecologists from all over the world. The high alpine meadows of

Box 2: Rangelands of the Qinghai-Tibetan Plateau

The Qinghai-Tibetan Plateau is the world's largest and the highest plateau covering an area of 2.5 million km². With its immense reserves of ice and snow, it is sometimes referred to as the 'third pole' or 'the roof of the world'. The rangelands in this region cover about half of the total area and extend from the Himalayas in the south to the Altai in the north, and from the Pamir in the west to the Minshan mountains in the east. Rangeland resources are vital for local livelihoods and livestock, and are an important habitat for many wildlife species, such as blue sheep (*Pseudois nayaur*), kiang or Tibetan wild ass (*Equus kiang*), Tibetan antelope (*Pantholops hodgsoni*), black-necked crane (*Grus nigricollis*), and the endangered snow leopard (*Panthera uncia*) (Miller and Craig 1996; Richard 2000). Thirteen million yak, 41.5 million sheep, large numbers of wild herbivores, and 9.8 million people, inhabit these rangelands. Domestic and wild animals compete for feed in many places. Continuous year-round extensive grazing (either transhumance grazing on the vast plain of the central Plateau or seasonal rotation within certain mountain regions) is a unique land-use pattern. There is generally abundant animal feed in summer and a significant deficit in winter and spring, but inappropriate practices have led to substantial degradation of the rangelands in recent times. Many areas are designated as protected and have a good potential for tourism. Due to the high altitude and harsh environment, agricultural cultivation is not possible on most of the plateau.

Box 3: The Rngeland system of Deqin County, Northwestern Yunnan

Rangelands have a high biodiversity value, as shown in the example of Deqin County in the southern part of the Tibetan Plateau on the northeastern fringe of the Himalayan region. The region is environmentally fragile but is very rich in both biological and cultural diversity. Alpine meadows are found along the vertical gradient; pastoral lands (including grasslands and scrub) cover 2,509 km² (33% of total land). Agriculture, including cultivation and animal husbandry, is the main source of livelihoods and income of both the local people and county government. Yak husbandry is important for subsistence and socioeconomic development. Production of pastures in the alpine meadows and scrub areas has declined. Maintaining rangeland productivity and biodiversity, increasing livestock output to meet growing demand, and improving the living standards of local people are challenging tasks.

the eastern Plateau are by far the most productive grazing areas, renowned for their vast verdant pastures and large yak, sheep, and horse herds. This area is also the origin of the Yellow (Huanghe) and Yangtze (Jinsha) rivers and is called ‘the mother of ten thousand rivers’. The terrain is mountainous, valley bottoms are rarely below 3,500 masl, and winters can be harsh, but the abundant rainfall during the summer growing season allows for relatively high grassland productivity. Yaks and sheep are the main livestock in this part of the Plateau, whereas more sheep and goats are raised in the western part.

India

The high-altitude mountain areas of India are dominated by rangelands, with the Ladakh area at the northern tip of the Indian sub-continent in Jammu and Kashmir State a typical example. Ladakh is located between the great Himalayan and Karakorum ranges and is interspersed with bare, rugged mountains. The altitude and climate make agriculture impossible in most areas and the local people, the Changpas, make their living as nomadic pastoralists, following the traditional routes of their forefathers. The lifestyle of these herders is very traditional, and they depend on livestock that rely on rangeland foraging. Local animal products are exchanged with food grains and other supplies as part of an age-old barter economy, and pashmina is sold in Kashmir. The vast majority of the Changpas’ livestock are pashmina goats and changluk sheep, but they also raise a few horses, donkeys, and yaks. The extremely cold winters, with temperatures as low as -48°C, and the high elevation enable the production of the finest quality of thick pashmina and sheep’s wool. Although the local economy is vigorous and the Changpas have a rich indigenous knowledge base, limited scope for income generation and lack of market options have kept them poor. Currently, the importance of the historic barter economy is declining as more cash-earning opportunities arise in the Leh area. The resulting decrease in locally produced grain is making the Changpa nomads more reliant on subsidized grain from government supply centres. As the small

amount of earnings these people derive from pashmina sales is not sufficient to procure necessary supplies, the Changpa's standard of living (including health and education) is rapidly falling behind that of their neighbours.

Nepal

Rangelands in Nepal cover about 12% of land, mostly in the high-altitude mountain areas. The rangelands in Upper Mustang are typical, covering more than 98% of total land use and comprising 48% of natural vegetation and 50% bare land (LRMP 1986). Much of the Mustang landscape is dominated by pastures, but the prevailing harsh climatic condition doesn't permit to growth of sufficient grass (Kunwar 2003). Agricultural production in the area is very limited due to scarcity of water, lack of proper irrigation, low temperatures for longer periods, and low rainfall. The majority of the land is uncultivated and barren. Animal husbandry is the main source of income. The major livestock are cattle, yaks, dzos (hybrid of yak and cattle), sheep, goats, horses, mules, and donkeys. Goat and sheep trading from China is also a common practice. Upper Mustang is a high-altitude steppe, a fragile landscape drained by the main Kali Gandaki river and its tributaries, in the rain shadow area of Dhaulagiri Himal and Annapurna massif. Rangelands are an important natural resource, and form the basis of the rich biodiversity of the region, supporting a large number of rare and endangered plants, animals, and birds. The vegetation of the area represents high-altitude grasslands that are Tibetan in character. Both domestic and wild animals use these rangelands intensively. The rangelands not only provide grazing lands for livestock, they are also important popular tourist destinations for both domestic and international tourists (Box 4).

Pakistan

The primary use of Pakistan's rangelands is for livestock production, with management systems ranging from nomadic pastoralism, through mixed subsistence farming, to commercial ranching. Pastoralists in the Pakistan rangelands depend heavily on direct consumption or sale of livestock products such as milk, butter, meat, draught power, transport, fibre, dung, income, and tradition. The rangelands are generally unsuitable for crop production due to aridity,

Box 4: Dolpo region of Nepal

The life of the pastoral population in the Himalayas is changing rapidly as previously remote areas modernize and begin to enter the market economy. Herders continue to practise the animal husbandry skills that have been handed down to them through generations. With proper development assistance, the pastoral population should be able to continue to use many of their traditional skills and practices, along with new information and techniques, to better manage the rangelands, increase livestock production, and improve their livelihoods. In addition, there is much potential for tourism in the region.

topography, and extreme temperatures. They support varying mixtures of native and non-native grasses, grass-like plants, forbs, and shrubs, which provide forage for free-ranging wild and domestic animals. While forage production for domestic livestock has been a key ecosystem service of these rangelands, the agropastoral system includes subsistence arable cropping, fruit production, livestock production, and, to an increasing extent, cash-cropping. These rangelands are also very important for nutrient cycling. Crop residues produced in the cropland are fed to the livestock and are partly turned into manure. Livestock constitute the dynamic component of a farming system helping nutrient flows in two ways: transfer of nutrients from ecologically more stable rangelands to the more fragile croplands, and recycling of nutrients from the cropland. Livestock thus serve as the living agency to mediate nutrient flows in these mountain agroecosystems. Some rangeland areas are also becoming popular destinations for tourists, e.g., the Deosai Plateau and Shandur pass, which are famous for trekking, festivals, and sports.

Economic Valuation of Rangeland Ecosystems

Economic valuation can be perceived as the anthropocentric orientation of ecosystem services. An economic perspective on ecosystems portrays them as natural assets providing a flow of goods and services valuable to individuals and society collectively. Examples include the purification of water, reduction of risk from flooding, pollination of agricultural crops, and recreation opportunities from biodiversity and habitat maintenance.

The economic valuation of rangeland ecosystem services has many functions. Economic values may be used as an input into analysing the costs and benefits associated with policies being proposed, or possibly already implemented. For example, with economic value determined, it becomes possible to compare the benefits of different land use options. Identifying and valuing ecosystem goods and services from the rangelands highlights the value of these natural assets to human welfare, which otherwise often remain hidden to the public. This recognition is important for the conservation of rangelands and their benefits. Valuation of total ecosystem benefits will be required to increase the level of conservation and protection of rangelands. Valuation is also the basis for damage assessment and compensation systems.

Heidenreich (2009) in a review did not find any empirical valuation research for temperate grasslands and concluded that the understanding of the total economic value of the goods and services provided by the temperate grasslands is virtually non-existent. Despite their significance, grasslands and rangelands are largely missing in the Millennium Ecosystem Assessment (MEA 2005). Some limited work on estimation of the value of rangeland ecosystems has been conducted in the USA, Canada, South America, and Australia, where the results and lessons provide policy directions for conservation and templates for methodology transfer. Based on case studies, Heidenreich (2009) reported that the total economic value of temperate grassland can range widely from USD 190 to USD 1,618 per hectare per year depending on location, extent, function, and significance to the human

Box 5: Methods for valuation of ecosystem services

1. Market price method: Estimates economic value of ecosystem products or services that are bought and sold in commercial markets.
2. Productivity method: Estimates economic value of ecosystem products or services that contribute to the production of commercially marketed goods.
3. Hedonic pricing method: Estimates economic value of ecosystem or environmental services that directly affect the market price of some other good; most commonly applied to variations in housing prices that reflect the value of local environmental attributes.
4. Travel cost method: Estimates economic value associated with ecosystems or sites that are used for recreation; assumes that the value of a site is reflected in how much people are willing to pay to travel to visit the site.
5. Damage cost avoided, replacement cost, and substitute cost methods: Estimate the economic value based on costs of avoided damage resulting from lost ecosystem services, costs of replacing ecosystem services, or costs of providing substitute services.
6. Contingent valuation method: Estimates economic value of virtually any ecosystem or environmental service. Most widely used method for estimating non-use, or 'passive use' values, asks people to directly state their willingness to pay for specific environmental services, based on a hypothetical scenario.
7. Contingent choice method: Estimates economic value of virtually any ecosystem or environmental service, based on people's opinion to make tradeoffs among sets of ecosystem or environmental services or characteristics; does not directly ask for willingness to pay – this is inferred from tradeoffs that include cost as an attribute.
8. Benefit transfer method: Estimates economic value by transferring existing benefit estimates from studies already completed for another location or issue.

population in the vicinity. As yet, there has been no research to estimate the total economic value of rangeland ecosystems in the HKH region; however, a general framework has been developed recently for valuing the whole range of ecosystem services in the Himalayas (Rasul et al. 2011).

Referring to the limited number of case studies in developed countries, Heidenreich (2009) highlighted the large research gaps in understanding the economic value, and hence the importance, of grasslands. Rangelands have values that include more than goods and services traditionally marketed. Incorporating these non-market values into land-use decision making is necessary for improved rangeland management. Assessment of non-use values (e.g., social and cultural services) and indirect value of ecosystem functions is particularly problematic due to methodological constraints (Box 5).

Discussion

Rangelands are valuable for many ecosystem functions. Rangelands play an important role in regulating ecosystem services that have local, national, regional, and global significance. In addition to livestock production, the rangeland areas in the HKH region provide ecosystem services such as soil and water conservation, carbon storage, biodiversity conservation, and cultural services (including landscape beauty). The HKH rangelands provide the basis of livelihoods for 25 to 30 million pastoralists and agropastoralists (Shaoliang and Sharma 2009), many of whom live in absolute poverty. The rangeland ecosystem services are also essential for existence and economic development in downstream areas. Conservation of the HKH rangelands is necessary for both economic development and to maintain the ecosystem services.

Most rangelands in the HKH region are degrading due to human activities; overgrazing by livestock and climate change are leading to severe, often irreversible, loss of vegetation and carbon stock. There is increasing awareness and concern about climate change and its impact, the role of grasslands in ecosystem services (mainly carbon storage, biodiversity conservation, and water services), and climate change adaptation.

Many of the important HKH rangeland areas are located within protected areas. National park policies restrict the introduction of exotic pasture species. Thus forage improvement and rangeland rehabilitation programmes in these protected areas will have to rely on native forage species. More work is needed to identify indigenous forage species with a potential for forage improvement and rehabilitation, and to determine the most practical ways to produce seed and obtain good grass establishment.

In the past, support to rangeland areas was dominated by support for increasing production, and, through this, reducing poverty. The need to target rangeland ecosystem services is being increasingly realized by national governments. Payment for rangeland ecosystem services, in which downstream and global beneficiaries pay rangeland communities for supplying the ecosystem services of concern, which provides a feasible approach for supporting rangeland maintenance and rehabilitation. This is also relevant in the case of hydrological services (regulation of water quantity and quality), as many primary river systems in the HKH region originate from the rangelands. In China, payment transfer, currently through the central government, is proving feasible. There is much potential for replicating such a programme in other HKH countries. However, information about the value of ecosystem services, the conservation role of rangeland communities, and institutional arrangements for implementing payment for ecosystem services (PES) schemes are limited. The transboundary nature of many rangelands and river basins will necessitate transboundary cooperation for developing PES schemes at a regional scale. Additional work is required to clarify the legal and tenure status for payment for rangeland ecosystem services.

There is confidence, based on pilot schemes, that PES can be a potential approach for better rangeland management in the HKH region. Schemes need to be adapted to suit the local context, scope, and importance of ecosystem services. Schemes can be based on a diversified financing mechanism with input from local, national, and international funds. Setting up a rangeland PES fund could also help in developing a better information collection system and piloting schemes in different contexts. While PES experience in rangelands is limited, whatever is available and has been learned, will be useful for developing relevant PES schemes.

Recommendations

The following recommendations are made for better management of rangelands in the HKH region.

- i) Raise the profile of mountain rangeland ecosystems and their services to the human population, both in the mountains and downstream, and further away in the region and the world.
- ii) Develop sustainable rangeland management strategies based on adaptive comanagement that involves local pastoralists and takes into account their needs, values, and perspectives.
- iii) Assess ecosystem services and their economic value in key mountain rangelands in the HKH region. Methods can be adapted from valuation studies conducted in the United States, Canada, South America, and Australia. Valuation is required for improved rangeland policies, management, and transboundary cooperation.
- iv) Develop PES schemes and pilot in different contexts in priority countries across the HKH region. There is relevant experience, particularly in China, that can help guide the development of appropriate schemes.
- v) Explore the possibility of bundling services for developing PES schemes. For example, payment for carbon storage under the current REDD+ mechanism may be extended to include biodiversity conservation and water services. However, it is important to note that PES schemes are not a 'silver bullet' for resource management, but may complement legislative and policy instruments (e.g., legislation to control grazing, provision of subsidies for inputs or products, investment grants for improved livestock and rangeland management, technical extension services).
- vi) Advocate for policy improvements to support implementation of PES schemes. For example, policy reform will be required in many HKH countries to deal with rangeland tenure, natural resource use, and transboundary issues.
- vii) Take necessary consultation and action at national and regional levels to establish a rangeland PES fund.
- viii) Strengthen local capacity, knowledge, and confidence through PES pilot schemes to address the limited capacity in the HKH region (manpower, expertise, and budget) for undertaking necessary action to promote PES for rangeland ecosystem services.

- ix) Tap into international networks and organizations (e.g., TEEB, Katumba group, FAO, UNEP) to share relevant knowledge, develop local and regional capacity, and for funding of PES research and pilot schemes.

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