

DYNAMICS OF ABOVE GROUND HERBACEOUS BIOMASS IN HIGH ALTITUDE RANGELANDS OF PAKISTAN

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ABSTRACT

Periodic monitoring of above ground biomass is a vital component for effective management of rangelands health and productivity. Rangelands in Gilgit-Baltistan are dominant land-use forms, spanning over 25% (16450.5 km²) of its total area, and contributing about 30-40% in the total household income. The present research is an attempt to document the field based above ground biomass assessment of selected rangelands in the Hindu-Kush, Karakorum and Himalayan (HKH) regions of Pakistan and to relate it with the current livestock numbers in order to assess the grazing pressure on these rangelands. Five sampling plots (1km²) at 17 catchments of five watersheds, representing the three mountain ranges were randomly selected for the study. The mean elevation of sampling plots ranged from 2500 m to 4100 masl. Within each sampling plot 3 quadrats (1m²) were chosen, located, at least, 250 m apart from each other. For each of the sampling plot plant species were identified, biomass was calculated, and evenness and diversity of species was determined. On average the wet as well as dry biomass, across all the grazing areas was 2279 kg/ha and 650 kg/ha, respectively, with highest in Khunjerab (2831 and 704 kg/ha) and lowest in Bathraite (1590 and 596 kg/ha). About 138 species belonging to 27 families were recorded from the study areas. The highest species richness was found in the Deosai Plains (11) followed by Bathraite (10). It was observed that the grazing areas nearest to the permanent settlement have highest non-palatable species, possibly due to extensive grazing. Grazing pressure in all pastures is increasing with maximum in Babosar and Bathraite, showing decline in productivity of the rangelands at these sites. Grazing management can improve pastures conditions as evident from high biomass in Khunjerab, attributed to grazing management under the National Park regime. This research will provide a baseline study for further research on rangeland management activities in the area and their sustainability.

Key words: Rangelands, Gilgit-Baltistan, grazing, livestock, encroachment, productivity

INTRODUCTION

Rangelands mean the land areas which have indigenous vegetation (natural potential or climax) and which consist largely of grasses, shrubs, forbs, and grass-like small plants. These include savannas, shrub land, natural grasslands, tundra, deserts, alpine pastures, meadows and marshes (Society for Range Management, 2001). Globally about 120 million pastoralists depend on rangelands while upholding more than 5000 M ha of rangelands (White *et al.*, 2000; Joshi *et al.* 2013), these rangelands are a great sink of carbon as it stores up to 30% of the world's soil carbon (Tennigkeit *et al.* 2008). Rangeland ecosystems provide multiple services for millions of people living in the Himalayan Hindu-Kush and Karakorum (HKH) mountain ranges. These rangelands are presently facing a myriad of challenges, such as over grazing, massive erosion, land use change, encroachment and climate change (Dong *et al.* 2009). Rangelands in HKH region of Gilgit-Baltistan are primary source of livelihood for agro-pastoral life, which contribute to food security and major portion of household income (Khan *et al.* 2013). Despite the general

arid and dry conditions, the rangelands contribute a major part of the food requirements for 2.0-2.5 million heads of livestock (Beg, 2010). In addition, rangelands provide various services; they are the primary sources of wildlife, timber, fuel wood, medicinal herbs/plants, biodiversity, etc. (Hamilton and Radford, 2007). Rangeland ecosystems provide multiple services for millions of people living in the Himalayan Hindu-Kush and Karakorum regions. Rangelands in Gilgit-Baltistan province are a dominant land-use, spanning over 25% of the total land-surface having an area of 16450.5 km² (Ishaq, 2017) and contribute up to 30-40% in the total household income (Khan, 2013). The rangelands in Karakorum regions are highly degraded mainly due to the removal of shrubs and trees, which are a source of fuel wood. The said degradation resultantly causes high erosion. Due to increase in livestock number and decades of over grazing the productivity of these rangelands has been adversely affected (Ahmad, 2000). Extensive grazing activities without any rangeland management has also resulted in species composition towards less palatable forage species *i.e.*, weeds and poisonous plants,

in many rangelands and pasture ecosystems in HKH regions (Joshi *et al.* 2013).

With changing climate and increasing human population biomass assessment is considered very important for national development planning as well as maintain ecosystem services and products including carbon sequestration (Parresol, 1999; Zheng *et al.* 2004; Zianis and Mencuccini, 2004; Pandey *et al.* 2010; Devagiri *et al.* 2013). Now a days biomass is being progressively used to help quantify carbon pools and fluxes from terrestrial biosphere, which is associated with land cover and land use changes (Cairns *et al.* 2003). Three major approaches are used for biomass assessment among which field-based biomass assessment is considered to be more accurate (De Gier, 2003) than remote sensing based biomass assessment and Geographic Information System (Lu, 2006). Above ground biomass estimations provide a vital indication of forage availability in pastures and the monitoring of growth dynamics gives indications of vegetation health condition in the pastures and rangelands (Reeves *et al.* 2001). In this way the pastoral communities get to know about the above ground vegetation health and its carrying capacity to graze their livestock during different seasons (Mundava *et al.* 2014).

Due to many environmental stresses and challenges, estimating plant biomass in rangelands is very important in the assessments of livestock fodder

availability and rangeland health condition for proper grazing management (Mbow *et al.* 2014). The present research is an attempt to investigate above ground herbaceous biomass of some selected rangelands in the HKH region of Pakistan. This study will act as a baseline research for rangeland management and sustainability in HKH region.

MATERIALS AND METHODS

Study Area: The study area is located in northern Pakistan/Gilgit-Baltistan (Figure 2, Table 1 and Table 4). Climate conditions in Gilgit-Baltistan vary from monsoon to moist temperate in Himalayas while arid and semiarid in Karakoram and Hindu Kush mountain ranges. 200 mm annual rain has been observed in areas below 3,000 m asl, while temperature in valleys vary from 40°C in summer to less than -10 °C in winter (Khan *et al.* 2013). Overall 5 sites with major rangelands were selected for detailed surveys, ranging from 2500 m to 4100 m asl in the altitude (Figure 1). The sites were selected on the basis of altitudes, livestock grazing pressures and ecological conditions. Grazing pressure is high in summer pastures during the months of May to end of August. In overall study area grazing lands are divided into winter pastures, intermediate pastures and summer pastures, which are distributed over different elevational profile.

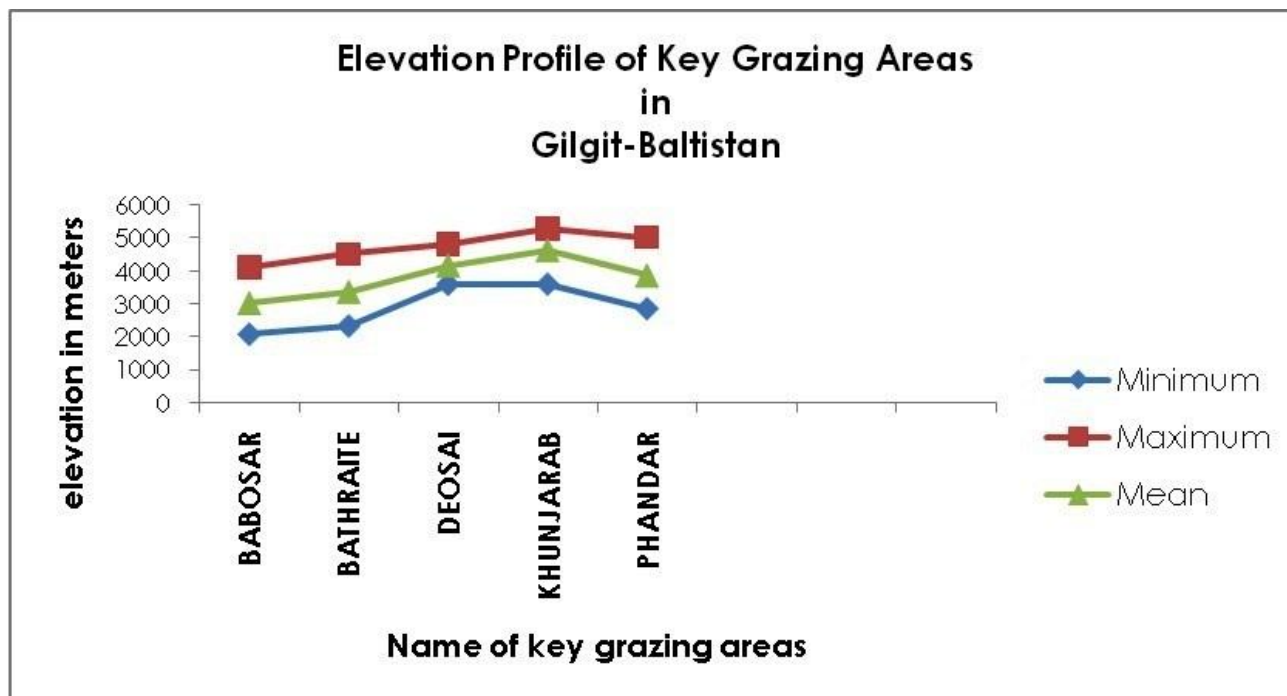


Figure 1. Elevational profile of major rangelands; NOTE: DNP, Deosai National Park; KNP; Khunjerab National Park

Table 1. Summary of key rangelands and their distribution along different mountainous ranges.

#	Name of grazing area	Total surface areas (km ²)	District	Mountain Range
1.	Babosar	975	Diamer	Western Himalaya
2.	Bathraite	3740	Ghizer and Dimer	Hindu Kush
3.	Deosai National Park	2503	Astore and Skardu	Western Himalaya
4.	Khunjerab National Park	2504	Hunza	Karakoram-Pamirs
5.	Phandar	1473	Ghaizer	Hundu-Kush

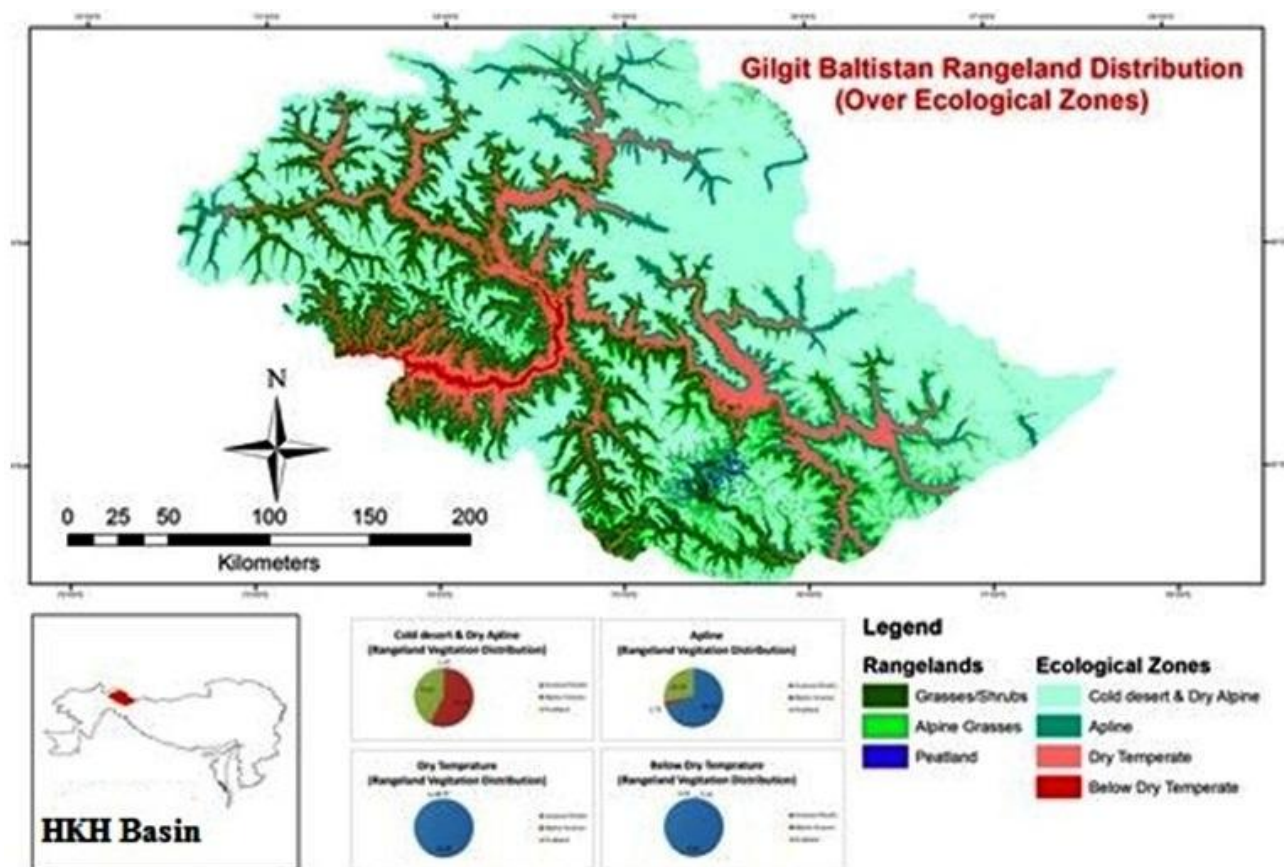


Figure 2. Rangeland distribution over different ecological zones in Gilgit-Baltistan

For each of the five sampling sites, grazing areas were selected keeping in the view accessibility to rangelands in the specific local circumstances and other considerations such as vegetation type and cover (homogeneity and heterogeneity) and altitudinal gradient. Five sampling plots, measuring 1 x 1 Km were selected in each sub-watershed. Within each of 1 Km² site 5 sampling quadrats were chosen for the study, such that all of them were, at least, c. 250 m apart from each other. The locations of each of the sample quadrats were marked using a handheld GPS device (Garmin ® GPSmap 60CSx). The fieldwork was carried out during July-August 2016 considering peak vegetative growth at this time. The size of quadrat chosen for the sampling was 1.5 x 1.5 feet (0.21m²). Within each of the sampling quadrat, the herbaceous vegetation was cut at the level of 2.3 cm above ground (as fraction of palatable portion of

the herbage) and placed in the pre-weighed A3 size paper bags (Mueller *et al.* 1974; Kent and Coker 1992 cited in Raza *et al.* 2014; Ishaq, 2017). Fresh biomass was measured during the fieldwork using a digital balance. Subsequently, the samples were oven dried at (65°C for 24-48 hours) until a constant weight was achieved and then dry weight of the biomass was measured. For the purpose of reporting, the biomass data were projected into kg ha⁻¹. The plant specimens were collected for identification with voucher numbers assigned for the purpose of identification. The identification of flora was carried out at National Herbarium of Pakistan (RAW), National Agriculture Research Center (NARC) Islamabad. Palatability ranking was done through consultations with local people as well as field observations on a nominal scale from High>Medium>Low>Nil/non palatable. Species richness

was calculated as the total number of plant species occurring in a community. Whereas, species evenness or equitability was calculated using evenness indices to standardize abundance and range from near 0 when most individuals belong to a few species, to close to 1, when species are nearly equally abundant (Smith and Wilson, 1996; Wilson *et al.* 1996). The Shannon-evenness index (E1) was applied to quantify the evenness component of diversity and was calculated as: $E_1 = H' / \ln s$

RESULTS AND DISCUSSION

On average the wet as well as dry biomass, across all the grazing areas was 2279 kg ha⁻¹ and 650 kg ha⁻¹, respectively. The average normal biomass for alpine pastures is said to be around 1500 kg ha⁻¹, however, a low productivity (100-500 kg ha⁻¹) across trans-Himalayan pastures has also been found in the previous studies (Mohammad, 1989, Khan, 2003). The dry as well as wet biomass was recorded highest in Khunjerab National Park (average, wet biomass 2831 kg ha⁻¹ and dry 704 kg ha⁻¹) followed by Deosai National Park (average, wet biomass 2615 kg ha⁻¹ and dry 681 kg ha⁻¹).

Table 2. The wet and dry biomass across different grazing areas

Grazing area	Name of sub-watershed	Wet Biomass (kg ha ⁻¹)	Dry Biomass (kg ha ⁻¹)
Khunjerab National Park	Zero point	2324	500
	Kuksel	3240	759
	Gulhail	2658	775
	Bithkish	2098	420
	Dhee	3998	1125
	Qarchenae	2671	648
Phandar	Barseth	2267	680
	Langar	2516	697
	Sanji Nulla	2618	681
Bathraite	Uskoor	1067	784
	KolayBaray, Majar Sgar, Chokopatara	2661	576
	Dalimoos, Moshadogan, Naron Namal	1042	428
Deosai National Park	Chilum Nala	2172	986
	Sardar Kothi	3136	699
	Deosai Plan	1537	360
Babosar/Gitidas	Loyalhalol	1518	416
	Gall/As	1322	464

The lowest amount of wet and dry biomass was observed in Bathraite valley (average, wet 1590 kg ha⁻¹ and dry 596 kg ha⁻¹). These results could be attributed to overgrazing by the largest number of livestock in Bathraite rangelands (Table 3). In Bathraite and Babosar there was not much difference in dry biomass, however, the wet biomass was higher in Babosar as compared to Bathraite (Fig 3). The similarity between Bathraite and Babosar may be due to the similar ecological, geographic and topographic conditions.

The higher biomass in Khunjerab National Park can be attributed to a grazing management system in the area, practiced by local community as part of the co-management of the Khunjerab National Park. The grazing system regulates number of animals and seasonality in the given pastures. The summer pastures of KNP are generally rich in herbaceous biomass due to an adequate moisture regime and so important providing habitats for both domestic and wild herbivores (Joshi *et al.* 2013). People living near the Khunjerab National Park, usually

the woman take care of the goats, sheep and yaks in the summer pastures above 4000 m asl, while in winter they bring them to winter pastures where whole family is responsible for looking after them (Knudsen, 1999).

The rangeland conditions are not good in Bathraite and Babosar due to highest livestock number as compared to other regions in the study area. These regions unlike the KNP have no grazing management plans and are open for free grazing. The wet biomass and dry biomass were found lowest in Babosar and Bathraite this could be due to largest number of livestock in both the rangelands (Table 3). This research shows highest number of livestock in Bathraite followed by Babosar, while lowest livestock were found in Khunjerab National Park. Animal density is highest in Babosar (176 animals km⁻²), followed by Bathraite (69.38 animals km⁻²).

It was found that livestock herding is the major livelihood activity in these areas followed by agriculture. Livestock number has been increased from last two decades, according to the livestock census of Gilgit-

Baltistan 1996, the population of goats and sheep has increased significantly from 0.88 million to 1.56 million from 1976 to 1996, respectively, with an annual growth rate of 3.56 %. This increase has enhanced pressure on rangelands (Hussain, 2014). Furthermore, research shows that livestock population in Gilgit-Baltistan during the last few decades has been increased significantly. Many

of the livestock, generally small ruminants are grazed in the rangelands primarily during summer because of the shortage of fodder production. The tremendous increase in domestic herbivores over the period and their greater dependency on rangelands has resulted in huge grazing pressure on the high altitude rangelands (Khan, 2013).

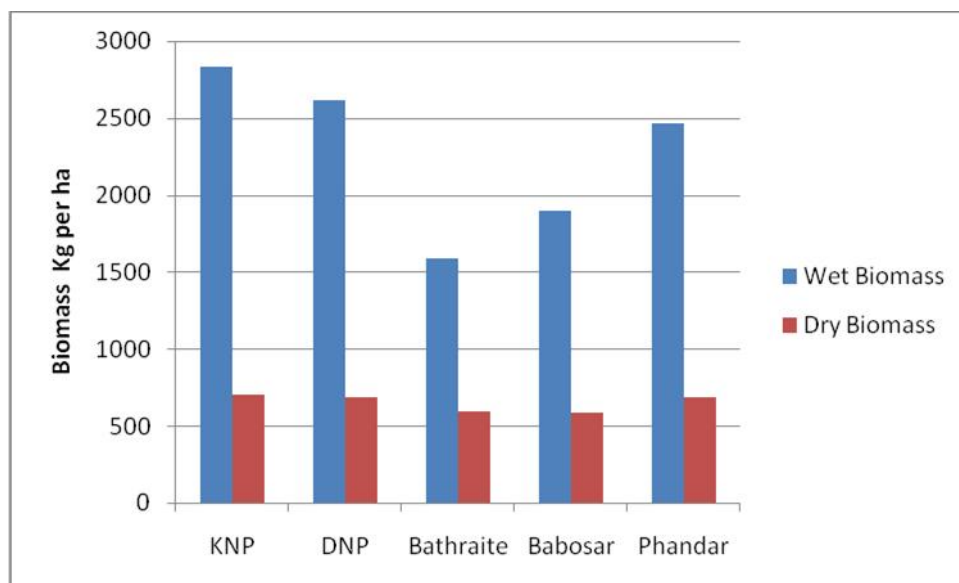


Figure 3. Average wet biomass and dry biomass across different range lands (Kg ha⁻¹).

Note: KNP; Khunjerab National Park; DNP; Deosai National Park

Table 3. A brief summary of livestock types and numbers in the valleys of selected grazing areas.

Name of Grazing Area	Tehsil	Beneficiary Valleys	Sheep	Goats	Cattle	Yak	Others**	Total	References
BABOSAR	Chilas	Batoghah	1193	14981	3565	0	958	20697	LS&DD, 2012
		Niat	4839	25182	4221	0	119	34361	LS&DD, 2012
		Thak	1765	26580	3947	0	863	33155	LS&DD, 2012
		Total	7797	66743	11733	0	1940	88213	
BATHRAITE	Gupis	Bathi	615	17472	5211	0	720	24018	LS&DD, 2012
		Dariial	1003	13750	1744	0	379	16876	LS&DD, 2012
		Darel	534	16912	3779	8	1206	22439	LS&DD, 2012
		Khanbari	3106	60799	11435	0	2648	77988	LS&DD, 2012
		Tangir	5258	108933	22169	8	4953	141321	
DEOSAI	Kharmang	Dhappa-Katisho	0	0	2000	2	0	2002	DNP, 2015
		Mehdiabad	50	100	1500	2	0	1652	DNP, 2015
		Deosi (Astore & Inner)	200	350	600	0	0	1150	*CBO
		Skardu	300	500	970	6	0	1776	DNP, 2015
		Total	550	950	5070	10	0	6580	
KHUNJERAB PHANDAR	Gojal-II Gupis	Khunjerab	2870	1536	410	180	30	5026	Khan, 2013
		Phandar	3000	4000	2000	50	250	9300	CBO

Note: *CBO=Community based Organization of the respective valleys; others**=donkeys and horses

Table 4. Other biophysical attributes of the key grazing areas.

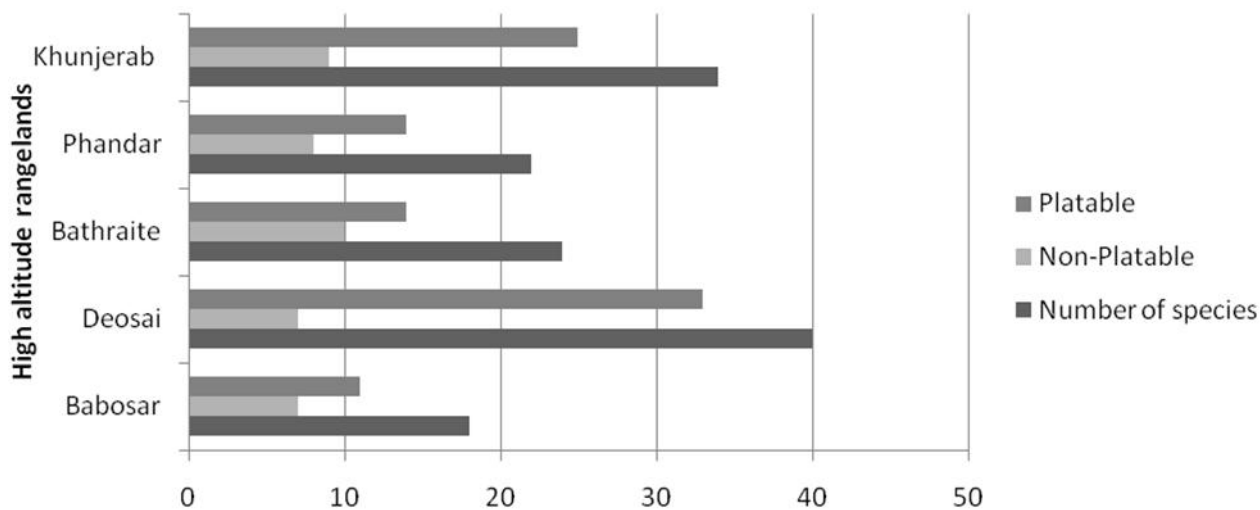
Name of Grazing Area	Total surface area (km ²)	Grazing lands		Livestock Density (Animals Km ⁻²)	Protected Areas	Important Wetland
		Km ²	% of total land surface			
Babosar	975	500	51.33	176.33	-	Lulusar Lake
Bathraite	3740	2037	54.46	69.38	HSNP	-
Deosai	2503	1295	51.72	5.08	DNP	Sheosar Lake
Khunjerab	2504	144	5.74	34.93	KNP	-
Phandar	1473	102	6.95	91	HSNP	Phandar Lake

Note: CKNP, Central Karakorum National Park; KNP, Khunjerab National Park; DNP, Deosai National Park; HSNP, Hunderab-Shandoor National Park; Source (Ishaq, 2017).

Species Composition and Palatability: A total of 26 species were recorded in the sampling quadrats. The species differed at each site. The highest species richness was found in the Deosai (2.4) and Khunjerab (2). The species diversity showed that there was an increase in number from spring to summer and then decreased after summer. As well as the species evenness also got increased from spring to summer and decreased afterward. About 138 species belonging to 27 families were recorded during the fieldwork, including the species found in the sample plots (Figure 4). The highest samples of species were recorded from Deosai (n= 40), Khunjerab (n= 34), Bathraite (n=24), Phandar (n= 22), Babosar/Gatidas (n=18). About (n=7) in Deosai, (n=9) in Khunjerab, (n= 10) in Bathraite, (n= 8) in Phandar and (n= 7) in Babosar /Gatidas were non-palatable species. The palatability and non-palatability was identified by asking from the local shepherds. The grazing areas nearest of the permanent settlement have highest non-palatable species; this is because of the external disturbances by local communities.

The relationship among environmental variables like altitude, climatic pattern, slope, aspect and inclination with species richness its diversity and

distribution, has been a subject to extensive research e.g. Miede (1997); Schickhof (2005); Tambe and Rawat (2010); Shaheen and Shinwari (2012). It has been found that along with other drivers like overgrazing, encroachment and erosion in rangelands, climate change has also a major impact on the rangelands of Himalaya Hindu Kush like vegetation change, low productivity, drying of peat lands and wetlands while it indirectly affecting the livestock and their health (Shaoliang and Sharma, 2009). According to Grytnes and Vetaas (2002); Bhattarai *et al.* (2004) the species richness in high altitude rangelands can be changed monotonically with an elevational gradient or form a hump shaped pattern. The species richness was found higher in Deosai, which was followed by Bathraite. It has been found that the northern face of HKH slopes are stated to have greater species richness because of higher moisture content and evapotranspiration as compared to drier southern face slopes (Panthi *et al.* 2007 cited in Shaheen and Shinwari, 2012). The summer pastures of these high rangelands lack ultra-dominant tree cover and thus allow more herbs and shrubs to grow freely. Species evenness was found lower in Bathraite (0.61) and higher in Deosai (0.91) (Figure 5).

**Figure 4. Palatability and non-palatability in the major grazing areas**

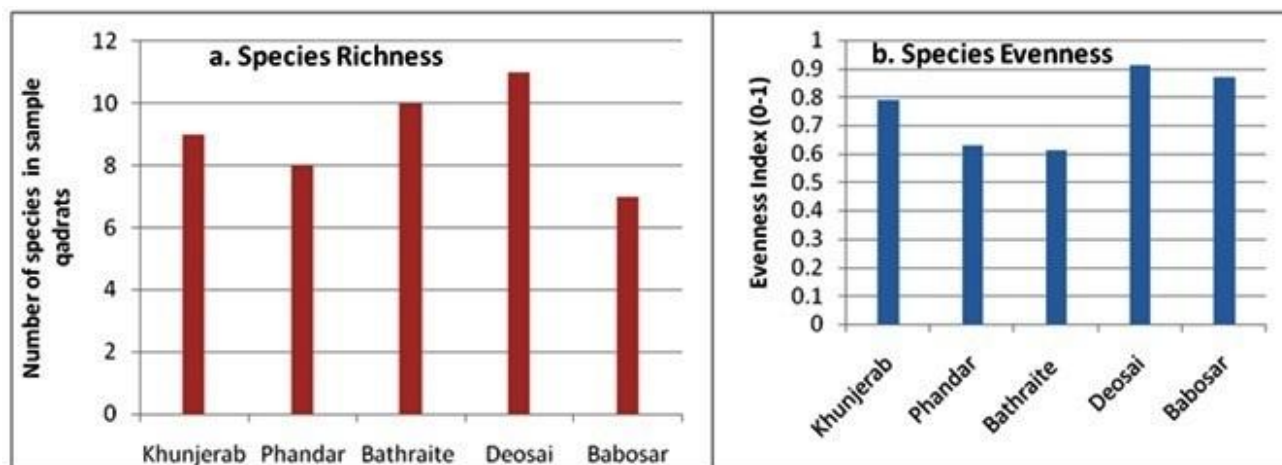


Figure 5. Species richness (a) and evenness (b) in the key grazing areas

Conclusion: Rangelands in mountainous landscapes like northern Pakistan are vital for agro-pastoral rural livelihoods. With increasing human population, grazing intensity in the rangelands is also increasing due to multiplication of households, which is evident from overall increase in the number of livestock; however, the number of livestock per household has been reduced over the past three decades. Despite greater species richness, quantity of biomass in western Himalayan pastures like Deosai and Babosar is low as compared to Khunjerab, which is a clear evidence of the ever-increasing grazing pressure from nomadic as well as local grazers. In Protected Areas where certain measure are taken for grazing management, productivity of grazing areas seems higher like in case of the Khunjerab National Park. The increasing amount of non-palatable species in the intensely grazed rangelands is also an emerging threat in addition to a decline in the productivity. Keeping in view high dependence of local people on agro-pastoral livelihoods it is challenging to reduce the number of grazing animals as a short-term strategy, therefore, grazing management is highly recommended. This can be done by rotational grazing and promoting stall-feeding to reduce the time of grazing animals in the high altitude rangelands.

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Plant Species Found in Key Grazing Areas

Annexure 1. Plant species found in Khunjerab National Park

Sub Water-Sheds			
Zero point	Qarchenae	Dhee	Gozhail
<i>Waldheimia stoliczkae</i>	<i>Waldheimia stoliczkae</i>	<i>Epilopium angustifolium</i>	<i>Lagotis giobsa</i>
<i>Waldheimia tomentosa</i>	<i>Waldheimia tomentosa</i>	<i>Epilobium latifolium</i>	<i>Linaria sp.</i>
<i>Brassica rapa</i>	<i>Brassica rapa</i>	<i>Brassica rapa</i>	<i>Pedicularis varae</i>
<i>Draba altacia</i>	<i>Draba altacia</i>	<i>Taxaxacum officale</i>	<i>Padiculsris rhinanthoides</i>
<i>Draba stenocarpa</i>	<i>Draba stenocarpa</i>	<i>Tragopogon</i>	<i>Scropanulaira scabiosifolia</i>
<i>Erysimum sp.</i>	<i>Erysimum sp.</i>	<i>Waldheimia stoliczka</i>	<i>Gagea eglans</i>
<i>Lepidium apetalum</i>	<i>Lepidium apetalum</i>	<i>Arenaria polytrichoid</i>	<i>Lloydia serotina</i>
<i>Androsace baltistanic</i>	<i>Androsace baltistanica</i>	<i>Silene goosperma</i>	<i>Reheum spiciforme</i>
<i>Androsace muscoida</i>	<i>Androsace muscoida</i>	<i>Anaphalis triplinervi</i>	<i>Nepeta discolor</i>
<i>Primule spp</i>	<i>Primule spp</i>	<i>Artemisia brevifolia</i>	<i>Thymus linearis</i>
<i>Primula buryena</i>	<i>Primula buryena</i>	<i>Chrysanthemum pyrethroides</i>	<i>Waldheimia tomentosa</i>
<i>Primule macrophylla</i>	<i>Primule macrophylla</i>	<i>Crepis flexuosa</i>	<i>Anaphalis triplinervis</i>
<i>Potentilla eriocarpa</i>	<i>Potentilla eriocarpa</i>	<i>Silene longicarpophor</i>	<i>Allium carolinianum</i>
<i>Potentilla phyllocalyx</i>	<i>Potentilla phyllocalyx</i>		
<i>dryadanthoides</i>	<i>dryadanthoides</i>	<i>Bromeos</i>	<i>Anaphalis triplinervis</i>
<i>Potentille plurijuga</i>	<i>Potentille plurijuga</i>	<i>Lloydia serotina</i>	<i>Rhodiola himalensis</i>
<i>Brassica rapa</i>	<i>Linaria spp</i>	<i>Saxifraga stenophylla</i>	<i>Tymus linearis</i>
<i>Draba altacia</i>	<i>Lepidium apetalum</i>	<i>Ephedra gerardiana</i>	<i>Oxytropis immersa</i>
<i>Draba stenocarpa</i>	<i>Erysimum sp.</i>	<i>Sisymbrium loeselii</i>	

Annexure 2. Plant species found in Phandar watersheds

Sub watersheds		
Barseth	Longar	Sanji Nala
<i>Aerva lanata</i> Juss	<i>Brassica rapa</i>	<i>Allium humile</i> Kunth
<i>Taraxacum officinale</i>	<i>Draba altacia</i>	<i>Brassica rapa</i>
<i>Berberis brandisiana</i>	<i>Urticadioica</i> L	<i>Taxaxacum officale</i>
<i>Berberis parkeriana</i>	<i>Swertia petiolata</i> D. Don	<i>Caltha alba</i> Jacquem.
<i>Potentilla phyllocalyx dryadanthoides</i>	<i>Epilobium latifolium</i> L	<i>Reheum spiciforme</i>
<i>Potentille plurijuga</i>	<i>Isodon rugosus</i> (Wall. ex Benth.)	<i>Nepeta discolor</i>
<i>Linaria spp</i>	<i>Thymus linearis</i>	<i>Waldheimia tomentosa</i>
<i>Allium carolinianum</i> DC	<i>Arctium lappa</i> L	

Annexure 3. Plant species found in Bathraite watersheds

Sub watersheds				
Uskoor	Kolay Baray	Naron Namal	Moshadogan	Choko Pataro
<i>Scorzonera</i> spp	<i>Jurinea dolomiaea</i> Boiss	<i>Aconitum laeve</i>	<i>Glycyrrhiza glabra</i> Linn.	<i>Carum carvi</i> , L
		<i>Roy le</i>		
<i>Senecio</i> spp	<i>Trifolium pratense</i> L	<i>Carumcarvi</i> . L	<i>Ephedra gerardiana</i>	<i>Chenopodium album</i> , L
<i>Cichorium intybus</i> . L	<i>Cydonia oblonga</i> . Miller	<i>Oxyria digena</i> L.	<i>Punica granatum</i> .L	<i>Dactylorrhiza hatagyrea</i>
	Gard			
<i>Clematis orientalis</i> L.	<i>Daphne mucronata</i> Royle	<i>Solanum nigrum</i> L.	<i>Thymus linearis</i> linn.	<i>Dianthus anatolicus</i> . Bois
	Syn			
<i>Cistanchetubulosa</i>	<i>Verbascum thapsus</i> . L	<i>Vicia faba</i> Linn.	<i>Morchella esculenta</i>	
<i>Schenk</i>				

Annexure 4. Plant species found in Deosai National Park watersheds

Sub watersheds			
Chilam Nala	Sardar Kothi		
<i>Acnagonon alpinum</i>	<i>Carex divisia</i>	<i>Mysotis alpestris</i>	<i>Primula macrophylla</i>
<i>Aconitium chasmanthum</i>	<i>Carex stenophylla</i>	<i>Nepeta discolor</i>	<i>Pulsitala wallichiana</i>
<i>Aconitium hetrophyllum</i>	<i>Chrysopogan</i> spp	<i>Oxytropis mollis</i>	<i>Rhodiola wallichiana</i>
<i>Agrostis gigantean</i>	<i>Dianthus anatolicus</i>	<i>Pedecula rioederi</i>	<i>Rosa webbiana</i>
<i>Allium carolianum</i>	<i>Draba cachemirica</i>	<i>Plileum alpinum</i>	<i>Salix alba</i>
<i>Anaphalis virgate</i>	<i>Draba stenocarpa</i>	<i>Poa alpine</i>	<i>Scorzonera</i> spp
<i>Androsaspp</i>	<i>Draba tibetica</i>	<i>Polygonum alpinum</i>	<i>Senecio</i> spp
<i>Artemisia capalaris</i>	<i>Elymus</i> spp	<i>Potentilla dryadanthoides</i>	<i>Potentilla pamirica</i>
<i>Artemisia maritima</i>	<i>Euphorbia</i> spp	<i>Astragalus</i> spp	<i>Primula denticulate</i>
<i>Artemisia brevifolia</i>	<i>Fragaria vesca</i>		<i>Medicago</i> spp

Annexure 5. Plant species found in Babosar watersheds

Sub watersheds		
Loyalhol	Gall	As
<i>Medicago sativa</i> L.	<i>Swertia petiolata</i> , Wall.	<i>Rosa webbiana</i>
<i>Onasma hispidum</i> Wall.	<i>Rumex napalensis</i>	<i>Mentha longifolia</i>
<i>Viola</i> sp	<i>Fragaria nubicola</i>	<i>Picrorhizakurroa</i>
<i>Verbascum thapsus</i>	<i>Rosa webbiana</i> Wall. Ex Royle	<i>Artemisia maritima</i>
<i>Urtica dioica</i> L	<i>Mentha sylvestris</i> L	<i>Tamarix</i>
<i>Clematis orientalis</i> L	<i>Peganum harmala</i> L	<i>Sonchusasper</i> (L) Hill