High-altitude rangelands and their Interfaces in Gilgit-Baltistan, Pakistan:
Current Status and Management Strategies

Muhammad Zafar Khan[1, 2*], Babar Khan[1], Saeed Awan[2], Garee Khan[1], and Rehmat Ali[1]

[1] WWF-Pakistan, Gilgit-Baltistan, Gilgit, Pakistan
[2] Karakoram International University, Gilgit, Pakistan

* mzkhan@wwf.org.pk

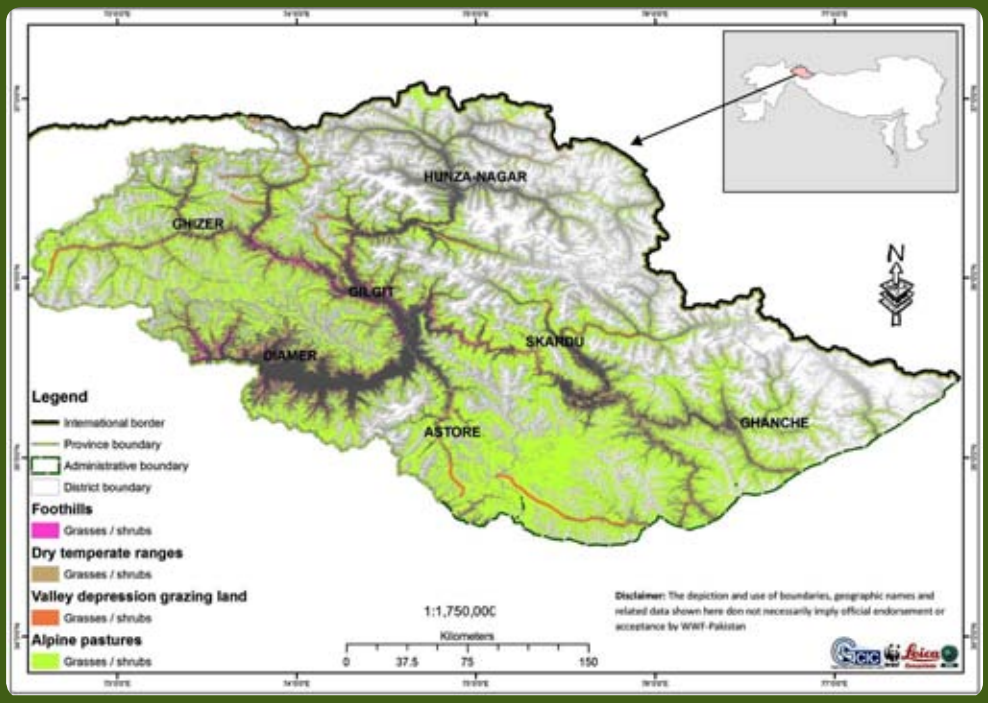
The rangelands and their interface areas in Gilgit-Baltistan of Pakistan span over 2.34 million hectares and constitute the second largest land cover after snow-capped mountains. Subsistence agriculture, including livestock herding, is the major source of livelihood for mountain dwellers, accounting for about 35–40% of their household income and 11% of GDP. Apart from conventional uses, the rangelands provide a substantial amount of fuelwood to meet domestic energy needs, fodder for livestock, and high-value aromatic and medicinal herbs for traditional uses and sale. As an ecosystem, rangelands have been vital for sustained economic growth, regulation of air and water, and ecosystem flows. However, the ever-increasing human population and increased livelihood needs have led to a rapid increase in livestock numbers over the past four decades. This increase, coupled with other factors such as removal of natural vegetation for fuelwood, fodder, food, and medicine, has resulted in degradation of the rangelands. The reasons for the fast depletion of rangelands in the region include lack of adequate regulations and appropriate policies regulating rangeland resource use, and sheer lack of capacity, both human and material, in the custodian departments to enforce and monitor even the available laws. A multi-pronged integrated conservation and development strategy comprising short, medium, and long-term interventions is required to protect, restore, and eventually improve the degraded rangelands in Gilgit-Baltistan.

Keywords: alpine; Baltistan; Gilgit; Himalayas; Indus; livestock; peatland; rangelands

Introduction

The region of Gilgit-Baltistan, formerly known as the 'Northern Areas', forms part of northern Pakistan amidst the Karakoram, Greater Himalayas, Pamir, and Hindu Kush mountain ranges. It shares international borders with Afghanistan to the northwest, China to the northeast, and India in the east. Gilgit-Baltistan encompasses an area of 72,496 km^2 and is home to a human population of approximately 1.2 million. Administratively, the region is divided into seven districts – Astore, Diamer, Ghanche, Ghizer, Gilgit, Hunza-Nagar, and Skardu – with the administrative capital in Gilgit city.

Figure 7: **Location of Gilgit-Baltistan and distribution of rangeland resources**



Source: GIS Lab, WWF-Pakistan, Gilgit

Table 10: **Extent of rangelands in Gilgit-Baltistan, Pakistan**

Rangeland category	Area (million ha)	Mountain range
Foothill grasslands	0.02	Karakoram-Hindu Kush
Dry temperate grazing lands	0.28	Himalaya-Karakoram-Hindu Kush
Valley grazing areas	0.21	Himalaya-Karakoram-Hindu Kush
Alpine pastures	1.83	Himalaya-Karakoram-Hindu Kush

Source: GIS Lab, WWF-Pakistan, Gilgit

One of the most prominent land use and land cover categories in Gilgit-Baltistan is that of high-altitude rangelands. According to a new land cover map prepared by WWF-Pakistan in 2012 using satellite images and GIS techniques, the area under rangelands is 2.34 million hectares, i.e., about one-third of the total land area of Gilgit-Baltistan. Earlier estimates of the extent of the rangelands in the province differed considerably, e.g., 22% (GoP and IUCN 2003) and 52% (FAO 1992). Table 10 and Figure 7 show the present extent and distribution.

Types of Rangeland

According to the classification of Khan (2003), there are two main types of rangeland in Gilgit-Baltistan: alpine pasture and trans-Himalayan rangelands.

Alpine pastures

Alpine pastures mostly comprise meadows, which remain under snow cover for almost six months and are accessible during summer. The meadows are situated above the alpine tree line which is located between 3,300 and 4,000 masl. At higher elevations, such as the Khunjerab and Deosai plateau, the growing season is very short and lasts only three to four months (June to September). Below this zone lies the sub-alpine scrub. Forage production varies from place to place depending on altitude, slope aspect, and moisture availability. Above ground biomass production varies from place to place, e.g., Khunjerab National Park (370–580 kg ha^{-1}) and Chaprote near Gilgit (500–750 kg ha^{-1}); with an overall average of 700 kg ha^{-1} (Khan 2003). If properly managed, alpine meadows contain luxuriant ground flora that offer the highest value grazing lands with an average stocking capacity of five animal unit per hectare (Khan 2003). Vegetation in the alpine meadows is dominated by grasses, perennial herbs, and shrubs. The most common floral species are listed in Table 11.

With the melting of snow during summer, vegetation in the meadows flourishes giving rise to an astonishing array of flowering plants. In addition to functioning as a food source for wild and domestic herbivores, these flowers attract a mass of insect biodiversity resulting in the appearance of a variety of birds in the zone for breeding. This region is home to 41 endemic butterfly species with a notable variety of Apollo butterfly of the genus *Parnassius* (IUCN 1997).

The major mammalian fauna inhabiting the alpine zone include brown bear (*Ursus arctos*), Himalayan ibex (*Capra ibex sibirica*), snow leopard (*Uncia unica*), markhor (*Capra falconeri*), musk deer (*Moschus chrysogaster*), long-tailed marmot (*Marmota caudata*), Royle's high mountain vole (*Alticola roylei*), True's vole (*Hyperacrius fertilis*), ermine (*Mustela ermine*),

Table 11: **Common floral species in alpine pastures**

Type	Species
Trees and shrubs	*Juniperus communis, Rosa webbiana, Berberis* spp., *Cotoneaster* spp.
Grasses	*Phleum alpinum, Agrostis gigantea, Trisetum* spp., *Poa* spp., *Elymus dentatus, E. caninus, Festuca ovina, Alopecurus gigantea, Dactylis glomerata, Pennisetum lanatum, P. filaccidum, Clamagrostis pseudophragmites, Oryzopsis* spp., *Carex* spp.
Forbs	*Plantago ovata, P. major, P. lanceolata, Trifolium pratense, T. repens, Fragaria nubicola, Medicago lupulina, Potentilla* spp., *Rumex nepalensis, Polygonum alpinum, Anaphalis contorta, Thymus linearis, Astragalus* spp., *Taraxicum officinalis, Iris hookeriana, Nepata spicata, Saxifraga* spp.
Medicinal flora	*Aconitum heterophyllum, A. chasmanthum, A. laeve, Saussurea lappa, Rheum emodi, Podophyllum hexandrum*

Source: Rasool 1998a; Karki and William 1999; Khan et al. 2011

Chinese birch mouse (*Sicista concolor*), and migratory hamster (*Cricetulus migratorius*). Major bird species include snow partridge (*Lerwa lerwa*), golden eagle (*Aquila chrysaetos*), snow pigeon (*Columba leoconota*), Turkistan hill pigeon (*Columba rupestris*), Eurasian blackbird (*Turdus merulus*), yellow-billed chough (*Pyrrhocorax graculus*), and red-billed chough (*Pyrrhocorax pyrrhocorax*). Skinks (*Liolopisma ladacensis*, *Agama himalayana*) and gecko (*Tenuidactylus baturensis*) are also found in this zone, as is the Baltistan toad (*Bufo siachensis*), which is found in water bodies (Roberts 1997; Mirza 1998; Rasool 1998b; Anwar 2011).

Trans-Himalayan rangelands

The Trans-Himalayan rangelands extend over the northern mountains in the Astore, Darel, Tangir, Haramosh, Jaglote, Kargah, and Naltar valleys. The climate has typically cold desert characteristics, with severe winters (usually with moderate to heavy snowfall) and dry summers. Altitudinal differences influence the climatic variation. At lower altitudes (below 2,300 masl), there are both diurnal and seasonal temperature variations and scanty precipitation. Areas between 2,300 and 3,300 masl receive sufficient snow and have a temperate climate. Areas above 3,300 masl are very cold with a limited growing season. Most of the areas lie in the rain shadow zone out of reach of the summer monsoon. Average annual precipitation in the valleys is 100-300 mm, mostly occurring during winter and early spring in the form of snow (Khan 2012). The main occupation of local communities is farming, which includes animal husbandry, limited agroforestry, and horticulture. Maize, wheat, buckwheat, and barley are the principal crops grown at lower elevations, with seed potato an important cash crop throughout. The grazing lands are deteriorating as a result of overgrazing of livestock and illicit removal of natural vegetation for firewood. Forage production varies from 500 to 1,500 kg ha^{-1}. Indigenous vegetation includes trees, shrubs, herbs, and forbs. Some of the common floral species found in the rangelands are listed in Table 12.

Table 12: **Common floral species found in the trans-Himalayan rangelands**

Type	Species
Trees and shrubs	*Juniperus macropoda, Quercus ilex, Pinus gerardiana, Cedrus deodara, Pinus wallichiana, Fraxinus xanthoxyloides, Artemisia maritima, A. sacrorum, Indigofera* spp., *Ephedra* spp., *Daphne oleoides, Sophora* spp., *Cotoneaster* spp., *Parrotia jacquemontiana, Salix* spp., *Jasminum* spp., *Sorbaria tomentosa, Caragana* spp.
Grasses	*Chrysopogon* spp., *Cymbopogon* spp., *Dichanthium annulatum, Pennisetum orientale, Aristida* spp., *Oryzopsis* spp., *Dactylis glomerata, Poa* spp., *Bromus inermis, Agrostis* spp., *Rottboellia exaltata, Phacelurus speciosus, Eragraostis spp.*
Forbs	*Iris* spp., *Tulipa stellata, Polygonum* spp., *Sambucus* sp., *Lotus comiculatus, Medicago lupulina, Plantago lanceolata, Lathyrus* spp., *Thymus linearis, Nepata spicata, Viola* spp., *Taraxicum officinalis*
Medicinal flora	*Ephedra nebrodensis, Artemisia maritima, Carum bulbocastanum, Thymus and Ferula, Juglans regia, Pinus gerardiana, Zizyphus sativa*

Source: Ahmed and Qadir 1976; Alam 2010; Qureshi et al. 2011

High-altitude rangeland Interfaces

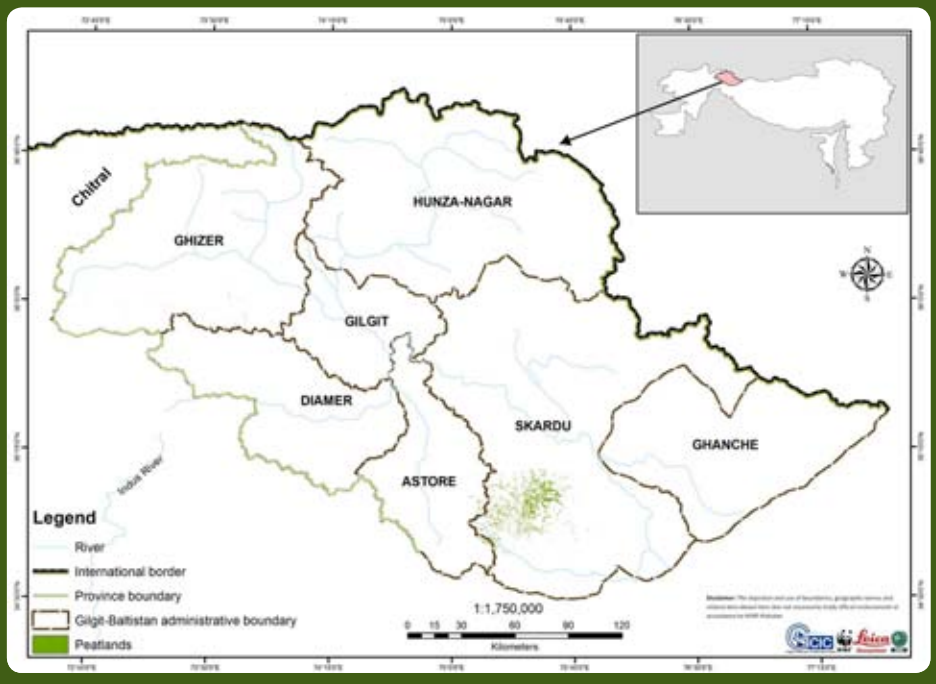
The unique confluence in Gilgit-Baltistan of three great mountain ranges – the Himalayas, Karakoram, and Hindu Kush – and the resultant altitudinal variation coupled with diverse topographic and climatic conditions, give rise to multiple interfaces over a short distance. Anthropogenic factors also produce different interfaces in the form of newly-formed boundaries. Some of the distinct interfaces found in the high-altitude rangelands of Gilgit-Baltistan are described briefly below.

Natural interfaces

Peatlands are interfaces between wetlands and rangelands. Globally, peatlands comprise an area of 150 x 106 km^2, about 3% of the total terrestrial surface. They contain a total of 550 Gt carbon stock, equivalent to 75% of all atmospheric carbon, equal to all terrestrial biomass, and twice the carbon stock in the forest biomass of the world (Wetlands International 2009). Peatlands' highly regarded carbon sequestration value equals around 13% of the global carbon stock.

In northern Pakistan, peatlands are found in the Deosai plateau, Langar-Shandoor wetlands (Phunder valley), Fairy Meadows, and Shimshal and Broghil valleys (Figure 8). An estimated 25,000 ha of Gilgit-Baltistan is covered by peatlands. Peatlands are valuable ecosystems that

Figure 8: **Distribution of peatlands in Gilgit-Baltistan**



Source: GIS Lab, WWF-Pakistan, Gilgit

provide services such as biodiversity conservation, carbon stock, water storage and regulation, grazing grounds, and domestic fuel. In Phunder and Broghil valleys, the peatlands are a major source of domestic fuel as these areas lack natural vegetation that can be used for fuelwood. Degradation and shrinkage caused by anthropogenic activities and climate change are major threats to peatlands. Anthropogenic pressures result from accessibility to nearby populations and result from extensive grazing, over-dependency for domestic fuel, and drainage and diversion of water sources.

The alpine timberline represents another predominant interface between forests and alpine meadows. It marks the junction between mountain forests and alpine meadows at elevations of 3,300 to 4,000 masl in Diamer, Astore, Naltar, Haramosh, Bagrote, Roundu Nagar, and Puniyal valleys. The specific geographical and ecological features of the timberline vary with ecological zone. Himalayan dry coniferous forest species like *Abies pindrow*, *Picea smithiana* and *Pinus wallichiana* are found at lower elevations, while higher elevations are dominated by species of *Betula*, *Salix*, *Juniperus*, *Rhododendron*, and large number of herbaceous species.

Anthropogenic pressures such as excessive grazing, cutting of fuelwood during seasonal stays in the high pastures, trampling effects, and soil erosion, combined with climatic factors, have caused a downward shift of the alpine timberline on south-facing slopes.

Forest–agriculture interfaces

The lower timberline generally encompasses the areas between mountain forests and farming land. The major vegetation at lower altitudes (1,400-2,000 masl) consists of Himalayan dry coniferous forest species such as *Quercus ilex*, *Artemisia maritima*, *Ephedra intermedia*, *Monotheca buxifolia*, *Corylus coluna*, *Cotoneaster nummularia*, and *Sophora mollis*.

The lower timberline ecotone is undergoing excessive degradation and severe erosion due to intensive farming, deforestation, infrastructure development, and frequent hazards like flash floods, mud slides, and land slips. It is further threatened by expansion of farming activities, road networks, resorts, and others infrastructure.

Protected areas

Bufffer zones of protected areas represent yet another type of interface. A number of protected areas fall within the geographical boundaries of Gilgit-Baltistan, in addition to an extension of the Pamir range in its territory. The Pamir range, predominantly situated at 3,500-5,000 masl in Tajikistan and Afghanistan and extending into Kyrgyzstan, China, and northern Pakistan, has a scattered network of protected areas (Schaller 2007). The entire range has man-made interfaces, along with human activities such as border fencing, road transportation, excessive hunting, and armed conflict pressurize the high-altitude ecosystems and their components. Schaller (2007) has shown that Marco Polo sheep (*Ovis ammon polii*) roam across the frontiers of Afghanistan, China, Pakistan, and Tajikistan in the Pamir Mountains. However,

fenced borders increasingly hamper their movement. According to Mr Aziz Ali (personal communication), fifteen carcases of Marco Polo sheep were found over a distance of only six kilometres along the fenced Afghan-Tajik border, testifying to the grave danger posed to this species. He suspects these deaths to have been caused by speeding animals colliding with the fence when they are chased by predators such as wolves or snow leopards. Recent fencing along the Sino-Pak border area is feared to cause similar perils for Marco Polo sheep and other wildlife species around Pakistan and China's mountainous landscapes (see also Joshi et al., this volume).

Current State of High-altitude rangelands

Gilgit-Baltistan has an arid climate, characterized by low precipitation (<200 mm annual rainfall), extreme temperatures, and low humidity, owing to the limited influence of the monsoon. Despite the general arid and dry conditions, the rangelands contribute a major part of the feed requirements for 2.0–2.5 million heads of livestock (Beg 2010). Rangeland productivity is believed to have decreased significantly due to excessive livestock grazing, increasing human and livestock population, and the expansion of dryland farming to marginal land to satisfy the increasing demand for food, and the cutting of shrubs and trees for domestic fuel (FAO 1987). Unpalatable low quality vegetation has replaced the more palatable grasses, shrubs, and trees that once covered the rangelands. Every year, insufficient forage during the dry period leads to heavy losses of livestock (Alvi and Sharif 1995; PARC 1998).

The alpine pastures are situated on gentle slopes of Greater Himalayas, where the habitat is under heavy grazing pressure and faces a decline in productivity and biodiversity (MACP/IUCN 2001). Accelerated erosion and land degradation illustrates the negative impact of mismanagement. Most of these lands are communal and management is a communal responsibility. However, the land tenure system directs the community's focus to immediate returns rather than long-term benefits. Table 13 shows the potential and actual productivity in selected pastures in three districts (Skardu, Astore, and Hunza-Nagar).

Table 13: **Pasture potential and actual productivity in Gilgit–Baltistan area of Pakistan**

Region/ District	Species composition	Cover (%)			Productivity (kg/ha)		Remarks	
	No. of species recorded	Foliar cover	Bare ground	Weeds	Estimated potential productivity	Productivity at the time of survey	Pasture condition	Pasture trend
Gojal (Hunza-Nagar)	27	73	27	2	1,400	407	Poor	Down
Astore	26	72	28	27	1,600	428	Poor	Down
Skardu	30	54	46	7	1,200	241	Poor	Down

Source: MACP/IUCN 2001

The number of livestock in Gilgit-Baltistan, especially cattle, sheep, and goats, increased from 0.88 million in 1976 to 2.45 million in 2006, an increase of 1.67% per annum. Almost 80% of the livestock are grazed in pastures and rangelands during summer. The substantial increase in domestic herbivores and their large dependence on rangelands has resulted in a tremendous grazing pressure on the rangelands. Generally, the animal production systems in the rangelands operate on a low input basis, but the pressure on grazing land is further increased by animals brought for grazing by herders from down country, particularly to pastures in Deosai. Currently, an estimated 0.86 million animal units are being grazed on 2.34 million ha of rangelands in Gilgit-Baltistan, which is a stocking rate of 2.73 ha per animal unit (Afzal et al. 2008), substantially higher than in 1996 (2.89 ha/animal unit, according to GoP/IUCN 2003), and about six times higher than the critical stocking rate of 16 ha/animal unit suggested by FAO (1987) for low potential rangelands. Thus the already burdened and overgrazed rangelands are likely to face further degradation. Such overstocking of animals and the resultant decline in vegetation cover will accelerate soil erosion and may cause desertification.

Significance of the High-altitude rangelands

One of the major functions of the rangelands in Gilgit-Baltistan is the provision of agropastoral livelihoods and contribution to food security and household income. With close to 2.5 million heads of livestock, 80-90% of the local people practice transhumant animal husbandry, which accounts for 20-35% of total income. In addition, nomadic and transhumant pastoralists also grow potatoes, peas, barley, and buckwheat in cultivable areas near high pastures if irrigation water is available from springs and seasonal streams, and also collect medicinal and aromatic plants in those areas. Rangelands also provide plant biomass for domestic energy requirements as the whole area lacks alternative sources of energy. People collect fuelwood from trees, shrubs, and bushes for both cooking and heating during the long winters.

Ecotourism and mining are also valuable rangeland attributes providing economic opportunities. The beautiful landscape and unique cultural heritage catch the eye of tourists from all over the world. The area possesses numerous mining sites, some currently under exploration such as Haramosh, Dassu, Bubin, and Nagar, and other valleys such as Chipurson, Yasin, and Gupis that are yet to be investigated for their potential.

Water regulation is another important function of the rangeland areas. There are a number of high-altitude wetlands most of which are fed by snowmelt or runoff from adjacent glaciers, which often have outflows in the form of small streams or rivers. These water bodies play an essential role in the hydrological regime of the Indus, which is the lifeline of the agrobased economy of the country, besides being a source of water for drinking, industry, agriculture, and hydropower generation. The Gilgit, Hunza, Ghizer, Astore, Shigar, and Shyoke rivers provide almost 72% of the total annual influx into the Indus. Freshwater lakes, rivers, and streams also provide habitat for indigenous and exotic species of freshwater fish. Rainbow and brown trout are abundant in the rivers and lakes of Gilgit, Ghizer, and Skardu valleys (Khan 2011).

Gilgit-Baltistan has a marked geographical, geological, and topographical heterogeneity. The myriad natural features together constitute an astonishing but fragile mountain ecosystem sheltering a rich diversity of flora and fauna, including 230 species of birds, 54 species of mammals, 23 species of reptiles, 20 species of fish, and six species of amphibians; many of them rare, endangered, and/or endemic to the Karakoram-Himalaya-Hindu Kush highlands (GoP/IUCN 2003).

Keeping in view the extraordinary natural wealth of these areas, the Government of Gilgit-Baltistan has brought certain key areas under the protected areas network by notifying five national parks, three wildlife sanctuaries, seven game reserves, and 24 community-managed conservation areas, covering some 30,000 km^2 almost half of the total land area.

Threats to the High-altitude rangelands

The rangelands in Gilgit-Baltistan are diminishing fast due to over grazing, encroachment and conversion into other land uses, drought and climate change, and trampling effects. The major threats and their causes are described briefly in the following.

Overgrazing

The majority of the rangelands in Gilgit-Baltistan are regularly grazed beyond their carrying capacity (FAO 1987; Alvi and Sharif 1995; Beg 2010). The overgrazing can be attributed to two main factors: lack of a grazing management system, and lack of a proper land tenure system, in which the protection of grazing lands seems to be no one's responsibility as they are a common asset. Shimshal Pamir pasture is a good example. In 2010 it was being used for grazing for 5,000 yaks, 2,000 goats, 1,900 sheep, and 500 cows, along with a few hundred wild herbivores such as Himalayan ibex and blue sheep, whereas the 10,429 ha area is only just enough to feed to 715 yaks for a maximum of six months (Khan 2012). Similarly, more than 420,000 animals are being grazed around Central Karakoram National Park (Baig 2011) with extensive grazing in some lower pastures year round. At higher altitudes, where foliage growth is limited by the harsh climate, grazing beyond the carrying capacity not only deteriorates the ecological health of the pastures, but also leaves less or no food for wild herbivores and accelerates soil erosion.

Encroachment

The lack of a proper management system is coupled with various exploitative uses of rangelands such as agriculture, extraction of plant biomass for fuelwood, and rapid infrastructure. The use of pasture and rangeland for crop cultivation is increasing at an alarming pace. The agricultural statistics for Gilgit-Baltistan show that nearly 83% (8,422 ha) of the total area is under vegetable crops (10,080 ha), mainly because potato has emerged as the only cash crop in the area. Removal of the sparse and scattered natural vegetation for fuelwood has also markedly increased the pace of rangeland desertification. Heavy vehicular movements and due to off-road driving has been a big threat to grasslands in the Deosai and

CKNP. However, prolonged grazing periods of big herds in alpine oases also result in overgrazing and trampling of pastures. Lack of grazing and pasture management regulations in the region are probably a contributing factors.

Climate change

The rangelands of Gilgit-Baltistan receive little precipitation, particularly at lower elevations where it rarely exceeds 200 mm per annum. The higher elevations (>3,500 masl) receive more snow during winter (Awan 2002). Mean temperatures range from -10°C in winter to +35°C in summer. Unlike the general global pattern, significant increases have been observed in the region in winter mean and maximum temperatures, and consistent decreases in summer maximum temperatures (Fowler and Archer 2006). Zeidler and Steinbauer (2008) reported an increase in annual mean temperatures from 1980–2006. Such climatic variations, coupled with other biotic and anthropogenic factors, have contributed to an alarming increase in the rate of desertification of the rangelands, especially in the arid and semi-arid zones (GoP 2010). Temporal data analysis by the Pakistan Metrological Department (PMD) also showed a decrease in vegetation cover over the northern half of the country compared to 1998, thought to be due to failure of the winter rains (Chaudhry et al. 2010). Similar evidence has been recorded from Afghanistan, China, Nepal, and other areas in Pakistan, where a decrease in rainfall has accelerated rangeland desertification, and in some places prolonged droughts have forced people to change their migration routes or abandon pastoralism completely. Pastures in Misgar, Chipurson, and parts of the Central Karakoram National Park (CKNP) such as the Bagrote valleys have been severely affected by droughts over the past decade or so (Beg 2010).

Recommendations for Improvement of the Rangelands

A multi-pronged integrated conservation and development strategy comprising short, medium, and long-term interventions is required to protect, restore, and eventually improve the degraded rangelands. Some suggestions are outlined below:

- Comprehensive assessment and valuation of rangeland and associated resources should be carried out and a rangelands monitoring framework needs to be developed.
- The existing policies and legislation that include land use practices should be revised and enforced according to the changing circumstances.
- At present, range management in Gilgit-Baltistan is looked after by the Forests and Wildlife Department, however, rangelands don't seem to be a priority area for the Department. There should be a separate department for rangeland management with appropriate technical competencies.
- Restore degraded rangelands through appropriate measures.
- Develop and implement research-based rangeland and livestock management plans.
- Engage local communities in the implementation of the management plans.
- Instill rangeland conservation values among local communities through awareness and education programmes.

Conclusion

Rangelands and their interfaces are the dominant land-use type in Gilgit-Baltistan and encompass unique ecosystems like alpine meadows and forests, peatlands, swampy areas, high-altitude lakes, and agroecosystems adjacent to high pastures and on alluvial fans. These ecosystems provide critical services to about 1.5 million vulnerable mountain people who often depend upon natural resources for their livelihoods. In addition to sustaining local livelihoods, the high-altitude rangelands and their interfaces amass major freshwater reserves and are the source of rivers that flow into the Indus and fuel the agrobased economy of Pakistan. In the absence of a proper management system, the rangelands and their components are facing serious threats from overgrazing, erosion, and encroachment. A rangelands monitoring and management framework is highly desirable to conserve the rangeland and associated resources in the area.

References

Afzal, J; Ahmed, M; Begum, I (2008) 'Vision for Development of Rangelands in Pakistan - a policy perspective'. *Science vision* 14: 53–58

Ahmed, MU; Qadir, SA (1976) 'Phytosociological Studies along the way of Gilgit to Gupis, Yasin and Phundar'. *Pak. J. Forestry* 26:93–104

Alam, J (2010) *Endemic flora of Gilgit and Baltistan and conservation strategies for threatened endemic taxa*. Department of Botany, Karachi University, Karachi, Pakistan, pp278

Alvi, AS; Sharif, M (1995) 'Arid zone agriculture and research in Pakistan'. *Progressive Farming* 15: 5–12

Anwar, M (2011) 'Major Ecological Zones and Associated Wildlife'. In Akbar, G; Anwar, M (eds) *Wildlife of Western Himalayan Region of Pakistan*. WWF – Pakistan, Islamabad, pp17–27

Awan, SA (2002) The Climate and Flood Northern Areas of Pakistan, Risk Potential of Commission on Science and Technology for Sustainable Development in the South. (http://www.comsats.org.pk/main_introduction.htm)

Baig, S (2011) *Pastures and Pastoralism around Central Karakoram National Park*. WWF – Pakistan, Gilgit-Baltistan, Gilgit

Beg, GA (2010) 'Current status of pastoral systems in Gilgit-Baltistan and Chitral, Pakistan'. In Kretzmann, H; Abdulalishoev, K; Lu, Zhaohui; Richter, J (eds) *Pastoralism and rangeland management in mountain areas in the context of climate and global change; Regional workshop in Khorog and Kashgar*, 14-21 July 2010. pp214. Deutsche Gesellschaft fur Internationale Zusammenarbeit, Feldafing (Germany) Bittner, C; Paul, D; Methke, D; Wachter, T (2008) Land use in Shigar Valley. Freie University Berlin

Chaudhry, AA; Haider, MS; Ahsan, J; Fazal, S (2010) 'Determining carrying capacity of untreated and treated areas of Mari Reserve Forest (Pothwar tract) after reseeding with Cenchrus ciliaris'. *Journal of Animal & Plant Sciences* 20: 103–106

FAO (1987) *Pakistan's experience in rangeland rehabilitation and improvement*. Food and Agriculture Organization of the United Nations. Rome, pp70

FAO (1992) *Report on the round table on pastoralism*. FAO Technical Cooperation Programme, Project TCP/IRA/2255. Rome

Fowler, HJ; Archer, DR (2006) 'Conflicting Signals of Climatic Change in the Upper Indus Basin'. *Journal of climate change* 19:4276–4293

GoP/IUCN (2003) *Northern Area strategy for sustainable development (NASSD)*. IUCN Pakistan, Karachi, pp85

GoP (2010) *Draft National Rangeland Policy, Ministry of Environment*. Islamabad, Pakistan, pp16

IUCN (1997) 'Biological diversity in Pakistan. IUCN The World Conservation Union Pakistan, 1-Bath Island Road Karachi, pp16 Karki M. 2010. Climate Change in the HKH Mountains – ecosystems under stress and implications on livelihoods'. In Kretzmann, H; Abdulalishoev, K; Lu, Zhaohui; Richter, J (eds) *Pastoralism and rangeland management in mountain areas in the context of climate and global change; Regional workshop in Khorog and Kashgar*, 14–21 July 2010. pp214. Deutsche Gesellschaft fur Internationale Zusammenarbeit, Feldafing (Germany)

Karki, M; William, JT (1999) *Priority Species of Medicinal Plants in South Asia*. Medicinal and Aromatic Plants Program in Asia. Indian development and Research Centre. New Delhi, India

Khan, B (2011) In FAROZAN (Urdu); special edition on International Mountain Day, December 2011. Karachi, pp13-16

Khan, AG (2003) *NASSD Background Paper: Rangelands and Livestock*. IUCN Pakistan, Gilgit. pp47

Khan, B (2012) *Vegetation and land cover dynamics. Pastoralism-wildlife conservation conflict and climate change in Karakoram Pamir trans-border area between China and Pakistan*. PhD Thesis. Graduate University of Chinese Academy of Sciences, Beijing, China; 23-59

MACP/IUCN (2001) *Biomass assessment study Mountain Areas Conservancy Project*. IUCN Pakistan, Karachi

Mirza, ZB (1998) *Illustrated handbook of Animal Biodiversity of Pakistan*. Centre of Environmental Research and Conservation, Islamabad

PARC (1998) *National Forage and Fodder Research Programme. Natural Resources Division*. Pakistan Agricultural Research Council, Islamabad.

Qureshi, RU; Khan, WA; Khan, B; Iqbal, S; Shafiq M, Abid M; Yaqub, A (2011) 'First report on the biodiversity of Khunjerab National Park, Pakistan' *Pak. J. Bot* 43: 849-861

Rasool, G (1998a) *Saving the plant that save us: Medicinal plants of Northern Areas of Pakistan*. pp92

Rasool, G (1998b) *Inhabitants of the Jungle: Wildlife of Northern Areas of Pakistan*. Revised Edition. Saad Printo Pack, Rawalpindi, pp230

Roberts, TJ (1997) *The Mammals of Pakistan. Karachi, Revised Edition*. Oxford University Press. Karachi, Pakistan

Schaller, GB (2007) *A proposal for a Pamir International Peace Pak*. USDA Forest Service Proceedings RMRS, pp49

Wetlands International (2009) Factbook for UNFCCC Policies on Peat Carbon Emissions. http://www.wetlands.org/LinkClick.aspx?fileticket=OMprLKqOHCM%3D&tabid=56 (Accessed 25.03.13)

Zeidler, J; Steinbauer, JM (2008) *Climate change in Northern Areas of Pakistan – impacts on glaciers, ecology and livelihoods*. WWF-Pakistan, Gilgit, pp70