

High-altitude rangelands and Land Use Practices in the Karakoram-Pamir Landscape

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The Karakoram-Pamir Landscape (KPL) lies in the transboundary area northwest of the Qinghai-Tibetan Plateau in the border area of Xinjiang Province in China and Gilgit-Baltistan Province of Pakistan. The landscape is known for its snowy peaks, glaciated valleys, high-altitude wetlands, alpine pastures, and globally significant biodiversity. High-altitude rangelands cover 24% of this landscape and form the main base of livelihoods for the pastoral and agropastoral communities. These rangelands are currently fragmented as a result of, infrastructure construction, and unsustainable development, which has resulted in the weakening of traditional land use practices and increased the socioeconomic vulnerability of the local herders. The degradation of the landscape has been accelerated by climate change and increased populations of both humans and their livestock. ICIMOD has launched a transboundary landscape management initiative involving key partners in Pakistan and China to enhance cooperation among the countries for biodiversity management and sustainable development and to achieve long-term conservation and development goals in the KPL. This paper provides an overview of the high-altitude rangelands in KPL and the related grazing systems.

Keywords: biodiversity conservation; high-altitude rangelands; Khunjerab National Park; migratory pastoralism; Taxkorgan Nature Reserve

Introduction

The landscape of the Karakoram and Pamir Mountains lies to the northwest of the Qinghai-Tibetan Plateau in the border area of Xinjiang Province in China and Gilgit-Baltistan Province in Pakistan in the western part of the extended Hindu Kush Himalayas (HKH). Almost a quarter of the landscape area comprises high-altitude rangeland, which forms the main base of livelihoods for the pastoralists and agropastoralists in the region. Topographically, this landscape includes some of the most rugged and imposing mountains in the world, with peaks mostly above 6,000 masl and rising to 8,600 masl, i.e., the peak of K2 or Mount Godwin-Austin. Recently, the International Centre for Integrated Mountain Development (ICIMOD) launched a Karakoram-Pamir Landscape (KPL) initiative to enhance transboundary

cooperation for biodiversity management and sustainable development in the China-Pakistan border region. The initiative began with an agreement signed in Beijing for bilateral collaboration between the governments of China and Pakistan to ensure the protection of Marco Polo sheep (*Ovis ammon polii*) and other endangered species in the two adjacent transboundary protected areas – Khunjerab National Park in Pakistan and Taxkorgan Nature Reserve in China, which represent unique cold desert ecosystems.

The outstanding features of the KPL include alpine lakes, mud volcanoes and other geological processes, highly fragile alpine ecosystems such as rangelands, small areas of forest, and wetlands (Khan 2011). The high-altitude rangelands in KPL are rich repositories of biodiversity and water, and providers of various ecosystem goods and services on which both upstream and downstream communities depend. The KPL provides habitats for wildlife such as ibex (*Capra sibirica*), blue sheep (*Pseudois nayaur*), and Marco Polo sheep (*Ovis ammon polii*). Carnivore species like Himalayan brown bear (*Ursus arctos isabellinus*), Himalayan lynx (*Lynx lynx*), snow leopard (*Uncia uncia*), and Tibetan wolf (*Canis lupus chanco*) are found in different parts of the landscape (Schaller et al. 1987; Khan 1996). The area is also rich in freshwater and tourism resources, which if managed carefully can bring about socio-ecological change in both countries, and especially for the pastoral communities residing in the border region. The KPL initiative is being implemented through the involvement and with ownership of the respective governments and allied departments on both sides of the international boundary. This paper provides an overview of the current understanding of the high-altitude rangelands and their related grazing systems and land use practices in the KPL region, which can be used as a benchmark for future planning of transboundary conservation.

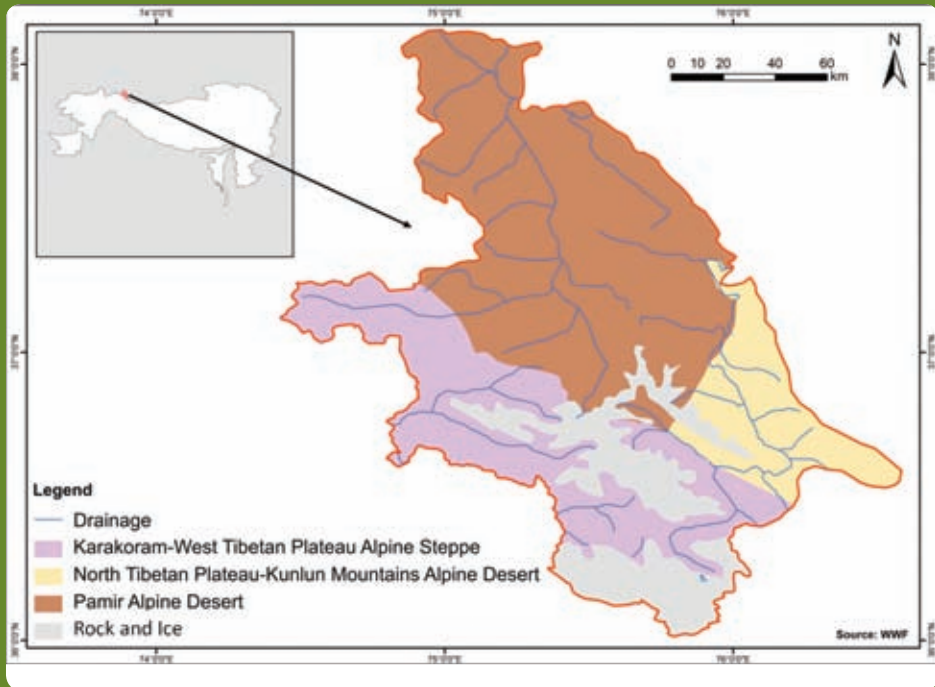
Ecoregions and Life Zones in the KPL

The KPL is a complex mountain region with diverse vegetation types especially adapted to an arid and/or high-altitude environment. The eastern boundary of the landscape merges into the Pamir Plateau and is dominated by semi-desert and desert, whereas the western boundary connects with the high peaks of the Karakoram range and contains alpine vegetation appropriate to the cold sub-humid conditions (Figure 2). The largest ecoregion in the KPL (60% of the area) is alpine desert, formed as a result of the continental and high-altitude conditions (Table 2). Alpine steppe, including alpine meadows, accounts for one quarter of the total and is the most important vegetation supporting local livelihoods in the form of migratory pastoralism.

Table 2: Ecoregions in the KPL

Ecoregion	Area (ha)	Area (%)
Karakoram-West Tibetan Plateau Alpine Steppe	473,070	25.2
North Tibetan Plateau-Kunlun Mountains Alpine Desert	227,696	12.1
Pamir Alpine Desert	890,755	47.4
Rock and Glacier	286,472	15.3
Total	1,877,993	100

Figure 2: Distribution of ecoregions in the KPL



The major life zones are described in two parts: the Taxkorgan Nature Reserve (TNR) in China and the Khunjerab National Park (KNP) in Pakistan.

Taxkorgan Nature Reserve

Taxkorgan Nature Reserve is located in the eastern part of KPL in western Xinjiang in China, on the western fringe of the Pamir Plateau. Much of the terrain is too high and arid to support much vegetation.

Sub-alpine steppe: 3,300–3,900 masl

In the sub-alpine belt, the landscape is dominated by steppe-like vegetation with sparse herbaceous plants and dotted shrubs. The vegetation cover rarely exceeds 15% and the average concentration of species is only around 4–6/100 m². The sparse vegetation is dominated by prickly cushion plants such as *Acantholimon*, *Lycopodioides* and *Thylacospermum caespitosum*. Other typical species include *Krascheninnikovia ceratoides*, *Ajanía fruticulosa*, *Stipa caucásica*, *S. glareosa*, and *Oxytropis microphylla*. The few shrubs such as *Ephedra intermedia*, *Berberís ulicina*, *Rhamnus prostrata*, *Myricaria elegans*, and *Potentilla salesoviana* are usually confined to special situations such as walls of bedrock, boulder-rich slopes, gullies, and scree fans.

Alpine meadows: 3,900–4,700 masl

The deeper river valleys in the central north-facing slope of the Karakoram are more arid than the higher slopes above around 4,200 masl (Dickore 1991). The alpine belt, which is extensive throughout the TNR, consists of alpine sedge-meadows (*Kobresia* spp. and *Carex* spp.) with many forb species and is similar to the vegetation over much of the Tibetan Plateau and the Tien Shan. From 4,200 to 4,500 masl, chamaephyte-communities (*Astragalus webbianus*, *Oxytropis chiliophylla*, *Ephedra monosperma*, *Pleurospermum govanianum*, *Ajania tibetica*, *Rhodiola fastigiata*, *Poa poophagorum*, and *Elymus schrenkianus*) grow on the boulder-strewn slopes. Tall *Carex nivalis* meadows (with *Delphinium brunonianum* and various other species) cover relatively large areas.

Sub-nivale vegetation: 4,700–5,200 masl

Delimitation of the sub-nivale vegetation belt is difficult, although the species composition is very characteristic. *Sibbaldia tetrandra* and *Saussurea gnaphalodes* are frequent cushion-like species on superficially thawing permafrost slopes. About 37 species of phanerogams have been found here, including nine species not found elsewhere (*Oxytropis* spp., *Carex haematostoma*, *Draba winterbottomii*, *Lagotis globosa*, *Potentilla gelida*, *Saxifraga oppositifolia*, *Sibbaldia olgae*, *Stellaria decumbens* and *Waldheimia tridactylites*). High-alpine or sub-nivale turf spots with a vegetation cover up to 90% are confined to the gentler slopes and shallow depressions.

Khunjerab National Park

Khunjerab National Park is located on the western side of the KPL in Gojal tehsil in Hunza-Nagar District in the extreme north of Pakistan. Major vegetation types in KNP include:

Sub-alpine steppe: below 3,700 masl

Sub-alpine dry steppe with 15-20% of total cover is found at medium and low elevations on south-facing dry slopes not covered by sub-alpine scrub and forest. It is sparsely vegetated with *Juniperus* spp. and *Artemisia* spp. A few woody species are found, including *Lonicera quinquelocularis* and *Artemisia mexicana*. *Primula* is the most prominent plant. Grassy species are found in relatively moister places and include *Setaria* spp., *Festuca* spp., *Poa bulbosa*, *Poa sinaica*, *Phleum* spp., and *Carex* spp.

Alpine meadows: 3,500–4,400 masl

Alpine meadows (20% of total cover) are confined to north-facing slopes, level ground, and depressions above 3,500 masl and along glaciers. They are generally rich in plant biomass due to an adequate moisture regime and are therefore important habitats for both domestic and wild herbivores. Sedges and grasses dominate, but forbs such as *Primula macrophylla*, *Potentilla desertorum*, *Gentiana* spp., *Anemone* spp., *Polygonum* spp., *Sedum* spp., *Plantago* spp., and *Saxifraga sibirica* are also common. *Poa bulbosa* and *Poa sinaica* are prominent among the grasses.

Sub-nivale vegetation: above 4,200 masl

Permanent snow field and cold desert cover an estimated 25-30% of the park area, lying mainly above 4,200 masl. Vegetation is sparse and most species adopt ecological modifications in order to cope with extensive sun radiation and chilling temperatures. The characteristic species in the community are *Saussurea simpsoniana*, *Allardia glabra*, *Christolea crassifolia*, *Primula macrophylla* subsp. *moorcroftiana*, *Oxytropis microphylla*, *Oxytropis chiliophylla*, *Potentilla desertorum*, *Mertensia tibetica*, and *Potentilla pamirica* subsp. *pamiroalorica*.

Grazing System and Land Use Practices in KPL

Pastoralism is the predominant land use in the Karakoram-Pamir border region and is only occasionally mixed with crop farming in low lying flat areas and valley bottoms. Livestock grazing on rangelands is a prominent way of life for the mountain communities and a major source of livelihood (Khan 2012). The grazing lands are characterized by steep, dissected slopes and narrow valleys, and terrain that is subject to active erosion and naturally unstable. Livestock herding accounts for 20–35% of total household income, contributing around 5.3% and 11% to the total GDP of China and Pakistan, respectively (Zhou et al. 2010; Beg 2010). Two different types of pastoral practices are common: transhumance and sedentary. In the transhumant system, animals are moved across a vast mountain terrain, utilizing sub-alpine and alpine pastures in a complex pastoral herding system according to season. Pastoralists maintain their principal settlements at lower altitudes, where they live for approximately seven months of the year. The system is characterized by a continuous search for pasture and the year round movement of cattle, sheep, and goats. In the sedentary system, the animals are kept on the farm all year round. Cattle (mainly yaks), sheep, and goats are allowed to graze on gentle slopes on community land and fallow fields and in fields after harvesting. Only 5% of the total population of ruminants in KPL are thought to be stall fed. Maize stover, hay, and grasses are the principal sources of fodder for stall feeding. Maize stover, green grass, and wheat straw are sold or exchanged among farmers in some villages.

The border area of Khunjerab National Park and Taxkorgan Nature Reserve is inhabited by Wakhi-Tajik, Kyrgyz, and Burusho people and their livestock (Schaller and Kang 2008). In the traditional form of migratory pastoralism, the movement up and down the mountains takes place in stages (Suleri et al. 2002). In late April or early May a part of the family takes the livestock to the edge of the coniferous forest where a second house is located. They stay there for three to four weeks before moving to a third house located within the forest itself. After a further stay of three to four weeks, both livestock and people move to the high alpine pasture, where they remain for up to two months. The return journey begins with the first snowfall in late September or early October (Figure 3). For the Wakhi people who reside in or near the Khunjerab National Park, women take care of yaks, sheep, and goats on the alpine pastures above 4,000 masl during the summer. In late autumn, herders move the yaks to lower elevations where they look after them through the winter (Knudsen 1999).

Figure 3: Pastoral migration in the KPL and surroundings



In Taxkorgan, the traditional migratory management system has been gradually transformed to a more sedentary style since the 1990s. With the support of the local government, many settlements were constructed with improved infrastructure. Even so, the seasonal pastures have been kept for rotational grazing of livestock. Of about 4,634,000 ha of summer pasture in the county, which are usually grazed for 120 days, 5,924,000 ha are winter pasture, used for 140 days and 211,000 ha of pastures are used during the transitional period in spring and/or autumn (Editorial Board 2009).

The local communities in KPL depend solely on the natural resources of the reserves for their livelihood. They collect fuelwood, timber, fodder, and non-timber forest products (NTFPs) from the area for subsistence and sale. Because of the limited livelihood opportunities, and to meet the energy needs, there is heavy pressure on bushes and scrub in the form of overgrazing and uprooting. The extensive collection of fuelwood to meet the demand of an increasing population has been reported as threat to habitat in Taxkorgan, with desertification accelerated by human activities (Animal Husbandry Bureau of Xinjiang 1993).

The high-altitude rangeland in KPL has become a tourist destination for mountaineering, culture (e.g., the ancient Silk Road), and archaeological sites. Tourism has provided economic and livelihood benefits to the local communities, but unregulated tourism is having a negative effect on the KPL due to the large amounts of solid and human waste left by expeditions and exploitation of fuelwood and other resources along trekking routes.

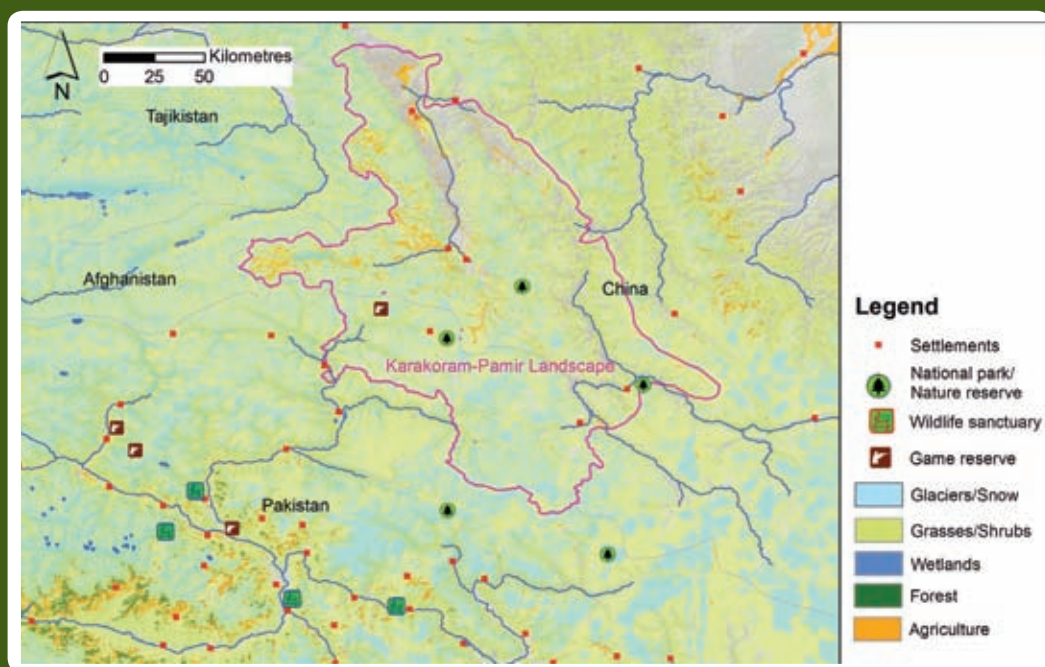
Challenges to Rangelands and Land Use Practices

The high-altitude rangelands in the landscape share boundaries with several other ecosystems such as forests, wetlands, and agricultural lands (Figure 4). Any shift in these boundaries can be an indicator of ecosystem dynamics and external disturbances. Recently, the intensification of land use in the high-altitude rangelands has resulted in some man-made interfaces being formed, e.g., the boundary of the protected area, which occasionally becomes a secondary transitional belt between conserved and degraded vegetation. Looking at the boundary shift can be a feasible way of studying the status and challenges faced by the rangeland ecosystem.

Degradation of rangelands

Although the rangelands in the KPL span a relatively large geographical area, they are an under acknowledged and rarely described resource. The KPL rangeland is under threat as a result of removal of shrubs and trees for fuelwood, overgrazing by livestock, and other land use changes. During the last few decades, the productivity of the rangelands has been adversely affected due to the growing human and livestock population, centuries of overgrazing, and changes in land use practices (Ahmad 2000). Overgrazing has also resulted in a move in species composition towards less palatable forage species, including weeds and poisonous plants, in a number of range and pasture ecosystems. In addition, extraction of the

Figure 4: Rangeland resources and interfaces in the KPL



roots of species of medicinal plants is not only damaging the vegetation but also upsetting the surrounding soil. Collection of *Saussurea simpsoniana* (boshi phonar) by Pakistani locals and Chinese traders is an emerging threat to the landscape. In the part of the landscape in China, extraction of medicinal plants by local traders is now occurring on a large scale; several valuable medicinal plant species are at risk, and there has even been destruction of vegetation. The main products collected by local people include *Radix Glycyrrhizae* (*Glycyrrhiza korshinskyi*, *G. inflata*), *Herba Ephedrae* (*Ephedra sinica*, *E. equisetina*, and *E. intermedia*), and *Apocynum venetum*. Furthermore, expansion of settlements, construction of roads recreational facilities, and other infrastructure, and other economic activities have also contributed to vegetation destruction and fragmentation.

Impacts of climate change

Climate change and its impact on ecosystems, especially high-altitude ecosystems, is an important current and emerging issue. The change in climate is posing a serious threat to the fragile ecosystems and poor communities of the mountainous areas of KPL. Almost all the natural ecosystems in the KPL are vulnerable to climate change, with effects including, but not limited to, loss of habitat, species extinction, growth of less palatable grasses in pastures, diseases in wild animals, pest attacks on crops, increased intensity of melting of glaciers, high turbidity in water bodies, heat waves, cold spells, droughts, landslides, water-borne epidemics, avalanches, heavy rainfall, heavy snowfall, glacial lake outburst floods, and soil erosion.

Furthermore, due to both climate change and population increase, the availability of water resources has become a major issue in Taxkorgan in terms of both quantity and quality. The water resources are used by both nomadic herders and livestock. There are few protective measures and water quality is frequently affected by livestock. More frequent droughts in recent decades have led to occasional shortages of drinking water; at the same time floods in the summer also affect the quality of drinking water and the health of local people. It is believed that global warming is contributing to the modification and breakdown of the traditional migratory system and sometimes disturbing the natural upstream-downstream interactive system. With earlier warming in spring, and a longer summer in the high mountains, herders in the Pakistan part of KPL can move earlier to higher summer pastures, and the traditional migration route has been modified accordingly (Joshi et al. 2013). The longer stay in summer pasture might help herders cope with the shortage of winter feedstuff, traditionally a critical issue, but may also increase pressure on this fragile ecosystem, allowing less time for recovery. A warmer winter might also lead to some negative effects, such as an increase in livestock disease. The nature of climate change has not yet been fully understood by scientists and is thought to vary greatly at the local level (Hewitt 2005).

Fragmentation of landscape

Historically KPL provided contiguous habitat for the local movement of threatened fauna. Recently, the international boundary between China and Pakistan has been fenced with

barbed wire leading to fragmentation of habitat. This has affected migration of wildlife especially the endangered Marco Polo sheep, which could lead to more intensive inbreeding and further degradation of the population. Flagship species such as Marco Polo sheep and snow leopard, share common wildlife habitats. Due to unsustainable hunting, habitat destruction, and restricted movement of these species across the border, the growth of the species is very limited. Land ownership conflicts have also contributed to natural resource exploitation on the Pakistan side (Sheikh et al. 2002). On the Chinese side, settlement of herders and fencing of pastures has introduced new issues in rangeland management. Enclosure of winter pasture on a large scale impacts the migration routes of both livestock and wildlife. A more sedentary grazing system can lead to intensive overgrazing around herders' winter settlements. A long-term monitoring system on land use change should be established to improve understanding of the changing trends and impacts.

In some parts of the KPL, especially in sub-alpine and alpine meadows with peat accumulation have been drained to enable cutting of peat for fuel (Ullah and Khan 2010). The collection of peat from wetlands not only destroys the vegetation cover, it also changes the hydrological cycle of the alpine ecosystems, which further impacts downstream areas. Fragmentation can also be seen in the timberline, the ecosystem interface between grasslands and forests in the alpine belt. The *Betula utilis* belt, which forms the upper treeline, has been largely destroyed due to depression of the treeline as a result of overgrazing (Schickhoff 1995). Since fuel is very scarce above the timberline, considerable areas of sub-alpine forest and scrub have been cleared in order to meet fuel needs.

Human wildlife conflict

Human-wildlife conflict is another major problem in the high-altitude rangelands of the KPL. Local communities have a close interaction with wildlife and high probability of sharing habitat for livestock grazing. Khan (1996) reported that about 70% of the pastures in the KNP area were degraded due to excessive use by domestic livestock, reducing the availability of forage for wild herbivores. Wildlife such as snow leopard and wolf, which prey upon domestic livestock, often cause economic loss. A decline in the availability of wild ungulates, a key component of the snow leopard diet, due to extensive hunting practices and habitat loss has caused a significant shift in predation pressure toward domestic stock in some areas of KPL (Khan 2012). Depredation by carnivores has become a major livelihood concern and an emerging challenge for conservation managers and park authorities in the protected areas of KPL region. According to Wegge (1989), livestock depredation rates in KNP were 10%, mainly due to snow leopard and wolf. In Taxkorgan Nature Reserve it was 7.6%, mainly by snow leopard (Schaller et al. 1987).

Conclusion

The high-altitude rangelands in the KPL region provide seasonal grazing grounds for native wildlife and livelihood options for the pastoral communities. Unfortunately, these rangelands

are becoming increasingly fragmented as a result of unsustainable development, resulting in the weakening of traditional land use practices and increased socioeconomic vulnerability of local herders. Lack of good understanding and description of rangeland ecosystems further aggravates the degradation process in KPL under the challenges of climate change. Local livelihoods, social needs, wildlife, and their complex interactions call for scientific innovation and handling of this landscape to facilitate sustainable adaptation by local communities harmonized with the natural requirements of the KPL. Close transboundary cooperation is needed between the stakeholders in Pakistan and China to conserve the biodiversity and sustain the livelihoods of local herders in this unique landscape.

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