Food and Agriculture Organization of the United Nations

Rangelands of Pakistan

Current status, threats and potential

RANGELANDS OF PAKISTAN

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Foreword

Pakistan is a largely agrarian economy, with more than 60 percent of the country's geographical area composed of Rangelands. As such, the country's economy is heavily dependent on healthy Rangelands.

Agriculture is pivotal to economic growth and development in Pakistan. It contributes approximately 21 percent to the nation's GDP and employs an estimated 43 percent of the labour force. Much of this is through rearing livestock for food and dairy products, and crops for food, fodder and forestry. Livestock accounts for 55.4 percent of the agriculture sector, amounting to around 11.9 percent of the national GDP. This vital sector contributes to food security and nutrition in both the rural and urban areas, through the provision of milk and meat. It also provides fuel sources and numerous other by-products. Rangelands in Pakistan have historically been an underestimated resource. Not only do they provide food and protection for wildlife, but they also support the entire cycle of climate change mitigation. The condition and management of the Rangelands is key to the future prosperity of much of the population. There is a dire need, in Pakistan, to develop policies and institutions to protect, manage and ensure Rangeland improvement and sustainability.

Policy-makers are aware of this need and are focusing a great deal of attention on this declining resource. In the Food Security Draft paper, the Ministry of National Food Security and Research have placed a special degree of emphasis on the improvement of this Pakistani asset. The paper states, "There is considerable scope to halt degradation and improve the productivity of the rangelands in Pakistan. The rangelands are a major source of meat production, particularly of sheep and goat, with much of the production being in the hands of nomads and transhumant. Rangeland improvement will require targeting and addressing the needs of these populations who are often not well catered to by provincial livestock services due to their lower social status, as well as the technical difficulties of providing services to a transient group. Support by the MNFSR to provincial livestock departments can play a major role in bringing in international experience on participatory range management. In addition there is a need to improve the genetic quality of the stock, which are showing a decline in productivity due to excessive inbreeding."

This report, Rangelands of Pakistan: Current Status, Threats, and Potential, by the Food and Agriculture Organization (FAO) highlights the overall status, challenges and gaps in Rangeland management in Pakistan. It goes on to provide recommendations for improving these across the four provinces and three autonomous regions of Pakistan.

In keeping with the federal government's policy, the Ministry of National Food Security and Research will continue to support initiatives focused on the improvement of Rangelands in Pakistan.

Foreword

Patrick T. Evans
FAO Representative, Pakistan

Rangelands are globally important resources having multiple benefits for animals, people and the environment. In Pakistan, rangelands account for more than 60 percent of the entire area of the country and support food security for a significant portion of the country's population. This is realized through the grazing of more than 181.2 million head of livestock which supports the livelihoods of millions of rural families. The rangelands of Pakistan are also important as catchments for rainwater and support water supply for the agriculture sector of the country. In addition, the rangelands of Pakistan have high value for medicinal plants as well as rich flora and fauna with outstanding potential for future ecotourism development.

In spite of the high value of rangelands to Pakistan, there is nearly a total lack of proper management. Overgrazing is a major issue, which deteriorates the range condition in terms of the foliar cover, species composition, palatability and overall productivity. It is the "*tragedy of the commons*" in that no one is responsible and everyone uses it to their maximum benefit. Management responsibility has been entrusted with the Department of Forestry; however, being a forester myself, I know their main focus is on trees.

Currently, more than 60 percent of the rangelands are considered degraded and are reverting toward desert due to excess grazing. In order to protect and properly manage the rangelands, comprehensive rangeland policies both at national and provincial levels are required. This should be then followed with government commitment and proper budgeting to support implementation with a focus on community empowerment and community based management.

This report has been a joint initiative by the FAO and the Pakistan Agriculture Research Council (PARC) to collect data on rangelands from all provinces and regions of Pakistan. The information, collected and discussed in a national rangeland symposium, provided recommendations on the way forward which are presented herein. The protection and sustainable management of Pakistan's rangelands is critical to food security and long term sustainable development of the country. To this end, the FAO stands ready to assist as and when requested.

Acknowledgements

This report on “Rangelands of Pakistan: Current Status, Threats, and Potential” was prepared by the Food and Agriculture Organization of the United Nations, Pakistan Country Office in Collaboration with Pakistan Agriculture Research Council, Islamabad. The original idea for the preparation of this document came from Dr Kevin Gallaghar, former FAO Representative Pakistan, and Dr Iftikhar Ahmad, former Chairman, PARC, and both of them deserve special recognition. The work was further guided by Mr. Patrick T Evans, FAO Representative, and his contribution is much appreciated. The input and contribution of Mr. Nasar Hayat, Assistant Representative Programme is greatly valued. The contribution of Dr. Mohammad Islam and Dr. Sarfaraz Ahmed NARC was invaluable in assisting the initial stages of the formulation process. The same way the efforts of Dr. Abdul Wahid Jasra from ICMOD are higly appreciated.

The good work done by the various consultants engaged for the preparation of the provincial reports and their subsequent participation in the consultation process has been of enormous help to the success of this report. Ms. Jennifer McKay and Ms. Nafeesa Haider edited the document, and thus deserve special thanks. Similarly, Mr. Shahid Ahmad contributed to the formatting and designing of the document. Dr. Faizul Bari was an integral part of the formulation process of this report from the very beginning and compiled this publication. He also compiled the proceedings of the Rangeland Symposium and provided technical support in the synthesis. The value of his contribution and support cannot be overstated.

Acronyms

ADPB	Area Development Programme Balochistan
AJK	Azad Jammu and Kashmir
AKDN	Agha Khan Development Network
AKF	Agha Khan Foundation
AKRSP	Agha Khan Rural Support Programme
AUE	Animal Unit Equivalent
AZRI	Arid Zone Research Institute
BCS	Balochistan Conservation Strategy
CBO	Community Based Organization
CENTO	Central Treaty Organization
CITES	Convention on International Trade in Endangered Species
CKNP	Central Karakoram National Park
DFID	Department for International Development
DM	Dry Matter
DRMP	Disaster Risk Management Plan
ERNP	Environmental Rehabilitation in NWFP and Punjab
FAO	Food and Agriculture Organization of the United Nations
GB	Gilgit-Baltistan
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information System
GNP	Gross National Product
GOP	Government of Pakistan
HKH	Himalaya-Karakoram-Hindu Kush
HWF	Himalayan Wildlife Foundation
ICIMOD	International Centre for Integrated Mountain Development
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resource Management
JICA	Japan International Cooperation Agency
KNP	Khunjerab National Park
KP	Khyber Pakhtunkhwa
MACP	Mountain Area Conservation Project
MAF	Million Acre Feet
MARC	Mountain Agriculture Research Centre
MoCC	Ministry of Climate Change
NGO	Nongovernmental Organization
P&D	Planning and Development
PARC	Pakistan Agricultural Research Council
PDMA	Provincial Disaster Management Authority
PFI	Pakistan Forest Institute
PFRI	Punjab Forestry Research Institute
PFSDP	Punjab Forest Sector Development Project
PRA	Participatory Rural Appraisal
PSDP	Public Sector Development Plan
PWD	Public Works Department
SAZDA	Sindh Arid Zone Development Authority

SDC	Swiss Development Cooperation
SIDA	Sindh Irrigation and Drainage Authority
TRDP	Thar Rural Development Project
UNDP	United Nations Development Programme
UNHCR	United Nation High Commission for Refugees

Executive Summary

Rangelands cover 52.3 million hectares of land in Pakistan, approximately 60 percent of the total geographical area of the country. The rangelands spread across various ecological zones, from tropical to alpine and sub-alpine zones. Around 60 percent of the total feed for the entirety of the country's 181.2 million head of livestock is contributed by these zones.

The livestock sector plays an important role in Pakistan's economy, contributing 56.3 percent of the agricultural value-added; it generates 11.8 percent of the national GDP, and provides livelihoods for a vulnerable population of more than 8 million. In addition to producing fodder, the rangelands also perform a number of important functions including the regulation of water flow, conservation of biodiversity, and the provision of income generation opportunities in the form of non-timber forest products for local people. The current productivity of the rangelands is low, with most attaining less than 40 percent of their potential output. Such low productivity naturally has adverse effects on the health of livestock, resulting in huge economic losses. Low productivity is mainly caused by mismanagement of rangelands, overstocking, overgrazing, and desertification.

While a significant amount of secondary data on Pakistani rangelands was available, it had previously never been coordinated and analyzed. The FAO and PARC commissioned five senior rangeland experts to conduct a study collecting and analyzing all the secondary data. The objective was to formulate a clear roadmap for the management of this vital resource. The study was a two-step process, the first of which was to review all available literature, analyse the findings and make recommendations. This was focused on different provinces and regions: Balochistan, Sindh, Punjab, Khyber Pakhtunkhwa, FATA, Gilgit Baltistan, and Azad Jammu & Kashmir. The second step was to organize a Rangelands' Symposium to gather key stakeholders to discuss the major issues, prioritize needs, make recommendations and determine the way forward for sustainable range management in the country. Section 1 of this publication summarizes the outcomes of this Symposium. The full provincial reports are available in Section 2, with information for sector professionals and officials involved in research and policy formulation.

To streamline the management of this important resource, the Rangeland Symposium, organized jointly by the FAO and the Pakistan Agriculture Research Council (PARC),was held in Islamabad on March 5-6, 2014. Mr. Sikandar Hayat Khan Bosan, Federal Minister for National Food Security and Research was the inaugural speaker, with experts and researchers from all over the country in attendance. Presentations were made by representatives from various Provinces and Regions. The focus of these included the significance of rangelands, their current status, potential threats and opportunities, and recommendations for improved rangeland management. Participants discussed key issues relating to sustainable rangeland management, such as policy and strategy, land tenure, rangeland resource management, valuation and payment of ecosystem services, biodiversity conservation, and institutional and financial arrangements. The recommendations resulting from this process included the development of a rangeland resource inventory, formulation of rangeland policies, valuation of rangelands products and services, rangeland research in the context of the climate change, promotion of rangeland enterprises, and ecosystem management for biodiversity conservation.

The symposium identified a number of follow-up actions including Provincial/Regional consultations on the way forward for rangeland management, formulation of provincial rangeland policies, preparation of an umbrella project spanning the entire country with specific provincial and regional components, and, resource mobilization. The symposium also identified the key stakeholders who would need to work together to implement the roadmap for future development of rangeland resources. It went on to reconfirm the commitment of the Federal and the Provincial governments to restoring the rangelands to their full potential for sustainable livelihoods, environmental protection and biodiversity conservation. The data presented in the symposium will subsequently be used for planning future actions on improved rangeland management.

Section 1

Rangeland Symposium

Summary

Introduction and Context

The symposium focused on the current status of the rangelands, and the related threats and opportunities for ensuring food security and livelihoods in the context of climate change. It was designed to review key issues relating to the sustainable development of rangelands, and to provide recommendations for future action planning. The discussion covered the following main topics:

1. Rangeland resources: extent, types with geographical and ecological description, and status including current condition and trend;
2. Valuation of ecosystem services of rangeland resources and their contribution to pastoral livelihoods, household energy, water regulation, wildlife habitat improvement, and economic utilization of high-value rangeland products;
3. Current use of rangeland resources: both formal and informal practices, including co-management and trans-boundary management; and
4. Identification of institutional gaps and formulation of rangeland policy.

A total of 62 professionals participated in the symposium including representatives from the Forestry, Livestock and Agriculture Departments of all the provinces, Federally Administered Tribal Areas (FATA), Gilgit-Baltitstan (GB) and Azad Jammu and Kashmir (AJK) along with the experts from FAO, PARC, and NARC.

To set the context for further discussion, a presentation was given, outlining the overall situation of rangeland management in the country, rangeland statistics, livestock supported by rangelands, types and locations of rangelands, significance of rangelands, major causes of degradation, and the rangeland degradation parameters.

The aspects most emphasised were related to the fact that rangelands cover 52.3 million hectares of land which is approximately 60 percent of the total geographical area of Pakistan. This resource supports more than 181.2 million livestock, and provides around 60 percent of feed for the livestock in the country. Similarly, the livestock sector provides food security, nutrition, and livelihoods for 8 million poor and vulnerable people in the rural areas of the country. Other functions include water flow regulation, protection of environment, and conservation of bio-diversity. The current productivity of rangelands is around 40 percent of the potential productivity and therefore there are great opportunities for enhancing the productivity and functionality of this resource.

The presentation further highlighted that the major causes of rangeland degradation include lack of appropriate rangeland policy, overgrazing, land tenure issues, poor institutional anchorage, lack of understanding of upstream and downstream relationship, low involvement of local communities, focus on the number of livestock rather than quality, frequent disasters, climate change (desertification), interface of livestock and wildlife, the concept of single (rather than multiple) use of land, and the lack of an integrated approach in addressing rangeland degradation.

Various current studies reveal that rangeland productivity and other parameters are very low:

- Current level of average forage production is approximately 6.6 tonnes/ha compared to the potential of 20.8 metric tonnes/ha; and
- Current forage production is 24 million metric tonnes per year, while potential is 74 million metric tonnes.

The following parameters have changed over a period of 20 years:

- The proportion of palatable species has decreased by up to 30 percent;
- Foliar cover of grass and forage has decreased by up to 40 percent; and
- Due to the climatic changes and other biotic factors desertification is happening at an alarming rate, especially in the arid and semi-arid zones, affecting a total of 43.3 million ha rangelands.

To rehabilitate its rangelands, the country needs to:

- Formulate a comprehensive national rangeland policy;
- Regularly assess and monitor rangeland resources;
- Plan and manage rangeland resources in a collaborative and integrated manner;
- Increase the availability of fodder produced outside rangelands to reduce pressure on the existing degraded ranges;
- Promote rangeland enterprises;
- Manage rangelands in a manner that would enhance water recharge and regulate the sustainable water flow and reduce sedimentation;
- Rehabilitate the range-ecosystem for biodiversity conservation;
- Mitigate the impact of global warming and climate change; and
- Raising awareness among policymakers regarding the significance of the rangeland resource

Technical Session: Group Work on Framing Key Policy Recommendations

Six thematic groups were formed with a team leader for each group and a list of questions related to the theme was provided to each group. Key findings and recommendations of the groups were presented in a plenary session. A brief description of the six thematic areas is as follows:

Policy and strategy: This group discussed various aspects including rangeland policy and legal framework, institutional arrangements for rangeland management, coordination with the relevant departments, sustainable management of the rangeland resource, and recommandations.

Land tenure: During group discussion, it was pointed out that rangelands are mostly owned by the state and communities. There are also some cases of private ownership as well. Depending upon the land ownership and tenure system, various rules and regulations are in place. In Pakistan, the management of the pastures and rangelands is the mandate of the respective Provincial Forest Departments and covered by the Federal and Provincial Forest Polices and related Acts. However, the Forest Departments pay far less attention to rangeland management than to the forestry component.

This has led to a strong need in the provinces, for separate Rangelands Polices which would focus on this important component of the land use. A couple of provinces have already prepared their rangelands policies, while the others are beginning to formulate them. These polices would not only focus on the technical and production side of rangelands, but would also address such aspects as rehabilitation of environment, conservation of biodiversity, water regulation, utilization of minor products, and enhancement of aesthetic value.

Rangeland resource management: This group discussed the current status of rangelands in the context of the provision of ecosystem services, the status of baseline information and monitoring of rangelands, and causes of rangeland degradation along with their impact on local livelihoods.

Baseline data collection is essential for launching a successful rangelands management programme, but unfortunately this aspect has not been addressed for a long time. Only in a few cases have baseline surveys been conducted, and even then, no proper methodologies have been followed. In the symposium this aspect was emphasized, and appropriate methodologies for baseline data collection and regular monitoring were suggested using suitable methods including GIS and Remote Sensing. The baseline should include the key parameters such as extent of the rangelands, composition of species, foliar and basal cover, productivity, and existing conditions and trends. Standard procedures and methodologies should be adopted for measuring and assessing these parameters.
Based on this analysis, the group developed a mechanism and strategy for rangeland improvement with an emphasis on rehabilitation of degraded rangelands, management of grazing, policy and legislative support, and investment in the rangelands.

Valuation and payment for ecosystem services: This group analyzed questions related to valuation and payment for ecosystem services which they considered a new concept. They noted that very little has been done so far and the only visible examples in this area were the payment systems for trophy hunting and animal grazing. They also highlighted the fact that there is no system for the payment for ecosystem services. Significant obstacles exist including lack of assessment procedures and mechanisms, lack of awareness, and insufficient capacity of the Forest Departments for planning and implementaion.

Biodiversity conservation: This group discussed questions related to the conservation of biodiversity including coexistence, disease transmission, and human-wildlife conflict.

Institutional and financial arrangements: This group addressed the theme in the context of land ownership, coordination mechanisms and professional education systems. The group identified three main categories of land ownership: government-owned, communal, and private.

Key Recommendations

Based on the various findings of the thematic areas from the group discussions, the following key recommendations were made:

1. Rangeland resource inventory and assessment should be conducted to establish a baseline;

2. The draft National Rangeland Policy should be finalized, and drafting of provincial rangeland policies should begin;

3. Rangeland-specific laws should be enacted at both federal and provincial levels;
4. Rules and regulations should be developed to support the implementation of rangeland laws;
5. All rangeland goods and services should be valued and utilized in the interest of communities;
6. Rangelands ownership and use should be defined more specifically and clearly, and document of rangelands ownership should be legally ratified;
7. GIS/RS techniques should be introduced to record rangelands classification and occupancy;
8. Dialogue between upstream and downstream water users on collaborative natural resource management should be initiated;
9. Research should be conducted on the impact of changing climatic conditions on various components of the rangeland ecosystem, (i.e., vegetation species, composition, zones, habitats, etc.);
10. Rangeland management should be included in the REDD+ mechanism;
11. Rangeland enterprises and value chains should be promoted;
12. Rangeland management should also ensure recharging and regulation of sustainable water flow and reduction of sedimentation;
13. Ecosystem management should include biodiversity conservation;
14. A five-year umbrella project should be launched with specific components for all the provinces and regions;
15. A nationwide awareness and sensitization campaign should be launched/conducted through electronic and print media; and
16. A donor conference should be organized to raise funds and mobilize resources for assessment of inventory and resources, policy formulation, and implementation of the umbrella project.

Follow-Up Actions

The following follow-up actions were proposed:

1. Consultations should be conducted to brief the Provincial/Regional governments on the key issues, recommendations, and the roadmap for integrated development of rangelands;

2. A national umbrella project should be designed and formulated with specific provincial and regional components;

3. The draft National Rangeland Policy should be finalized and approved;

4. The rangeland policy formulation process should be initiated in Punjab, Balochistan, FATA, and AJK;

5. A strategy for the valuation of rangeland resources, products, and services should be developed; and

6. A donor conference should be organized to mobilize resources.

Section 2

Provincial Reports

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BALOCHISTAN

PROVINCIAL REPORT

Balochistan

Background

Rangeland resources represent a major part of the land in Balochistan. Despite harsh climatic conditions, low and erratic rainfall, extreme temperatures in winter and summer, recurrent droughts, and no ownership support, the rangelands provide livelihood opportunities for 87 percent of the rural population of the province. This is primarily due to the fact that the rangelands cater to the provision of forage for about 32.934 million head of livestock (projected population 2012). In monetary terms, this amounts to approximately 477 billion rupees. With the inevitable dependence of livestock on rangelands, the monetary share of the rangelands amounts to 327 billion rupees or 68.5 percent of the total value. If the rangelands make strides to fulfil their potential capacity, they may support up to 90 million heads of livestock. In that case, the monetary value of livestock, based on the current market prices, would be approximately 1300 billion rupees. Consequently, the share of the rangelands in monetary terms would increase to 890.8 billion rupees.

It is important to be cognizant of the fact that rangeland ecosystems, not only, contribute significantly to the preservation of surface and ground water resources, but also provide 90 percent of the energy supply for the rural population in the form of fuel wood. They also create shelter and cover for wildlife, simultaneously serving as a place for recreation. Only a small number of initiatives for the development of rangeland resources have been undertaken, to date, and only a handful of them can be considered successful. It can hardly be considered coincidental that communities have yet to experience a degree of empowerment in managing their rangelands. The studies undertaken have provided clear indications of the recovery potential of both the natural vegetation and of the introduction of exotic species. At this time, however, these studies cannot be considered representative, as the research area covered is very limited when compared to the wide range of ecological zones and climate variability of the rangelands. Due to institutional gaps, ambiguous land tenure, and the lack of policy and grazing management strategy, the biodiversity of the resource will continue to diminish over time, and the rate of desertification process will rapidly increase. If sustainable development of the resource is not ensured, the loss of rangeland ecological services and functions will ultimately place lives at significant risk in the province.

In this report, a number of recommendations have been proposed, in particular, establishing a district-wise baseline inventory of rangelands, a resource use policy, and a mechanism for the valuation of ecosystem services. A mitigation and adaptation mechanism has also been recommended to cope with climate change, to explore and improve livestock marketing at the local and international level, and to create incentives for livestock farmers.

With an area of 347,190 sq km, Balochistan, is the largest province of Pakistan, and constitutes approximately 44 percent of the country's land area. The province is sparsely populated due to harsh climatic conditions. The total population as per projected figures of 2010 is 8.9 million with an annual population growth of 2.47 percent (GOB, 2010). Topographically, the province accommodates diverse landforms with elevations ranging from sea level to over 3520 meters. Soil is calcareous, with low organic matter of 0.3 to 0.5 percent (ADPB, 1998).Climatically Balochistan falls in an arid zone. Three distinct climatic zones can be differentiated in the province on the basis of increasing precipitation: hyper arid, arid and semi-arid. Generally, the Annual Mean Maximum temperature in the province is 31° C, while the Mean Minimum is 16.6° C. However, the extreme summer and winter temperatures recorded in the province vary from 53° C in Sibi (May, 2010) and as low as -15° C in Kalat (January, 2013). Rainfall is scant and erratic. The Mean Annual rainfall varies from less than 50 mm (Nushki/Chagai) to more than 400 mm in (Shirani/Musakhail). Recurring drought is a common phenomenon, and generally every third year is considered dry due to below average rainfall. Balochistan saw a long drought from 1998 to 2004, which adversely affected the production sectors in the province. Similarly, the floods of 2010-2011 caused greater collateral damage than had ever been seen before (PDMA, 2012).

The range resource is the most major land use in the province. The gross rangeland area is 32.3 million ha, which comprises 93 percent of the total land area. Out of this gross area, 21 million ha (65 percent) is considered grazing land. The vegetation supported by the rangelands in the province is mostly xeric in nature. Based on the characteristics exhibited by the vegetation it can be broadly classified into two types: Irano-Turanian (IT) and Saharo-Sindhian (SS). The former covers about 40 percent of the province and is characterized by winter rains. The latter, or Saharo-Sindhian (SS) type are characterized by summer rains. The vegetation of Sulieman range, receiving both summer and winter rains has not been formally investigated. Based on temperature and rainfall regimes, the range resource of the province is further divided into Central ranges, South-Western ranges, Eastern ranges and Sulieman Mountain ranges (Mohammad, 1989). Rangelands falling in the Eastern and Sulieman Mountain ranges cover comparatively less area but with higher precipitation and milder climate, enjoy higher productive capacity and potential than the Central and South-Western ranges.

Growth in both the human and livestock populations of the province have placed tremendous pressure on the rangeland resource to fulfil greater needs for fuel wood, water, forage and recreation. This increased demand for goods and services, coupled with prolonged and severe drought has led to the deterioration of rangelands in the province. In spite of their worsening condition, rangelands still play a vital role in the economy of the province through provision of livelihood for the rural communities. The rangelands of the province contribute about 50 percent to the agriculture sector through livestock and crop production and in turn, are responsible for about 52 percent of the GDP. From the point of view of the ecosystem, range resources are providing both direct and indirect services to the inhabitants of the province. These will be elaborated on in this report as further indication of the integral role played by rangelands.

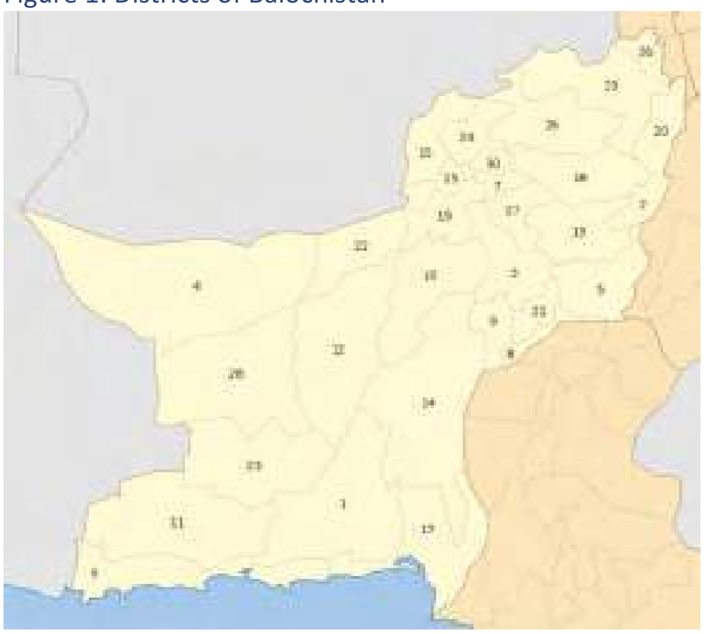
Historical fact unequivocally indicates that the major portion of the province used to be covered by vegetation (Rafi, 1965). As recently as, pre-1950, the vegetation cover in the province was more than 50 percent. However, the arrival of Afghan refugees, in the early 1980s, added an unmanageable degree pressure on the health and productivity of the rangelands, negatively impacting these resources in the long run. As a result of this influx of people, forest and rangeland vegetation near refugee camps were completely wiped out. According to UNHCR (2007), trees and bushes on more than 174, 577 hectares of Balochistan's forests and rangelands were completely uprooted. At present, a downward trend has been observed in the vegetation surface cover. Mann & Rehman (2006) reported that vegetation cover in the province, as a whole, falls at 10 to 25 percent. However, in state forests and rangelands, vegetation cover is more than 50 percent. This is an indication of the encouraging effect of protection on vegetation cover. In this regard, Hazarganji-Chiltan National Park in Quetta serves as an extremely valuable reference area. It clearly exhibits the application and functions of conservation practices and, therefore, offers an excellent opportunity to compare current livestock grazing effects with the potential impacts that can be expected when areas are not subject to overgrazing and poor management (BFWD, 2013).

Experiments that were conducted have been thoroughly reviewed and appear to indicate that rangeland resources in Balochistan have the potential for natural vegetation recovery through a focus on protection and cover improvement. This can be carried out by undertaking planting, seeding and introduction of forage species. Similarly, protection and water harvesting practices will also result in increasing productivity and floristic diversity.

Institutionally, rangelands have been a neglected provincial resource. There is no separate office in the Forest and Wildlife Department to cater to them. Until recently it had no legislative support in the Forest Act 1927 and Forest Regulation 1890. However, in the new Act which is under scrutiny, the resource has been provided legal cover, along with other natural living resources. This seeks to authorize incentives for communal rights on natural living resources, including the range resource. In present-day Balochistan, save for some traditional systems regulating the grazing on rangelands, no grazing management exists. Rangeland resources have a centuries long tradition of being used by nomads, transhumant and sedentary graziers, and are now under transformation for climatic, social and political reasons. Rangeland productivity is declining, and production is about 87 percent below its potential (FAO, 1983).

The importance of rangeland resources for the livelihoods of local communities cannot be overstated. It is, thus, recommended that this precious resource should be managed by reorganizing the Forest Department into Research, Technical and Legal Services Organization with the community as the executing agency. Alternatively, this could be managed through the creation of a separate Provincial Disaster Management Authority (PDMA), with social members from the community and technical members from the Forest and Livestock and Dairy Development Departments. An integrated approach and long term planning is needed for the restoration of deteriorated areas and improving the productivity of low producing pockets, to ensure sustainable use and development. The technical members of the department should have an advisory role and the resource should be managed and developed on a "by the community and for the community" approach, for maximum impact.

Figure 1: Districts of Balochistan

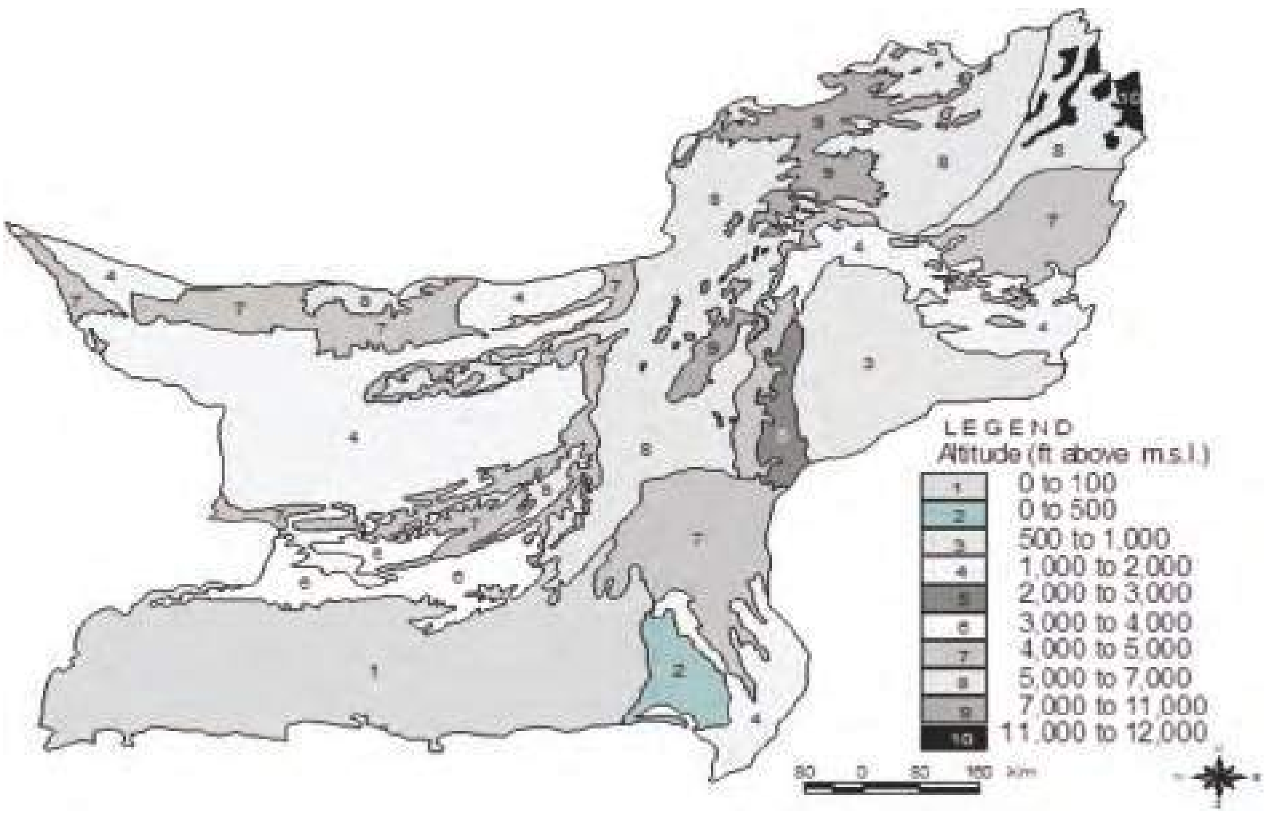


1. Awaran	11. Kech	21. Nasirabad
2. Barkhan	12. Kharan	22. Nushki
3. Bolan	13. Kohlu	23. Panjgur
4. Chagai	14. Khuzdar	24. Pishin
5. Dera Bugti	15. Killa Abdullah	25. Quetta
6. Gwadar	16. Killa Saifullah	26. Sherani
7. Harnai	17. Lasbela	27. Sibi
8. Jafarabad	18. Loralai	28. Washuk
9. Jhal Magsi	19. Mastung	29. Zhob
10. Kalat	20. Musakhel	30. Ziarat

(Source:https://commons.wikimedia.org/wiki/File:Sherai_ District.svg)

Balochistan, with its thirty districts (Figure 1), is topographically the eastern extension of the Iranian plateau, it is highly diverse, subdivided by mountains, upland valleys and sand plains ranging from sea coast to 3,520 meters above mean sea level as shown in Figure 2.
Balochistan falls in the arid climatic zone. Within the province, three distinct climatic zones can be seen with increasing precipitation quantities, the hyper arid, the arid, and the semi-arid. Temperature and precipitation varies in these climatic zones. Generally, the Annual Mean Maximum temperature is 31° C and Annual Mean Minimum is 16.6° C. Due to arid climatic conditions prevailing in the province, rainfall is scant and unpredictable, and this aridity is the province's most striking feature. Recurring droughts are common with below average rainfalls every third year. It has also been observed that severity and longevity of droughts are increasing and the drought between 1998 to 2004 actually shook the vegetation base and saw a drastic rise in the mortality-rate of livestock (Jasra, 2001). Similarly, the floods of 2010 and 2011 caused a great deal of collateral damage to districts in the plains of the province (PDMA, 2012).

Figure 2: Balochistan (altitudes)



(Source ADPB, 1998)

Table 1, reflects the annual average rainfall of selected stations in Balochistan from 2006 to 2009 while Table 2, shows the monthly rainfall distribution pattern for 2009 (GOB, 2010). Analysing the information indicates no identifiable pattern for rainfall at any station, highlighting the unpredictable nature of precipitation in planning range resources improvement and management, this aspect of rainfall needs to be taken into account.

Table 1: Annual average rainfall (mm)) of selected stations in Balochistan 2006-2009

Stations	2006	2007	2008	2009
Dalbandin	69.1	153.8	82.7	124.5
Zhob	303.6	357.4	304.7	269.5
Jiwani	95.0	92.0	53.0	134.0
Lasbela	180.5	340.7	253.9	103.6
Nokundi	7.2	107.0	77.3	47.3
Panjgur	123.0	162.9	75.5	59.5
Pasni	116.8	206.9	172.3	49.9
Quetta	197.0	227.9	130.0	197.0
Sibi	169.7	371.9	206.5	126.1
Barkhan	784.0	388.1	397.0	294.0
Khuzdar	268.6	274.3	302.2	233.9
Kalat	162.2	254.2	220.4	176.7
Ormara	249.0	505.0	80.0	25.0
Turbat	125.0	251.0	87.0	67.6
Gawadar	140.4	91.7	17.3	38.6

(Source: dev. Statistics Baloch. 2010)

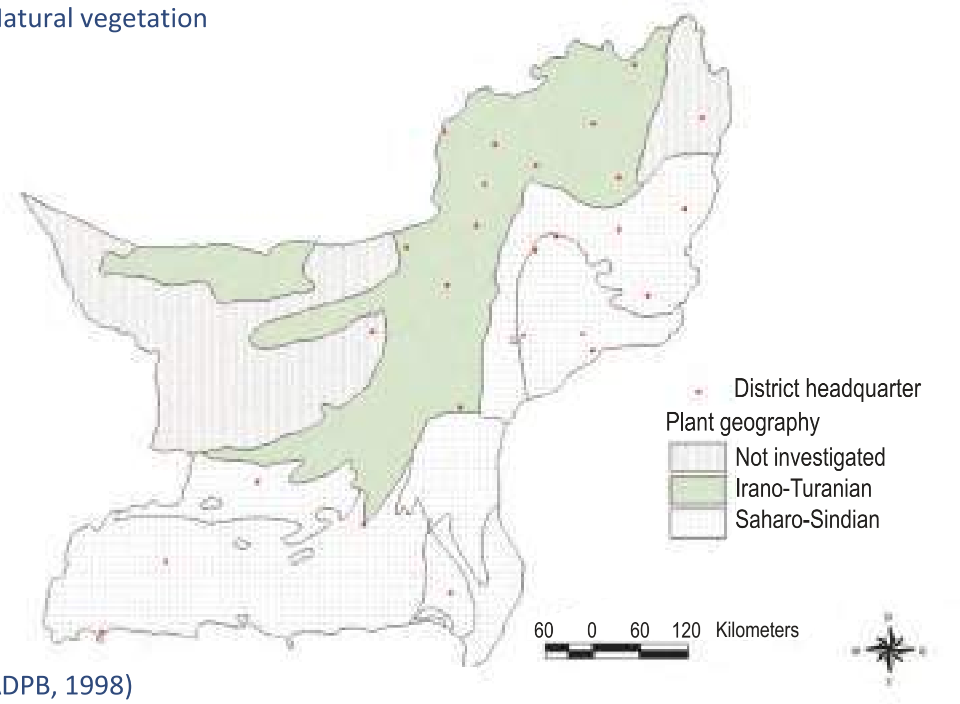
Table 2: Rainfall (mm) of selected stations in Balochistan by month in 2009.

Station	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Khuzdar	50.8	7.3	36.0	3.8	0.0	0.0	29	59.3	6.7	0.0	0.0	41.0	233.9
Lasbeal	13.6	7.8	30.7	5.7	0.0	9.8	13.1	3.1	0.0	0.0	0.0	19.8	103.6
Dalbandin	69.0	18.0	1.0	8.5	TR	0.8	4.0	0.0	0.0	0.0	0.0	24.0	124.5
Pasni	35.2	0.0	1.5	0.0	0.0	2.0	2.0	0.0	1.0	0.0	1.2	7.8	49.9
Turbat	27.0	0.0	0.6	10.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	24.0	67.6
Quetta	54.0	31.0	22.0	35.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	45.0	197.0
Kalat	71.9	13.0	30.7	10.1	2.0	0.0	9.0	3.0	0.0	0.0	0.0	37.0	176.7
Ormara	9.0	0.0	0.0	0.1	0.0	0.0	2.0	2.0	0.0	0.0	0.0	12.0	25.0
Sibi	53.0	3.9	3.3	0.0	0.0	1.0	28.5	32.4	0.0	0.0	0.0	4.0	126.1
Nokkandi	33.4	0.0	0.0	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	47.3
Barkhan	23.0	14.0	40.0	12.0	21.0	31.0	0.0	5.0	0.0	0.0	0.0	2.0	294.0
Panjgur	38.0	0.0	8.5	4.0	0.0	0.0	14.6	0.0	0.0	0.0	0.0	9.0	59.5
Jiwani	113	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	134.0
Zhob	23.0	33.4	34.0	47.6	0.0	9.9	99.4	9.1	5.5	0.0	0.0	7.6	269.5
Gawadar	15.6	0.0	TR	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.1	38.6

(Source: Dev. statistics Baloch. 2010)

The vegetation structure in Balochistan (Figure 3) consists of deserts, steppes, savannahs and sparse woods. As previously mentioned, the natural vegetation growing on rangelands in the province can be classified into two distinct types: the Irano-Turanian (IT) and the Saharo-Sindian (SS) type (Gils & Baig, 1992). The IT vegetation type occupies the Continental and Mediterranean climatic zone, which covers 40 percent of the province from mid to high altitude lands with winter rains. The Saharo-Sindian (SS) vegetation type covers the low mountain areas, and lowland deserts of Balochistan, which are characterized by summer rains. The pine belt in the Suleiman Range receives both the winter and summer rains, and is quite different to both of the aforementioned types. The IT high mountain vegetation type has Juniper forests with wild Ash. The mid altitude belt has dwarf shrubs including, *Artemisia spp., Austragulus spp.*, *Prunus eburnean,* cold deciduous broad-leaved woods (Ash, *Pistacia*) spp., and perennial grasses. The SS type has various *Acacias spp.*, Palms and perennial grasses such as *Panicum spp., Pennisetum spp.* The vegetation of the Suleiman Range includes Pistachio, Olea, Wild Ash, Chilghoza pine (*Pinus gerardiana)* and blue pine (*Pinus walliciana)* with perennial grasses dominated by *Cymbopogon spp.* and *Chrysopogon spp.* (ADPB, 1998).

Figure 3: Natural vegetation



(Source: ADPB, 1998)

Rangeland Resources

Rangelands are the most major land resource being utilized in the province, as is shown in Figure 4. The south-western part of the province mainly supports shrubs and is used as a browsing area, while the north-eastern part accommodates mixed vegetation types which are generally known as grazing area. In the agro-pastoral economy of the province, rangelands play a pivotal role through both their direct and indirect contributions. Direct services consist of meat, food, fibre, fuel and forage to grazing livestock; shelter, cover, forage and feed to wildlife including migratory birds; and protection of the watershed of 18 water basins in the province. The indirect services include amelioration of the environment, provision of recreation facilities, regulating the stream flow, increasing the yield of water and decreasing the sediment load to increase the longevity of dams and lakes in Balochistan. (Baloch & Tanik 2004; Ahmad et al., 2012).

Out of the total 34.7 Million hectares (Mha) of land area in Balochistan, rangelands cover 32.3 Mha (93 percent). Out of this gross range area, about 21 Mha (65 percent) is considered grazing land (FAO, 1983). The southern part of the province is mostly browsing area and the northern part as grazing with sparse woods shown in Figure 4. Table 3 gives further details about land cover and land use.

Figure 4: Landuse

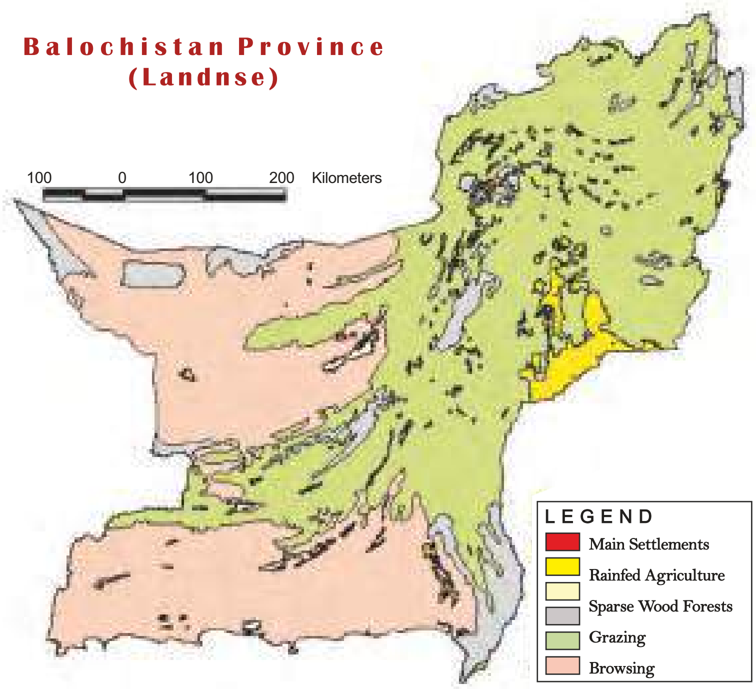


Table 3: Land cover/ landuse in Balochistan

S.NO.	Land cover/land use	Area(000'ha)	% age
1	Forest	508.1	1.5
2	Rangeland	9255.8	26.7
3	Agriculture land	822.2	2.4
4	Bare Soil	4494.7	13.0
5	Exposed Rock	16425.7	47.3
6	Deserts	3189.4	9.3
7	Built-up area/land	6.7	0.02
8	Waterlogged and Saline	15.2	0.04
9	Water bodies	1.8	0.01
	Total	34719	100

(Source: Land use atlas Pakistan 2004)

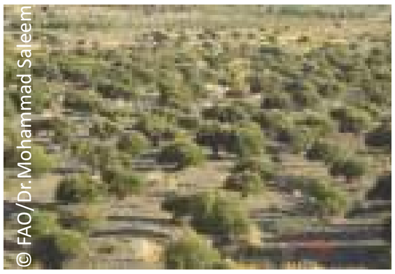
The forest cover is very limited, which isless than 2 percent of the area is under forest classified as State and Protected forest, which are also used for grazing. The major land use in the province is rangeland, constituting about 27 percent of the province, but the exposed, barren rocks, which occupy another 47 percent area of the province and the bare soil, and deserts, which cover 13 and 9.3 percent of the area respectively, also provide grazing opportunities during the wet season, and could be considered a part of the rangelands. Agricultural land is very limited: little more than 2 percent. Due to non-availability of flow water in the province, irrigated agriculture is practiced on a limited scale and it is mainly confined to the central-eastern region and covers about 1 percent of the area. Rod Kohi/rain fed agriculture is practiced in the foothills of mountainous areas as stated by the National Land Use Project of the Ministry of Environment (NLUP, 2004).

From the grazing pressure point of view, rangelands are broadly divided into the Northern (13.2 Mha or 38 percent of the province), and the Southern Zones (21.5 Mha or 62 percent of the province). The Northern zone receives high rainfall and supports 76.5 percent of the total livestock, while the Southern zone gets low rainfall and supports only 23.5 percent of the livestock (FAO, 1983). The most common ecological zones of rangeland according to (Muhammad 1989 and Ahmad et al., 2012) are Central Ranges, South-Western Ranges, Eastern Ranges and the Suleiman Mountain Ranges. Each of these types is briefly described below:

The Central Ranges mainly include the ranges of Quetta, Kalat, Mastung, Killa Abullah and Pishin districts and parts of the contiguous districts. The climate is Mediterranean, annual rainfall ranges from 100 to 200 mm, and altitude varies from 1000 to above 3000 m. Common range species are *Cymbopogon jawarancusa, Chrysopogon aucheri, Juniperus excelsa, Pistacia spp. Fraxinus xanthozyloides, Caragana ambigua, Prunus eburnea, Artimesia spp. Haloxylon griffithi* and *Alhagi cameloru.*

The South-Western Ranges include the desert ranges of Kharan, Washuk, Nushki, Chaghi, Panjgur, Kech, Gawadar and Lasbela and parts of the adjacent Districts. Here rainfall is low (50-150 mm). Common range species are *Acacia spp., Cousinia alepidea, Haloxylon griffithii, Alhagi camelorum, Sccharum rvannae, Stipa plumose, Tamarix spp., Zhgophyllum atriplicoides, Sudaeda fructicosa, Salsola spp. and Panicum antidotale .*

The Eastern Ranges include ranges of Zhob, Loralai, Musakhail, Barkhan, Kohlu, Sibi, Nasesrabad, Bolan, Khuzdar districts and parts of the adjacent districts. Here, there is a greater quantity of rainfall in both summer and winter. Common range species are *Cymbopogon jawarancusa, Chrysopogon aucheri, Tetrapogon villosa, Pennisetum orientale, Panicum antidotale, Stipa spp., Saccharum spp., Poa bulbusa, Alhagi camelorum, Cragana ambigua, Berberis balochistanica, Prunus eburnea, Pistacia khinjuk, Acaciai modesta, Acacia procera, Olea cuspidata*.



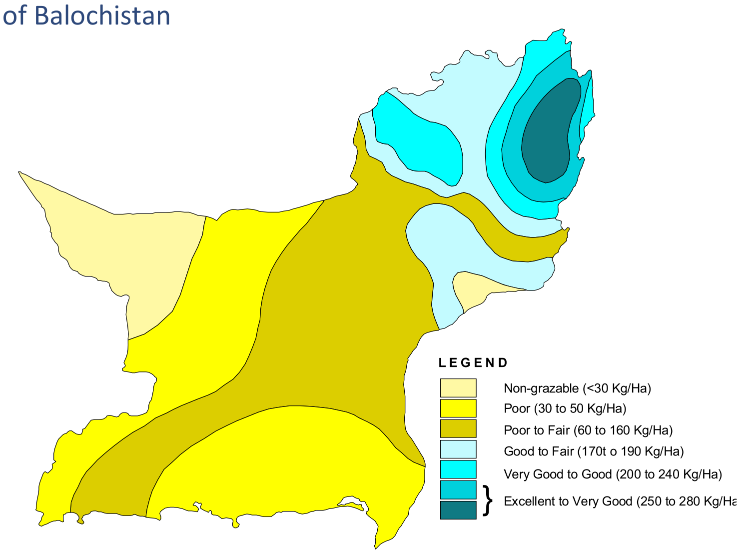
The Suleiman Mountain Ranges include the ranges of Shirani and parts of Zhob district bordering with Afghanistan. Here rainfall is high both in summer and winter and common range species are similar to those present in the Eastern ranges with addition of Chilghoza, blue pine, and Wild ash.

Range Productivity, Utilization and Trend

The current productivity compared to its potential and the level of utilization is important parameters for the formulation of a range development plan. Moreover, understanding the current trend and condition are also important dimensions for better planning, The productivity of Balochistan's rangelands is on the decline due to a number of factors including over-grazing, uprooting of bushes for fuel wood, and climatic changes mostly because of rain and snow fall. The estimated productivity of the rangelands varies from less than 30 Kg/ha/year Dry Matter (DM) to over 280 Kg/ha/year of DM in Figure 5 (DRMP, 2012). The overall carrying capacity of the rangelands is from 2 to 3 ha/ewe[1] (FAO, 1983).

Due to the particular ecological conditions of the rangelands, no universally accepted grazing strategies for restoration and improvement exist. However, resting and restricting grazing are methods which have proven very effective for the recovery of natural range vegetation and for forage improvement in many arid and semi-arid regions (Ahmad & Islam, 2007).

Figure 5: Rangelands of Balochistan



(Source: Balochistan government disaster risk management plan)

[1] A ewe weighing 33 kg with a lamb (3 months of age) consuming 330 kg dry matter forage per year.

The productivity of rangelands is a dynamic attribute and varies greatly depending on the favourability of climatic conditions. In particular, it is affected by low and high rainfall seasons, time and the frequency of grazing, accessibility of the range area, distribution of the animals and range management practices if any. Another vital element that cannot be ignored is human influence, whether positive or negative. The productivity estimates at any point in time may not be considered final, as the same area at more or less favourable environmental conditions would provide a different estimation of its productivity. Also, the area selected for estimation of range productivity may not be representative of the entire region. The potential varies from 1.00 to 2.5 Tonnes/ha (Table.4) (UN 1994; Saleem, 1995).

Table 4: Estimated annual forage production and the improvement potential of Balochistan rangelands

Range Type	Area Million ha	Current Production		Improvement Potential		Approximate Time and Resources @ Rs. 14000/ha for 5 years*
		DM (T/ha)	Total DM (MT)	DM (T/ha)	Total DM(MT)	(Rs. billion)
Central	8.00	0.5	4.00	1.00	8.00	112
Eastern	5.00	0.4	2.00	1.50	7.50	70
Western	18.50	0.3	5.35	0.80	14.80	259
Suleiman Mountain	1.50	0.3	0.45	2.00	3.00	21
Total	33.00		12.00		33.30	462

*the last column exists as an estimate of the rangelands improvement to their potential with the assumption, that the environmental conditions remain favourable and the variations existing in the range types have minimal impact.

(Source: Saleem, , ICIMOD, 1995)

Currently, Balochistan's rangelands are attaining on average, 28 percent of their total productive potential. There is immense scope to increase the production through employing improvement practices. The practices which promise to be the most beneficial are mainly in the field of water harvesting and reseeding/planting to arrest the vegetation-cover losses. This is of vital and urgent importance as vegetation-cover is reported to have decreased from 50 percent to 25 percent in the last 57 years (Rafi, 1955; Mann & Rehman, 2006). Recovery of vegetation through natural processes, such as succession, is slow and in some cases where the climax vegetation is lost, it may not return at all, as the trajectories of succession and retrogression are not always consistent. In the case of lower vegetation, improvement could also be brought about through simple protection or grazing management.

In Kuch Mulazi, Muslim Bagh (district Killa Saifullah) it took two years to achieve a 50 percent increase in forage production of grasses and shrubs in the protected area, as opposed to the adjacent open to grazing and bush collection area. Improvement through artificial means, such as reseeding and planting, with water harvesting for range and watershed management purposes, has been estimated to cost about Rs 12,000 to 14,000/ha for a normal project period of five years. As such, improvement to the optimal potential of 33 million ha (Table 4) of range resource would cost approximately Rs 462 billion. This would aim to enable the range resource to produce up to its estimated annual forage production potential (Table 4). However, in the case of higher vegetation (trees) the improvement cost would be much higher and a longer time period would be required, depending on the species planted and its rotation. It could take 6 to 10 years for Poplar or Eucalyptus, 20 to 22 for Acacias, and 62 for Shisham or over 100 years for Pines (Sheikh, 1993), provided all the other environmental factors remained favourable. With Balochistan's climate not conducive to plant growth, grazing management is essential for the rangelands. Simultaneously a conservation strategy for dry afforestation needs to be adopted, followed by water harvesting techniques, except for critical areas or watershed areas of dams.

In a study conducted on the productivity and improvement potential of rangelands in highland Balochistan, it was reported that the initial dry matter forage production recorded for Mastung, Ziarat and Loralai during 2007 was 80, 60 and 184 kg/ha, respectively. However, as a result of protection, an increasing trend was observed with each passing year. During 2010, dry matter forage production recorded for Mastung, Ziarat and Loralai was 230, 485 and 864 kg/ha, respectively, showing an average increase of over 400 percent. It is worth mentioning that the total annual rainfall recorded at Quetta representing Mastung and Ziarat representing Tomagh ranged from 104 to 247 mm and 390 to 462, respectively (Ahmad & Islam, 2011). All sites of the community-degraded rangelands showed similar recovery potential. At Mastung the dominated range vegetation is Artemisia and *Haloxylon* species while at Loralai/ Tomagh site perennial grasses (*Cymbopogon jwarancusa, Chrysopogon aucheri*) were the dominant species.

Range recovery depends largely on the distribution of rainfall and management practices. The Loralai (Tomagh) sites reflected better recovery potential of range vegetation because of the prevalence of both winter and monsoon rains. The arid rangelands of Balochistan, characterized by highly unpredictable and variable rainfall patterns, behave as a non-equilibrium system. This means that both climatic and grazing factors are important in any range management and improvement interventions (Ahmad & Islam, 2011).

It is crucial for the range managers to be aware of the current level of utilization of the rangeland, in order to set appropriate numbers of livestock for a given area. For centuries, the rangelands in Balochistan have been traditionally grazed by Baloch, Pushtoon, Brahvi, and Sindhi pastoralists and Afghan nomads. Afghan nomads, called Pawindas, have travelled to Balochistan for centuries. However, since the early 1980s, Afghan refugees have sought sanctuary in Balochistan, first from the Russian invasion in Afghanistan, followed by war between the Afghan Warlords and now from the American-Afghan war. The livestock of these refugees have also started using the rangelands of the province. They have completely uprooted the vegetation in Populzai, Surkhab and Gawal State Forests in Pishin district. Similar damages have been noted in the vicinity of other refugees camping districts. The cumulative impact of multiple groups utilizing the rangelands for grazing and fuel wood collection has naturally been severe. One factor common to these groups is the complete lack of understanding of the percentage of the forage to be grazed and the percentage to be to be left, to make the practice sustainable (ADPB, 1998). At a time when the livestock population in the province was 20 million head, grazing lands were reported to be overstocked by up to 6 or 7 times their capacity (FAO, 1983). With the increasing livestock population now at 32.934 million, projected up to 2012 (Livestock Dept. 2012), the overstocking has increased to about 10 to 11 times their capacity climate change, severity of drought, particularly the longer drought of 1998 to 2004, and the increase in the rural population, combined with continued process of the uprooting of range bushes, have not been accounted for. This has greatly aggravated the situation and the burden on the range resource has increased exponentially above what was estimated.

Determination of trends in rangelands vegetation requires an experiment over a long period of time and establishing a base line to compare the changes in vegetation. In the literature review, no indication of any experiment has been found that has been specifically designed to determine the rangeland vegetation trend. However, the result of experiments conducted by AZRC or Balochistan University in Highland Balcochistan, show that floristic diversity was higher in the protected sites than the open to grazing site (Fakhara et al., 2012). Similarly, many desirable shrub species like *Caragana ambigua*, *Stocksia brahvica*, *Berberis Balochistanica* and *Prunus eburnea* have been replaced by *Haloxylon grifithii* and other unpalatable species (Ahmad & Islam, 2011). There have been established ecological exclosures in Ziarat (Juniper forest) over the last 50 years, and later on more were established in Kuch Mulazai (Killa Saifullah District) and Kadi Karze (Mastung District). However, no trend data could be collected (Forest Dept, 2012); the exclosures are not fully intact and grazing in these occurs from time to time so they cannot be used as a baseline for ecological changes. The only sites which may provide some indication on the vegetation trend in the rangelands are grave yards, the protected agriculture fields, the border areas of orchards, and areas in the vicinity of the villages. Of these, graveyards, protected agriculture fields and the orchard border areas, where grazing is not intensive or vegetation not removed for fuel wood, have higher floristic diversity than the surrounding grazing areas. In contrast, areas in the vicinity of villages, where sedentary grazing is continuously taking place and/or vegetation is removed for fuel wood, are either largely devoid of vegetation cover or covered by undesirable species. This change of trend could be seen in the central and eastern range types. Changes on the above mentioned sites provide reliable indications retrogression has set-in.

The current trend in vegetation surface cover is downward with Mann and Rehman (2006) reporting that vegetation cover as a whole is 10 to 25 percent. However, the vegetation cover in protected forests and rangelands is in excess of 50 percent. The effect of protection on vegetation cover is very encouraging. As mentioned previously, Hazarganji-Chiltan National Park, Quetta is an excellent illustration of the application and function of conservation practices and offers excellent opportunity to compare current livestock grazing effects with the potential impacts that can be expected when areas are not subject to overgrazing and poor management.

Major Causes of Rangeland Deterioration

The inescapable fact of the matter is that the rangelands in Balochistan are deteriorating and at an accelerated rate. A combination of a number of factors is likely responsible for this trend. In, the literature reviewing these factors, experts have assigned different scores to their views on the matter. The most factors which are the most to blame appear to be:

Overgrazing: Rangelands in Balochistan are overstocked by 6 to 7 times over their carrying capacity (FAO, 1983). This overstocking of livestock on rangelands, mainly of small ruminants, has led to over-grazing. It widely recognized that overgrazing is the main cause of rangelands deterioration.

Overgrazing pattern

Moderately grazed rangeland

Intensively grazed rangeland

Collection of fuel wood: The entire rural population and, to an extent, part of the urban population, is dependant on rangelands for their fuel wood requirements for cooking and heating. For this purpose, shrub, bushes and sometimes even the herbaceous vegetation, are uprooted. This uprooting of bushes, shrubs or wood from rangelands has caused the deterioration of already depleted forests/rangelands of Balochistan. It is estimated that an average family household of 10 members may utilize half a donkey load (weight 50 kg) of bushes per day. In terms of monetary value, this would cost from Rs. 300 to 500 depending on the lead bushes/wood is being cut and carried. The projected human population of Balochistan up to 2012 is about 9.23 million, with 87 percent residing in rural areas. The total rural population therefore is approximately 8.004 million or 0.800 million households. The estimated fuel wood consumption would be around 20.01 million kg per day or 7.3 million tonnes per year. In term of biomass this is a huge extraction which would invariably cause high levels of denudation of rangelands. In monetary terms the annual fuel wood from rangelands costs about Rs. 10,000/tonne, amounting to an estimated Rs 73.00 billion. Many experts, including BCS, (2000) support the view that grubbing /extraction of shrubs, bushes and wood is one of the main causes of range resource deterioration in Balochistan.

Lack of grazing management: Lack of grazing management is one of the root causes of land degradation in general and rangeland degradation, in particular (FAO, 1983). In Balochistan there are three main livestock production systems: sedentary, transhumant, and nomadic. In the past, there was some grazing management, which was endorsed by traditional norms. In these grazing management systems, part of the grazing area would be closed usually for a full growing season, and the area closed to grazing was called (Pegore or Rakh). After closure for a growing season or one full year, animals would be allowed to graze the area in the next growing season/year. This traditional grazing management system has mostly vanished in Balochistan, except in the Musakhail district where it is still practiced (S. G. Muhammad, CCF South, Personal account, 2012). In addition, the notables of Khuzdar district, especially in the Wadh area, do not allow illicit cutting of vegetation. Consequently, the vegetation is still in good condition (M. Taj, CCF North, Personal account, 2012). In the rest of Balochistan, in the sedentary livestock production system livestock is herded mostly by small children, with no concept of grazing or its consequences. Continued year-round grazing on the village rangelands, for many years, has led to range depletion. This is visible in the vicinity of villages across the entire province. Similarly, the transhumant and nomads also no longer practice any grazing management, despite having done so in the past. Nomads are no longer following their traditional grazing routes and the transhumant returns early on the first spell of rain in the uplands due to shortage of forage/feed in the plains (Buzdar et al., 1989).

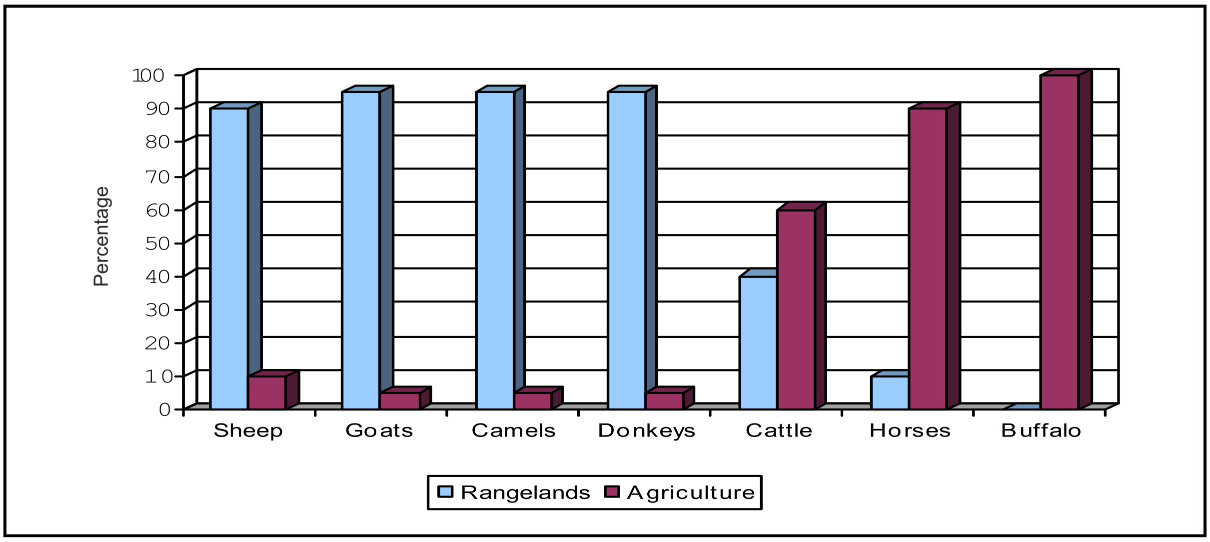
Tragedy of the common: The rangelands of Balochistan fall under two property regimes: wastelands, declared as Government property (Open), and community land (common) (BCS, 2000).The open rangelands are free access ranges and are in poor condition, whereas the community owned lands have some ownership, where nomads ask permission or pay the tribe for grazing privileges. In Baloch/Brahvi areas, ranges are mostly owned by the tribal heads/elites, whereas in the Pushtoon areas, ranges are owned by the tribes and have common ownership. Grazing on almost all rangelands is free. Where there is a fee charged, it is very nominal. This has led to a lack of understanding of rest or relief from grazing or seed setting. It may, infact be the reason many ranges have been grazed to the point of no return. The development interventions, if any, have had very brief and unsustainable levels of impact. This is because most of the project/programmes are implemented for short durations, and once finished; there is no ownership to continue the care. This has led to the population becoming inured to the deterioration of the rangelands around them. Thus the tragedy of the common is as true in Balochistan as in any under-developed part of the world.

Misuse of water resources and lack of an integrated watershed approach: Degradation of the natural resources, including rangelands, is attributed to the misuse of water resources in the province and lack of a holistic Integrated Water Resource Management (IWRM) approach (Baloch & Tanik, 2004). Rangelands in Balochistan serve as catchment areas for the watersheds of the basins. However, these are not appropriately managed. There is no co-ordination amongst the sectors to adopt a common development approach and integrated natural resource management approach. The Planning & Development Department (P&DD), Government of Balochistan, has made a principle decision dictating that in all dam construction projects, at least 1 percent of the project cost, should be spent on the protection or improvement of natural living resources in the catchment area. Thus far, this has not been implemented and the ranges in the catchment areas of the dams are consequently facing denudation. Similarly, the installation of 14,363 tube wells paired with the excavation of 11,371 dug wells, has resulted in the decline of the water table, which has led to ground water mining (BCS, 2000 and has placed the anticipated life span of the dams at risk.

Climate change: Climate change is increasingly becoming a factor in rangeland deterioration. Global warming due to the greenhouse effect, has led to the estimate that temperature will rise, globally, by anywhere from 2°C to 4.5°C by the end of the current century (Arjumand, 2009). Although no country is exempt, poorer countries will naturally be the worst hit, due to poor planning and lack of financial resources to undertake mitigation efforts. Pakistan in general and Balochistan in particular, may be hit the worst, because of the exceedingly arid conditions prevailing in the province and its weak economy. Signs of climate change already seem to have become visible in the shape of declining snowfall, irregularity of rainfall, severity of the droughts and increased flood damage. The drought of 1998 to 2004 delivered a serious blow to water, agriculture, forests, and rangelands resources in the province, shaking the very base of vegetation in Balochistan and causing drastic losses to livestock (Jasara et al., 2001). As previously mentioned, the 2010-2011 floods caused unprecedented damage, particularly in the irrigated districts of the province (PDMA, 2011).

Lack of alternatives: So far no alternatives have been developed or provided for the shortage of livestock feed from agriculture fields, or for fuel wood collection in the provincial rangelands. Feed shortage is the single most limiting factor to livestock production. The entirety of the fodder crops grown (Sorghum, Maize, Alfalfa, Berseem, Barley etc.) hardly cover 4 to 6 percent of the total cropped area. Fodder crops grown in such an area can only meet about 22 to 25 percent of the total livestock feed requirement (GOB, 2010). The available forage is also deficient by about 7 percent in terms of total digestible nutrients (TDN) and 16 percent in terms of digestible protein (DP) (ADPB, 1998).This deficiency in TDN and DP poses a very serious setback in operating an efficient livestock production system in the province. It is because of this that, at present, livestock achieves only 75 to 80 percent of its inherent production capacity (Soomro, 1998). Livestock species present in the province depend to varying extents on the fodder crops produced by the agriculture (Figure 6). Similarly, the lack of alternatives to firewood and bushes cut from the rangelands is considered a major cause of rangelands deterioration.

Figure 6: Livestock species



(Source: BFWD)

Lack of ownership: Both the community and the government consider rangelands a rich natural resource, with few exceptions. No traditional/communal and scientific management of range resources is practiced in the province. This seems counter-intuitive, considering the unarguable fact that range resources are a major source of livelihood for the people of Balochistan.

Uncontrolled removal and marketing of range bushes: Due to the lack of ownership/common ownership, rangelands are open for the grubbing and open marketing of bushes as a source of income. In district Killa Abdullah, this activity is a commercial enterprise. The existing forest laws lack a specific section, terming this activity illegal.

Past Development Initiatives

Development initiatives for range development or improvement have been few and far between. The first ever project in Pakistan for range management was launched in Maslakh (Balochistan) in 1954 with the financial assistance of USAID. This project was initially operational for five years and was then extended for another five years (BFWD, 1960). Range vegetation improvement was achieved through water harvesting and grazing management techniques. However, the project ended in failure due to a disease outbreak in the livestock of the project, as the livestock department was not part of the initiative (Forest Dept. 1960). Subsequently, other range rehabilitation, range development and range research projects were executed by the Forest Department and Arid Zone Research Institute, Quetta. In the project, which was directly related to range improvement and development, a number of other development initiatives concerned with watershed planning and management project, and forestry projects were also implemented. The objective was to restore and improve vegetative cover. Some of the range and forestry projects were implemented through a participatory approach where communities were sensitized to and mobilized on awareness-raising and ownership of natural living resources, including rangelands through incentives. The result, in a nutshell, is that employment of protection, grazing management and water harvesting techniques all yield very positive results and are indicators of the resource development potential. However, the question of sustainability remains, even with the success of development initiatives and expertise.

Rangeland Ecosystem Services

Contribution towards pastoral livelihoods: Raising livestock is one of the major activities and a key economic source of livelihood for the inhabitants of the rural areas of Balochistan. Significant elements of the national livestock population, particularly small ruminants (sheep 46 percent; and goats, 23 percent) are reared in this part of the country (Nadeem 1998; Soomro, 1998). It contributes about 50 percent toward the agriculture share in the provincial economy, which in turn occupies about 52 percent share in the provincial Gross Domestic Product (GDP) (Raziq et al., 2010). Rangelands have the highest contribution in terms of supporting/providing forage to 32.934 million head of livestock (projected 2012) with an annual growth rate of 2.26 percent (Table 5).

Table 5: Livestock population (million head) from 1955 to 2006 & projected to 2012

Animal Species	1955	1960	1972	1976	1986	1996	2006	2012 Projected
Cattle	0.295	0.246	0.482	0.684	1.157	1.341	2.253	3.342
Buffaloes	0.026	0.026	0.022	0.033	0.063	0.161	0.319	0.562
Sheep	1.157	2.564	3.859	5.075	11.111	10.841	12.804	14.248
Goats	0.702	1.596	3.238	4.441	7.299	9.369	11.784	13.735
Camels	0.070	0.086	0.185	0.212	0.349	0.339	0.379	0.415
Horses	0.014	0.010	0.019	0.023	0.029	0.043	0.059	0.077
Assess	0.061	0.099	0.171	0.244	0.370	0.383	0.471	0.544
Mules	0.002	0.004	0.001	0.001	0.004	0.006	0.006	0.011
Poultry	0.283	0.454	1.183	1.958	3.295	4.637	5.911	6.885
Total	2.610	5.482	9.160	12.671	23.677	27.120	33.996	39.819

(Source: Livestock & dairy development dept. 2012)

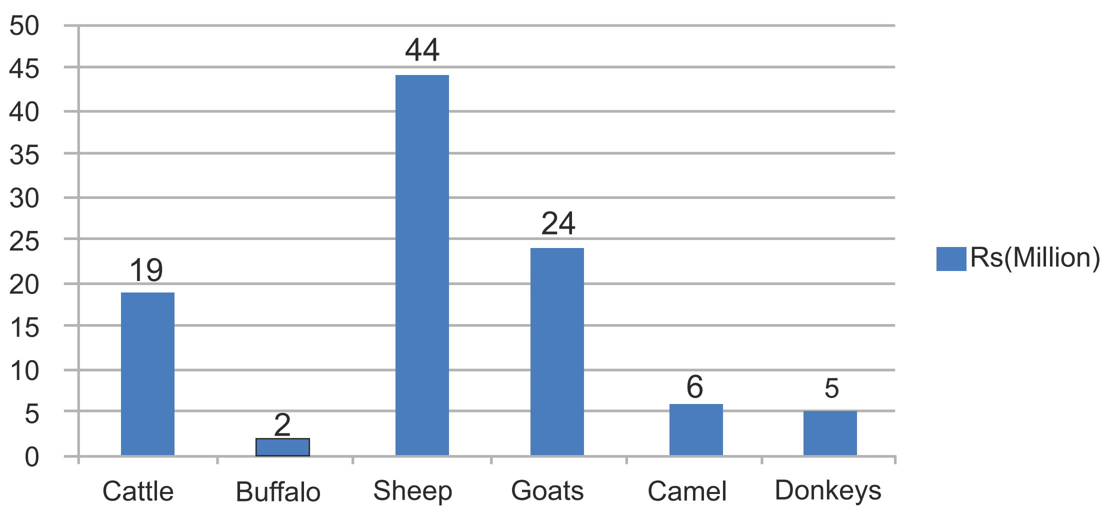
Rangelands provide about 90 percent of the forage requirement for small ruminants (sheep and goats), 95 percent for pack animals (camels, donkeys, horses and mules), and 5 percent for buffalo (Figure 6). In BCS in monetary terms the livestock wealth has been reported as being worth Rs. 100 million (Figure 7), which does not appear accurate. The annual worth of livestock estimated for 2010-11 is Rs 219.3 billion (Livestock and Dairy Development Dept. 2013). For the projected population of 2012, the monetary value based on the live animal heads, excluding poultry and assuming 33 percent as young and 67 percent as adult animals, is estimated/ derived from Table (5) and ultimately shown in Table 6. As touched upon at the start of this report, this amounts to about Rs. 477.33 billion. The figures discussed are further broken down in these tables. The dependence of the livestock on rangelands bring the monetary share of the rangelands to Rs 327.09 billion, or 68.5 percent of the total monetary value. Each figure proves that Balochistan's rangelands contribute enormously. Figures that stand out show that if the range resource is improved and enabled to produce up to its potential, the rise in livestock value may enable the rangeland contribution to increase by approximately 186.5 percent. If for nothing other than livestock potential, range resources in Balochistan merit protection and ought to be a high priority for management and development.

Table 6: Monetary value of livestock projected population 2012 (amount in Rs. Million)

Types	Total no	Young	Avg. Price	Value	Adults	Avg. Price	Value	Total Value	%	Rangeland Share
Cattle	3342583	1103052	0.010	11031	2239531	0.065	145569	156600	40	62640
Buffalo	562812	185728	0.010	1857	377084	0.08	30167	32024	0	0
Sheep	14248492	4702002	0.005	23510	9546490	0.012	114558	138068	90	124261
Goats	13735170	4532606	0.004	18130	9202564	0.01	92026	110156	95	104648
Camels	415364	137070	0.025	3427	278294	0.075	20872	24299	95	23083
Horses	77039	25423	0.020	508	51616	0.05	2581	3089	10	308
Mules	11492	3792	0.020	76	7700	0.035	269	345	10	34
Asses	544784	179779	0.010	1798	365005	0.03	10950	12748	95	12110
Total	32937736	10869453		60337	22068283		416992	477329		327087

(Source: Derived from table 5 based on current market rates)

Figure 7: Monetary value of livestock



(Source: BCS)

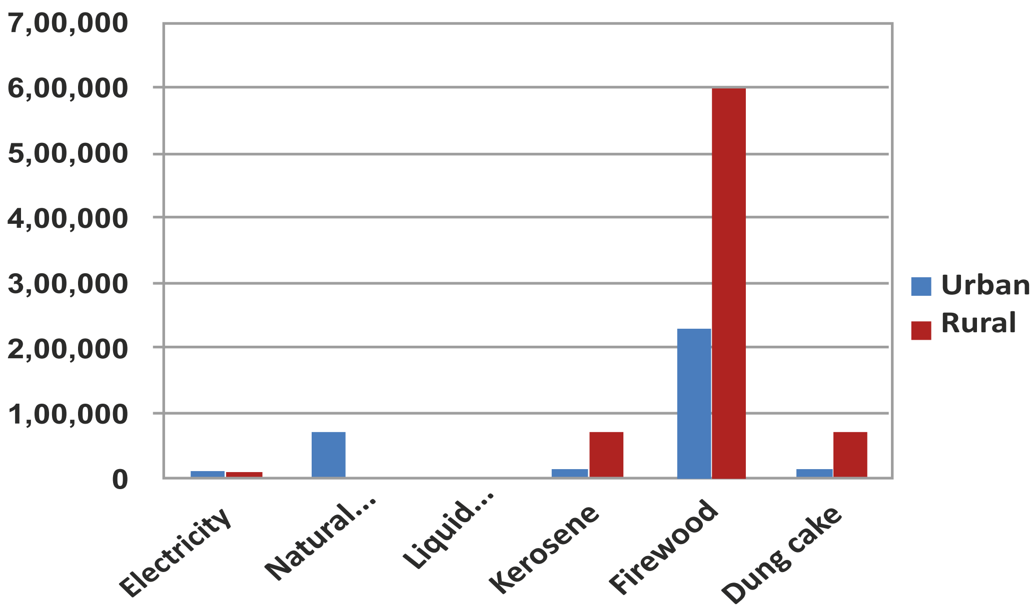
Table 7: Energy consumption in Balochistan, 1991-93 (TOE/year)

Fuel Types	Urban	Rural	Total	%age
Electricity	14,089	8,551	22,640	2.2
Natural Gas	43,532	0	43,532	4.3
Liquid Petroleum Gas	-	-	8,901	0.9
Kerosene	11,118	20,839	31,957	3.1
Firewood	230,011	598,477	828,488	80.9
Dung cake	13,669	74,514	88,183	8.6
Total			1,023,701	100

(Source: BCS, 2000)

From a perusal of the Table 7 and Figure 8, (with dung cake included among sources of energy) Balochistan's rangelands appear able to meet about 90 percent of inhabitants' firewood requirements. However, some estimates claim that about 20,000 truckloads of firewood are imported from Punjab and Sindh each year (Ahmad Ex CCF Balochistan, 2013). These truckloads of fuel wood are mostly brought to fulfil the energy requirements of urban households; the rural areas are almost entirely dependent on fuel wood/ bushes cut from rangelands. This provides strong support to the argument that rangelands in Balochistan have deteriorated, more through the cutting of firewood and grubbing of bushes than through grazing (FAO, 1983).

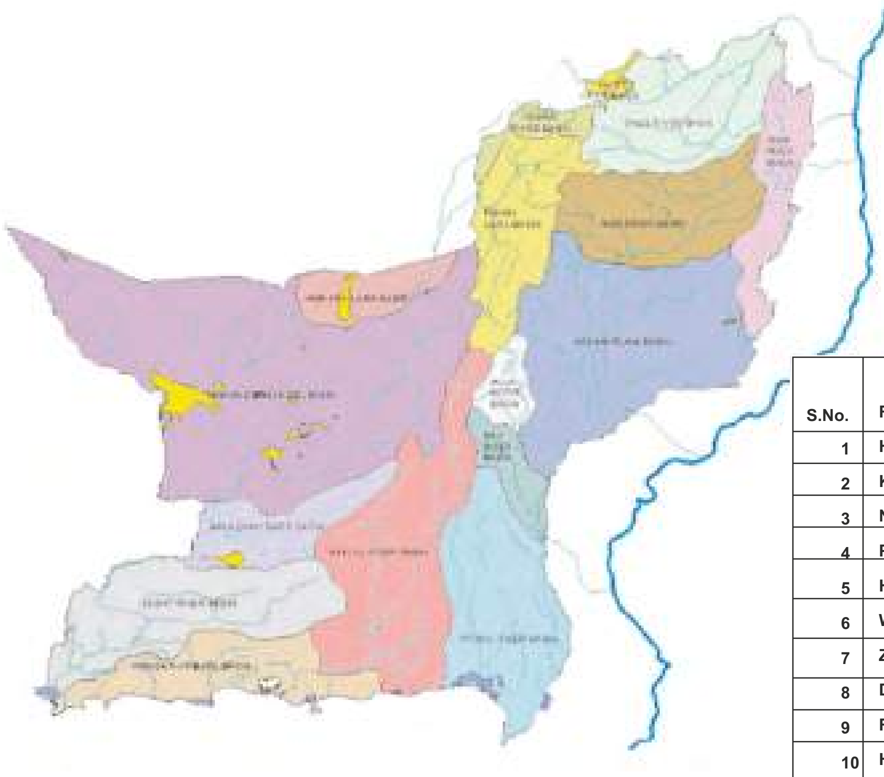
Figure 8: Energy consumption in Balochistan 1991-93 (TOE/ Year)



(Source: BCS, 2000)

Watershed and water regulation: Rangelands in Balochistan, not only provide forage for the livestock, but are also serving as watersheds of the river basins (Figure 9), by regulating the flow of water in the basins catchment. Balochistan is drained by ten main rivers: Zhob, Nari, Pishin-lora, Mula, Porali, Kolachi, Hingol, Dasht, Rakhshan and Gaj. Most of these are ephemeral in nature, except for a few with perennial water flows. These rivers originate from the central and southern parts of the province and fall into the Arabian Sea. Some rivers join the River Indus, while others disgorge into lakes in the southern areas. There are 14 to 18 major river basins which generate about 12.76 million acre feet of water annually as runoff (Irrigation and Power Department, 2005). The water balance of the 14 hydrological basins in the province is given in Table 8. Considering the overall water resources of the province, it becomes apparent that there still exists a potential of 15.6 million acre feet of water.

Figure 9: Balochistan's water resources - hydrological basins



S.No.	River Basin	Available Water (MCM)	Extracled (MCM)	Balance Available (MCM)
1	Hamun-c-Lom	33.9	16.84	17.06
2	Karachi	37.8	11.9	25.9
3	Nari	25.6	25.6	0
4	Pishin Lon	129.6	129.6	0
5	Hab	149.1	74.6	74.5
6	Wialar Nai	119.4	59.6	59.8
7	Zbob	10.9	5.2	5.7
8	Das in	111.7	102.4	9.3
9	Rakhshan	45.5	8.9	36.6
10	Hamun-c-	25	4.4	19.6
11	Mashkhcl	61	4.7	56.3
12	Hingol	265	132.7	132.3
13	Gaj	34	18	16
14	Mula	23	9	14
	Total	1070.5	603.44	467.06

(Source: Irrigation and power dept. 2005)

Table 8: Water resource of the province (million acre feet)

S.No	Description	Quantity (MAF)		
		Available	Utilized	Balance
A.	Indus water as per Indus Accord			
1	Perennial	3.870	3.052	0.820
2	Flood	4.620	--	4.620
	Total	8.490	3.052	5.440
B.	Non Indus Basin			
1	Flood Runoff	12.756	3.000	9.756
2	Groundwater	0.870	0.490	0.380
Total		13.626	3.490	10.136
Total		22.116	6.542	15.577

(Source: Irrigation & power dept. 2005)

The range vegetation cover of the catchment areas of these river basins influences the impact of the rain from its very first drop, by minimizing its speed. It reduces runoff and resultant soil erosion, and increases the infiltration rate and time for ground water recharge. The vegetation acts as live check dams for rill and gully erosion and subsequently regulates the flash floods in the main rivers and streams. The positive role of range vegetation, forest plantations and other watershed rehabilitation activities, has been repeatedly proven through various studies conducted in different parts of the world (Bashir, 1998). Protection of the catchments, control of grazing, and plantation of shrubs and bushes in the watersheds, minimizes the silt load and increase the longevity of the storage and delay action dams.

Wildlife: Balochistan's rangelands are home to number of wildlife species, and provide feed, forage, shelter and cover to a large population of these valuable species. Along with the big game animals, desert ranges in Nushki and Chaghi districts are home to a large reptile population some of which are endemic to Balochistan (BFWD, 2012). Apart from the local fauna, the rangelands in Balochistan are home to a number of exotic bird species such as falcons, cranes and *Houbara bustard*. There are two National Parks, fourteen Wildlife Sanctuaries and eight Game Reserves which have been established to protect the wildlife (BFWD, 2012).

Apart from the protected areas, Balochistan has both high and low mountains and vast sandy plains which house their local exotic wildlife species. Among these, the most mentionable high mountains include Suleiman range, Toba-Kakar, Kakar Khurasan range, and the Central Brahvi range. Among the low mountains, the Kirther range, Pab range, Chagai and Makran costal ranges are the most famous ranges. A coastline of approximately 770 km is also of special conservation interest (Ghalib et al., 2007). No data is available to report in assessing the monetary value of wildlife in Balochistan. Marketing, in the shape of trophy hunting on a limited scale of Suleiman Markhor, Urial, Ibex and Chinkara, is being conducted in a few government and community owned game reserves, which brings about Rs 40.0 million per year. This amount is then distributed between communities and government at the ratio of 8:2. Hunting of the *Houbara bustard* and falcon by Arab dignitaries is a means of promoting the country's international relations (BFWD, 2012). The degradation of rangelands has resulted in livestock encroaching on the wildlife habitats. This has serious implications in terms of competition for forage and may also cause outbreaks of disease in the wildlife population.

Medicinal plants: The rangelands of Balochistan are home to more than 1,330 plant species out of which 700 are of significant medicinal value (Zebta, 2009).These herbs can be used in many forms, including flavours, spices, perfumes and medicinal ingredients. Most of these herbs contain essential oil (volatile oil), which gives them a distinctive taste and fragrance. Other commercial compounds in these medicinal herbs include aldehydes, ketonnees, and alcohols. Various wild herbs are collected and sold in the market by the local community members. However, very limited scientific knowledge is available on the potential herbs that can be cultivated and utilized for various purposes. Until a decade ago, Balochistan has been marketing Ephedra herb (*Ephedra nebrodensis*) to Marker Alkaloids for medicine production. However, this has now halted due to availability of synthetic substitutes.

Some of the aromatic and medicinal herb plants which have the potential for increasing the income of the local farmers include lavender, rosemary, mint, thyme, marjoram, oregano, basil, dill, sage, fennel, and tarragon (Ahmad & Islam, 2011). Today there is a growing demand in the international market for plant-based medicines and health products, food supplements, and cosmetics etc. Currently, the annual turnover in this market is over USD 60 billion. Data has been gathered and analysed on about 80 important species (Khan & Islam, 2011). The exploitation and over-grazing of rangelands is diminishing the medicinal plant resources. In view of this fact, it has become imperative to prioritise rangeland protection while simultaneously exploring research opportunities to utilize the medicinal plant wealth to the fullest of its potential.

Rangelands: Current Formal and Informal Use

As previously mentioned, the Balochistan rangelands broadly fall under two property regimes: 1) Open rangelands, inclusive of the watersheds designated as Government property, over which communities have a claim of ownership; 2) The common/communal rangelands owned by the tribes. Open rangelands are over-grazed and are therefore in poor condition. The common or community/communal rangelands are managed under tribal customary traditions. Permission is asked for grazing use or payment of some kind is made for grazing. In general, rangelands, whether open or common, have mostly free access for grazing.

Out of the three livestock production systems that have been discussed, sedentary agro-pastoralists make up 10 percent ,transhumant (with fixed summer and winter quarters) constitute 60 percent, while nomads (permanently on the move) come to about 30 percent. Nomadic livestock is constantly on the move following spells of rain, in search of forage and water. In winter they move from upland to lowland areas and then return in summer. They follow their fixed traditional routes and receive up to 90 percent of their forage from the tribes'/communal rangelands. They have contact/contracts with the tribes, who allow them to use the tribe's ranges and in return they sell them animals and provide labour for orchards and farms (BCS, 2000).

In the transhumant livestock grazing production system, the flock owners move between their winter and summer quarters. Depending on the weather conditions and availability of feed/forage, they stay in the Sibi and Kachhi plains for about five to six months. Notably, some of the flock owners own land in the plains. They have taken on the form of semi-sedentary livestock farmers. They graze their agricultural land and when no feed remains for their livestock, they start grazing the rangelands in the flood plains (Buzdar et al., 1989).The semi-nomadic flock owners' use the flood plains for grazing and sometime purchase feed from the land owners. When there is rain in the uplands they move there early and graze the range in the early stages of their summer quarter. Under this system, livestock contributes about 80 percent to the household income.

In the sedentary livestock production system, flocks are small (5-15). The flock is usually herded year-round by a single herder on the same village range. They are mostly dependent on the feed of agricultural crops (sorghum, alfalfa, barseem, maize, bajra and wheat and barley are sometimes used as green fodder). Sedentary flocks are also fed on the leaves and waste/fallen fruits of orchards. Livestock under this production system contribute about 15 to 40 percent of the household income (BCS, 2000).

In studies conducted in upland Balochistan, it has been reported that the livestock production system is undergoing changes due to electrification of villages, mechanization of agriculture, availability of transport and the Afghan war. In view of these changes, new livestock production systems have emerged for the commercial nomads and Nomad Transhumant (Jasra et al., 2001). The commercial nomads keep small flocks of 15-20 animals, purchase feed from orchards/agriculture fields and each morning brings these animals to sell in the local sale market locally called *Peri.* The Nomad Transhumant are nomads who are now settling and establishing their Barani Agriculture, or raising orchards through the installation of tube wells.

As mentioned earlier changes in the lifestyle of sedentary livestock farmers have led to the abandonment “Pergore” or “Rakh” system, except in the Musakhail district. Alternatively, the pastures were grazed at an interval of 3 days to a week but this is no longer practiced. Similarly, transhumant and nomadic graziers too have not remained true to tradition. The nomadic are becoming transhumant and transhumant sedentary due to the mechanization of agriculture, electrification of tube wells and advancement in transportation system.

Due to increases in the population and electrification of villages, rangelands are used informally by converting them into Khushkaba (rain fed) cultivation, orchards and human settlements. Although no data is available to quantify the extent, the informal use can be seen while travelling along the highways, such as Quetta-Karachi highway, at Dasht Goran (Kalat district), Quetta-Naseerabad highway, Quetta-Loralai via Spera Ragha, and Quetta-Zhob highway. Rangelands along these areas have been converted into rain fed/Barani-agricuture or tube well irrigated orchards. New settlements in many areas of the province are gradually taking on the form of new villages. Due to this, the number of villages once enumerated at around 6,000 (P&D Dept. 1997) may have increased by the hundred since the last count. This also indicates that the area of the rangeland is decreasing and pressure on the resource is increasing with every day. In Quetta and its suburbs, the foothills previously used as grazing grounds and watersheds of the Quetta valley, have now been completely converted to human settlement. This practice looks as though it will continue and the informal use of rangelands in Balochistan will increase along with the increasing human population and availability of civic facilities in rural and sub-urban areas.

The range management is carried out by the Balochistan Forest and Wildlife Department, and those too are limited to the rangelands of the state and protected forest (Forest Act of 1927 and Forest Regulation 1890 and the Wildlife Act/Ordinance 1974). In the distant past, the ranges of the state forests were used for livestock grazing by permit holders for a fee (BFWD, 1970). This is no longer practiced mainly because the rangelands/under-wood areas of the state forests are depleted and are not very different to the common rangelands present elsewhere in the province. Under some range development schemes, the village/local communities were involved through social interventions such as providing range resource awareness trainings, in-country exposure visits, and some socio-economic activities for village women including embroidery, raising poultry and kitchen-gardening. This co-management of the rangelands resource initially started with the first ever range management project at Muslakh (the then Pishin district) in 1954. The project, which was initially envisaged for a five-year period, was later extended for another phase and remained in implementation for ten years. In this project the local communities were involved in grazing management and range improvement activities. The project was considered successful to the extent of vegetation improvement, but as mentioned earlier, suffered due to lack of involvement from the Livestock/Veterinary Department (BFWD, 1954-1964). Similarly, there followed many range, watershed and Feed resources development and rehabilitation projects implemented by the Forest, Livestock or the Arid Zone Research Centre. All of them were mostly donor-funded projects or sponsored by the Federal Government and were launched with community participation/co-management.

Besides this handful of development projects, some other community based range and watershed development projects were implemented by IUCN and some local NGOs with natural resource development components. All these projects have spent considerable financial resources and invariably achieved their objectives during the life of the project with active participation of the communities in the trainings, meetings and workshops. The thing that remains lacking, however, is community empowerment for independent efforts. The failure was primarily that of bringing about awareness in these communities and the lack of mobilization which would enable them to either co-manage the range resources or manage them independently. Trans-boundary influences, in the form of Afghan nomads, on the rangeland resources are also a factor. Afghan refugees and Sindhi pastoralists who are utilize the grazing potential of the range resources also contribute to their depletion.

Policy and Institutional Gaps

Range management problems in Balochistan are diverse and complex. The rangelands of Balochistan are open and there is no single body responsible for their management. Land value is considerable but land as a range resource appears to have no appreciable value. Approximately 4 percent of rangelands are under the control of Balochistan Forest & Wildlife Department, while the rest belongs to different groups (Ahmad & Islam, 2011). To assist in the future management of this precious resource, the major policy and institutional gaps are identified in the following paragraphs.

Land tenure: In Balochistan the ownership of land, especially rangeland, is unclear. In the south-west of the province, land is mostly controlled by the tribal heads/elites and the common man has very little or no authority in deciding its use. In the north, land is owned by the tribes collectively, locally called "Shamilat". The Government had a legal declaration stating that all the wasteland is vested in the government, but the community have their own claim of ownership. Currently, it is a social and political issue which no one is willing to touch leaving the issue unresolved. It poses difficulties in the planning of initiatives and special efforts have to be made in the selection of sites for development projects to improve or develop the range resource.

Institutional arrangements: Rangelands in the province are under the portfolio of the Balochistan Forest and Wildlife Department. Balochistan, due to arid and harsh climatic conditions, has very meagre forest resources: only 0.7 to 1 percent of the area is under tree cover. However, collectively the department legally controls about 3 percent of the total area of the province in the form of state protected forests, rangelands, and wildlife protected areas (BFWD, 2012). Despite the magnitude of the range resource, and its acknowledged potential to support the livestock industry and provide substantial livelihoods for rural communities in the province, no institutional arrangements exist in the Balochistan Forest & Wildlife Department to optimally manage and harvest its potential. Two positions of Range Management Directors (B-19) were created in the Department to take care of the rangeland resources, but these have now been changed to the position of Conservator of Forests. This potential resource, with all its future prospects, is administratively ignored and scientifically unexplored.

Range use policy and legislation: Rangeland is a massive resource accounting for about 93 percent of the total land area of Balochistan. This report explores the fact that the grazing land provides feed to millions of head of livestock with considerable monetary value while contributing several other ecosystem services. Despite this, there is no range use policy or legislative support to ensure its legal protection. Until recently, the Forest Act 1927 and the Forest Regulation 1890 contained no section protecting against the misuse of rangelands such as grubbing of bushes or converting the rangelands into dry-farming or orchards.

Now the Balochistan Forest & Wildlife Department has enacted new legislation titled "Forest Act 2011" which is under legal scrutiny so that it may be formally approved. This act imparts legal protection to the rangeland resource and its ecosystem (BFWD, 2012). However, a Provincial Range Policy is urgently required to direct its use and development. Apart from these documents, a workable implementation plan is also needed to translate policy and legal documentary statements and directives into action so that it may have some impact.

Grazing management: Contrary to popular belief, it is often lack of grazing management and not over-grazing and uprooting of bushes from the rangelands, that is the main cause of rangeland deterioration (FAO, 1983). From a historical perspective, when the economy was pastoral, the government charged a grazing fee from nomads, called “Terni”, and the local livestock farmers, mostly sedentary in nature, were setting aside part of the range resource called “Pergore” or “Rakh” as described earlier. Due to these practices, the rangelands were in good condition but this has now mostly vanished. In some areas livestock grazing was also manipulated in such a way as to graze a pasture for a few days then rest it for 3 to 5 days before returning to it. Now almost none of the livestock production systems are strictly followed, and the distinction which existed in the past between the nomads and the transhumant graziers has now become obscured. All of these factors point to the lack of grazing management as a major reason for range deterioration.

Lack of research and reliable data: Rangelands cover almost the entire province and occupy all the ecological zones with a diverse topography. None of the development projects executed so far included a research component, as they were mainly demonstrative in nature. There were a few projects executed by AZRC which provide some data for a few locations, but the data cannot be considered representative of its ecological zone. From the research point of view, the range resource is totally unexplored highlighting a complete lack of adequate reliable data. This fact has been indicated in almost all reports written about natural resources including the rangeland resource. Similarly, the data provided in the present report is taken from the literature review and has the same weaknesses. It is therefore felt that unless comprehensive studies are conducted on an eco-zone basis, the data presented so far in almost all the reports including the present one will not be sufficient.

Financial resources: The share of Balochistan Forest & Wildlife Department, in the departmental budget, has always been minimal, while the share of rangelands development has been negligible with the exception of funds provided by the donors for the range resources. Table 9 shows the annual PSDP position.

Table 9: Comparison of annual forestry PSDP allocations to annual provincial PSDP allocations

Year	No of Schemes				Forestry PSDP Allocation Rs million	Provincial PSDP Allocation (Rs. million)	% Forestry Allocation
	Total	On-going	New	Completed			
2008-2009	8	8	-	2	34.564	15745	0.22
2009-2010	6	6	-	5	22.578	15163	0.15
2010-2011	2	1	1	-	6	26329	0.02
2011-2012	6	2	4	3	54.9	31352	0.18
Total				10	118.042	88589	0.13

(Source: P&DD, 2012)

The average annual allocation for the last four years was Rs 29.51 million which comes to 0.13 percent of the total average annual Provincial PSDP (Rs. 88,589 million) (P&D Dept. record 2012). In comparison to the magnitude of the rangeland resource, it is a very meagre amount indeed. It undoubtedly falls short of an appreciable effort towards improving and developing the province's natural living resources, including the range resource. This is particularly true under the present inhospitable environmental conditions. It is not only the size of the sum made available to the resource in a budget which matters, but the provision of a budget for a longer duration and on a regular basis. Ongoing management compatible with natural living resources including the range resource must be provided for (Dr Saleem, Personal Account).

Integrated planning and sustainable development: In the developmental hierarchy, the P&DD, Government of Balochistan, is symbolic of integrated development. The P&DD's mandate is to coordinate the efforts of different development sectors towards the achievement of a common objective. In practice, however, the Department is still striving to materialize. So far, in PSDP, the development schemes are approved on a sector basis. Due to a lack of integration, the development activities conducted by closely related sectors, such as agriculture, forest, livestock and irrigation, are not complementing each other or achieving their required goals. Also, the failures faced and the lessons learned in development schemes are not being fully assimilated by the sectors to avoid repeating mistakes. The PSDP still faces political interference despite efforts that to minimize this interference in all individual sectors. The involvement of the community, for whose benefit the PSDP is prepared, is only partially addressed. Although the development era in the province has been underway since the 1970s, the issue of sustainability has not been fully addressed to ensure the maximum measurable impact.

Conclusions and Recommendations

Conclusions: Land in Balochistan is primarily used as a range resource. Despite the inherent harsh and inhospitable climatic conditions, low and erratic rainfall, extreme temperatures in winter and summer, with no ownership support, and recurrent droughts, rangelands provide livelihoods to 87 percent of the rural population. This is achieved by providing forage to about 32.934 million head of livestock, which in monetary terms amounts to about 477.33 billion rupees. The share of rangelands amounts to Rs. 327.09 billion or 68.5 percent of the total monetary value. Should the rangelands be improved to meet their potential, there is a possibility that they could support a livestock population of up to 90.5 million head and the monetary value, based on the current market prices, could be raised by up to about Rs. 1,300 billion, while the share of rangelands in monetary terms could rise to Rs. 890.8 billion. Additionally, the ecosystem contributions towards surface and ground water resources, providing 90 percent of the energy for the rural population as well as to shelter and cover for wildlife and recreation, are innumerable.

Initiatives undertaken for the development of rangeland resources have been few and far between, achieving only their short-term objective during the life of the project. However, the sustainability, and community empowerment are yet to be achieved. The studies undertaken have clearly shown the recovery potential of the natural vegetation and introduction of the exotic species. However, the findings fall short of being considered representative, even when comparing the research area covered, to its own ecological zone and the climate variability of the resource. In the wake of existing institutional gaps, ambiguous land tenure, lack of policy and grazing management, it appears likely that the biodiversity of the resource will diminish and the desertification process will increase drastically. The loss of its ecological services will put lives at risk if sustainable development of the resource is not ensured.

Recommendations:

Short term

1. To gather reliable data, the existing forest staff of each district should be provided with resources and made responsible for conducting range resource inventories of their districts.This should be performed under the guidelines provided by the range experts or senior research officers of the department. The data collected should be sent to the research wing of the department to establish a base line for each district. This data must be updated on a regular basis to seek comparisons and establish trends in the vegetation of the range resource as and when required. The updated data should be used for further research and preparation of development projects.
2. The department should initiate extension and awareness activities through the district forest staff to create a pervasive sense of ownership for the management of rangelands.

Medium term

1. A Range Policy and Action Plan should be formulated directing community-based management of the range resource. The basic research should be entrusted to universities and the adaptive research in the field should be assigned to the department to conduct with community involvement wherever necessary.
2. Two positions at the DFO level, one each with CCF North and CCF South, should be designated or created. These should be assigned to work as focal officers for range resources, and liaise with the livestock owners and communities to work on the mechanics of the integrated development of the range resources. Working with the communities, the focal officers should establish the community Grazier Associations (GAs) at the union council level.
3. The Planning and Development Section of the department should prepare community based participatory development schemes, where the community is involved in every stage from selection of the site to preparation of the scheme and its implementation. This would serve to mobilize the communities and prepare them for future management of the range resource. Awareness should be created in communities for the restoration and sustainable management of the range resource through protection and grazing management. A period of 5 to 10 years should be planned on for this exercise.
4. Political support for range resource should be created using the community platform. Land tenure of the pastoral lands should be redefined up to the union council/Village level to allow for range use and development on multiple-use concept. Using political support, efforts should be made to provide natural gas to all the main towns in the province and LPG at the union council level to preserve the province's environment.
5. The Research wing of the department should be made a permanent structure, manned by willing workers through option. It should be facilitated and mobilized to conduct adaptive research trials on an eco-zone basis and to provide proven techniques and plants species to cope with the recurring droughts and climate change requirements.
6. Pakistan is an agricultural country where the livestock industry plays a significant role in the agro-economy. Balochistan is, clearly, a livestock region with a large rangelands resource. It is therefore recommended that a main research institute for range and livestock research and training be established in Balochistan with its sub-institutions in other provinces in order to promote the livestock industry on a commercial basis, impart training and conduct research to

cope with the recurring droughts and climate change challenges through mitigation and adaptation strategies.

7. Forest and livestock sectors in the province should be required to have close coordination and pool their financial and human resources to improve the range resource to its full potential, and raise the livestock industry from its current, subsistence, level to the commercial level. Additionally, work should be undertaken to create innovative management where the community is given a central role in the resource management and both the departments adopt advisory and regulatory roles, and conduct adoptive research trials for demonstration purposes.

Long term

1. The Research wing of the department should gradually be expanded to the district level. Over time, the entire department should be transformed into a Regulatory, Advisory, Adaptive Research, and Trial Services-providing Organization. The communities should be given the role of resource management and conservation.Morover the Provincial Rangeland Development Authority (PRDA) should be created with Social and Technical wings, having social members from community and technical members from Forest and Livestock Departments. This body should have complementary units at eco-zone level, with a clear mandate and responsibilities for each wing and units to develop the range resource through a “by the people and for the people” approach.
1. The decision makers, especially the P&DD, should be convinced to allow long-term development planning of at least 10 years for the development of the natural living resources. The provision of funds may not increase but a longer duration would ensure sustainability. The development schemes of the range resource should be advertised under the technical and advisory supervision of the Forest Department and be implemented through the respective GAs of the Union Council to create a sense of ownership and to ensure the sustainability of the range resource development and management.
2. Easy Flow of Funds Mechanism (FFM) and an effective Monitoring and Evaluation System should be institutionalized.
3. Part of forest staff in each district should be designated as range staff to undertake range resource related activities throughout the year, so that it becomes a regular performance of duty.

SINDH
PROVINCIAL REPORT

Sindh

Background

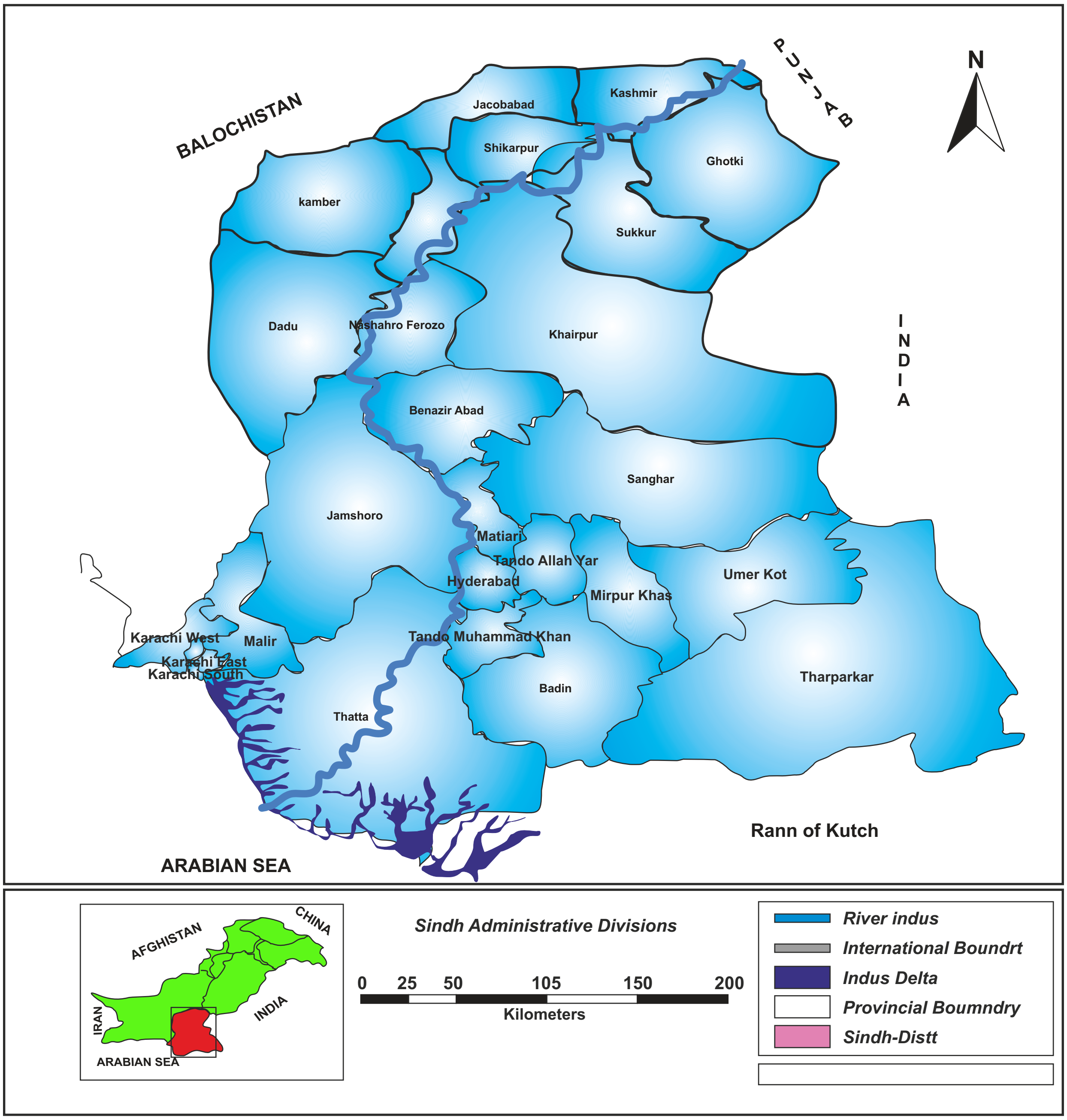
The key rangeland zones in Sindh include Kohistan, Tar, and Nara with areas of 4.3, 2.3, and 2.2 million hectares respectively. The rangelands in the province are highly dynamic and are categorized as a fragile and depleted ecosystem due to overgrazing. The rangeland condition and productivity has also been declining at an alarming rate due to natural, environmental, and anthropogenic factors such as severe environmental and socio- economic stresses.

Major challenges in rangeland management include overstocking, a lack of understanding for the concept for participatory grazing management, and frequent movement of animals from one region to another. Decline in rangeland productivity is also attributable to: management challenges; and, ecological threats. Biodiversity, water resources, and other valuable activities should also be properly evaluated. Most development activities have a direct impact on biodiversity. Demographic trends and socio-economic conditions have far-reaching consequences on the local rangeland ecosystems. Population growth and poverty have exerted heavy pressure on natural resources available in rangelands. Isolated interventions have not addressed the root causes of the biodiversity loss and the reduced rangeland productivity.

The rangelands of Sindh can be characterized as having too little or too erratic rainfall to support forestry or permanent cultivation. Therefore, livestock is of considerable importance to the economy of the Sindh rangeland areas which are mostly used by the pastoralists and their grazing animals. Stretching over 60 percent of the Sindh territory, livestock grazing constitutes the biggest land-use in the province. In addition to meat and milk, the livestock sector produces such by-products as hides, skins, wool, hair, bones, and manure. People derive fuel, building materials, medicinal and food plants from the rangelands. Rangelands also control soil erosion, ensure high quality of water, support Sindh's wildlife (which is a potential source of additional animal protein), and, in some areas, constitute a significant tourist attraction, especially during and after the rainy season.

Sindh is Pakistan's second largest province, covering 14.091 million ha (17.7 percent) of the country. Sindh's ranglelands cover 41 percent of the province. Situated in the south east, it is bordered on the east by the India's Rajasthan, in the south by the Runn of Kutch and the Arabian Sea, in the west by the arid rocky mountains of Balochistan, and in the north, by the irrigated plains of Punjab. The province contains 23 percent of Pakistan's population and plays an important role in the national economic and development agenda. Forests cover 1.125 million ha (8 percent) of Sindh's total area, of which 0.457 million ha (3.25 percent of land area of forests in Sindh) and 41 percent of total land area of the province is occupied by rangelands under the control of Sindh Forest department.

Figure 10: Location and boundaries of districts in Sindh

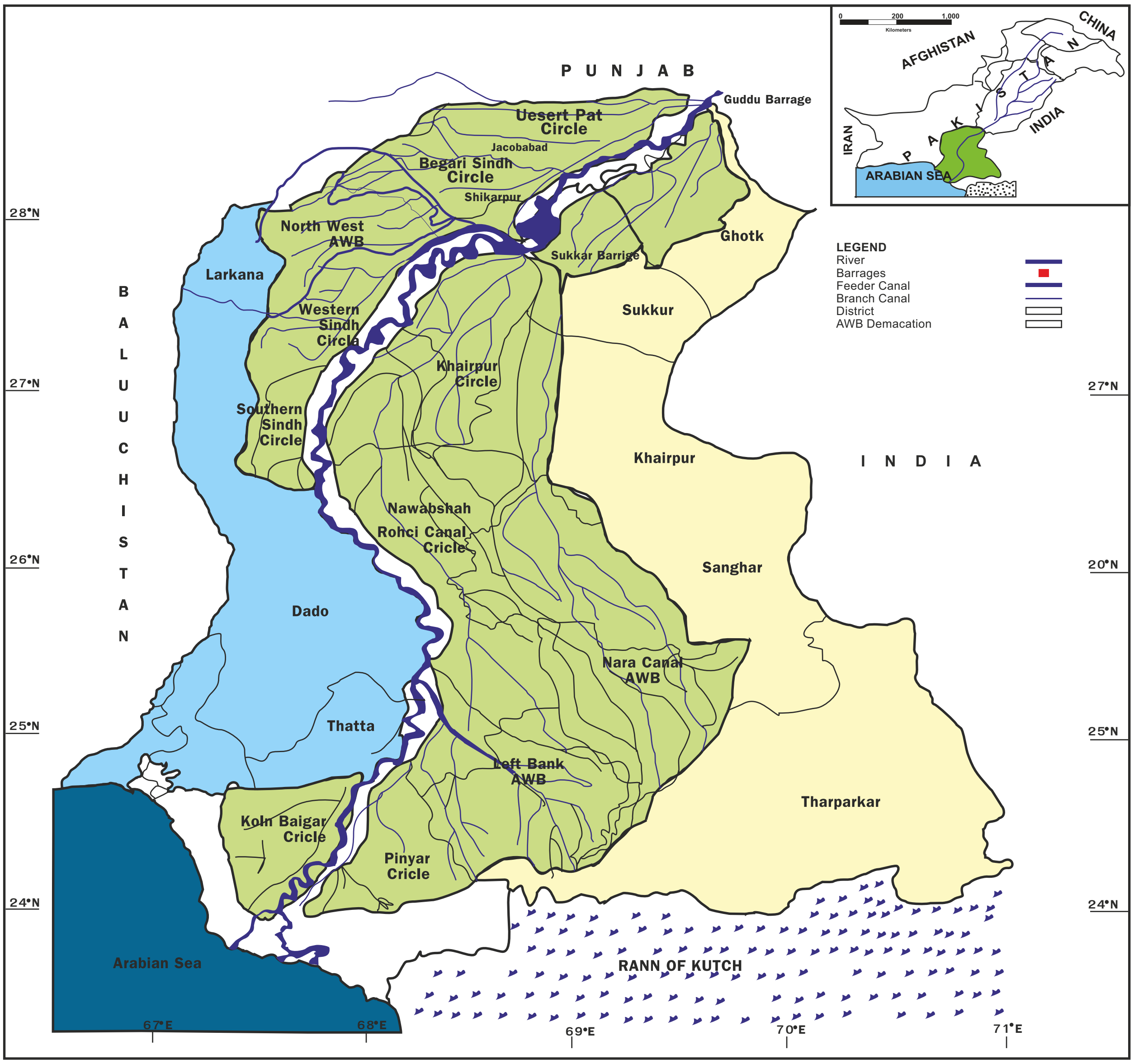


Source: SIDA & LBG/Indus consultant

Administratively the province is divided into the left bank and right bank of Indus. Districts located on left side include Ghotki, Sukkur, Khairpur, Naushahro Feroze, Shaheed Benazirabad (Nawabshah), Sanghar, Hyderabad, Matiari, Tando Allahyar, Mirpurkhas, Umerkot, Tharparkar, Tando Muhammad Khan, Badin and eastern part of Thatta. On the right side of Indus are the districts of Kashmore / Kandhkot, Jacobabad, Shikarpur, Qambar/Shahdadkot, Larkana, Dadu, Jamshoro, Malir (Karachi East), Karachi South, Karachi West and Karachi Central located on right side of Indus. Figure 10 shows the location and boundaries of districts on the provincial map.

Sindh is a province of contrasts containing deserts, hilly area irrigated lands, riverine lands, a deltaic region and coastal/marine zone. The province is divided in three distinct ecological regions: Thar Desert, Kohistan zone and the canal irrigated zone. The irrigated zone is located in the centre of the province which is bisected by river Indus dividing it into left bank and right bank areas. This irrigated zone is flanked by two arid ecological zones: Thar and Nara deserts on its east; and rocky Kohistan on its western side (Figure 11).

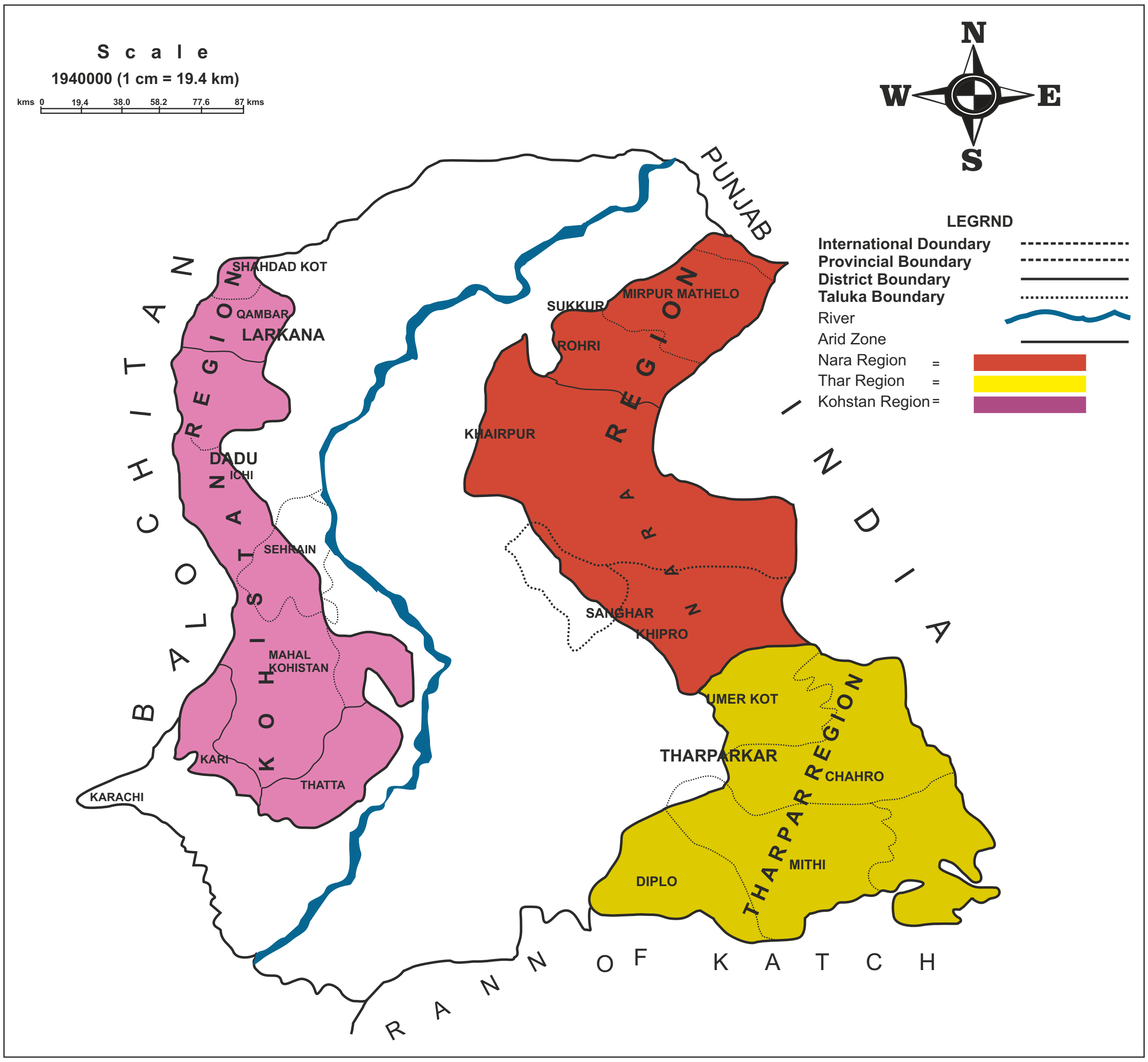
Figure 11: The ecological distribution of Sindh



It is divided into four distinct topographical parts; the Khirthar range on the west, a central alluvial plain in the middle through which runs the Indus River, a desert belt in the east, and the Indus delta.

Zonation of arid zones of Sindh: The Sindh arid zone consists of two long strips to the east and west sides of the irrigated agricultural zone. The Sindh arid zone has a total area of approximately 88,000 sq.km (21.736 acres) which is approximately 62 percent of the land area of the province (Sindh Strategy for Sustainable Development). Thar and Nara are located on the eastern side and the Kohistan zone is located along the western side (Figure 12). These zones are classified as sub-tropical deserts. The location and area of each zone are described below:

Figure 12: Arid zones of Sindh



(Source: IUCN-Sindh state of environment and development)

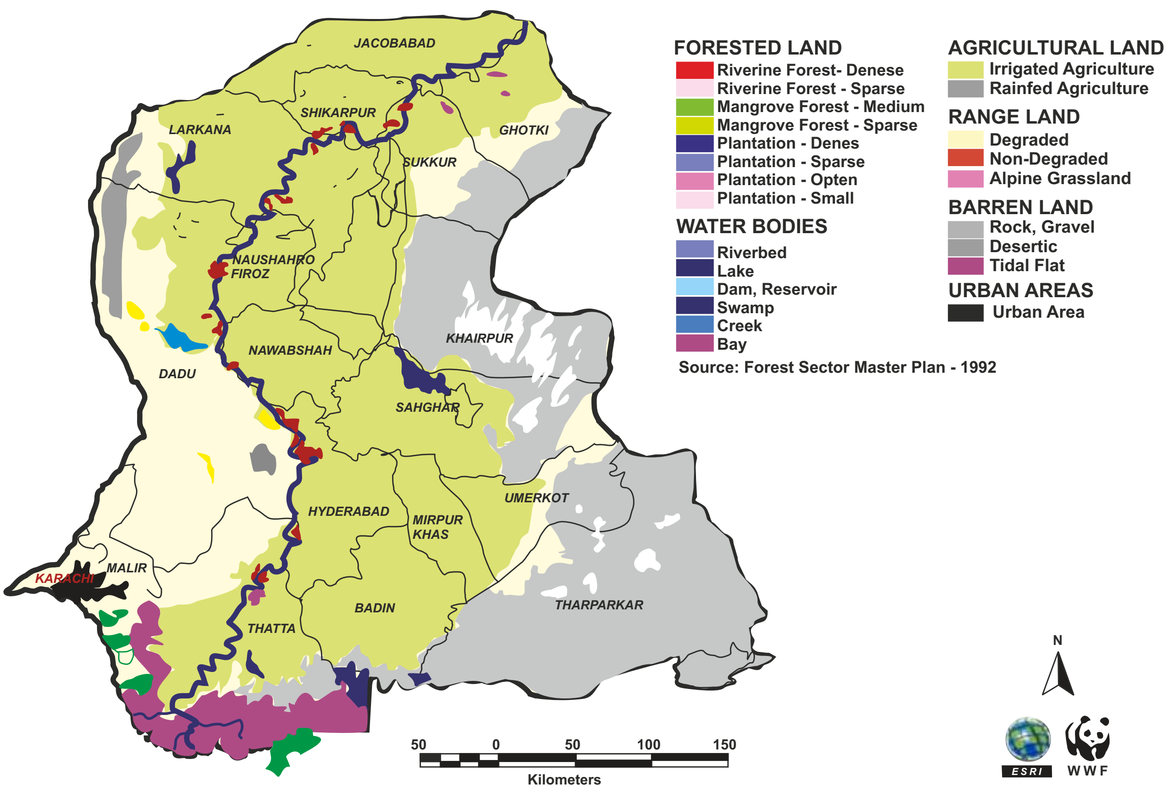
Thar: The Thar Desert extends 45,000 sq kms (4.498 million ha) and is part of the Great Indian Desert. This zone is further divided into two regions i.e. Thar and Nara. Thar occupies an area of 23,000 sq. kms (2.299 millon ha) and is located in Tharparkar and Umerkot districts, and extends southwards along the Runn of Kutch.

Nara: Nara region stretches over 22,000 sq. km (2.199 million ha) and lies in Ghotki, Sukkur, Khairpur, Nawabshah and Sanghar districts. Both the Thar and Nara are located on the left side of Indus and form the eastern boundary of the province (Sindh Strategy for Sustainable Development).

Kohistan: The Kohistan region covers 43,000 sq. km (4.298 million ha) and is located in the districts of Qambar/ Shahdad Kot, Dadu, Jamshoro, Malir-Karachi and Thatta. The Kohistan lies along the western boundary between Sindh and Balochistan and extends in the south along the Indus delta. Ecologically, it is characterized as a tropical sub-mountainous zone and is classified as a tropical maritime rangeland (Sindh Strategy for Sustainable Development).

Land use classification: Three main land uses of Sindh are shown in Figure 13.

Figure 13: Major land use classification of Sindh



(Source: IUCN- Sindh State of Environment and Development)

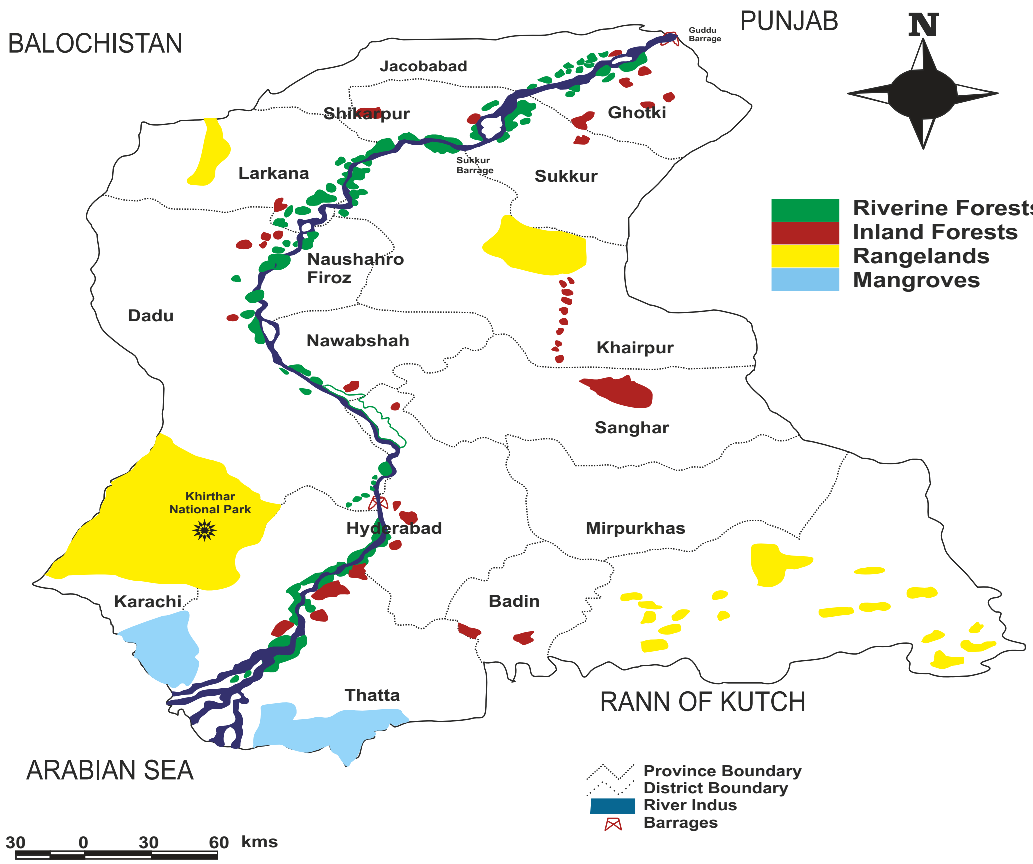
The province is distinctly divided in three longitudinal regions. On its eastern side is the Ragistan comprising of Nara and Thar deserts, on its western side is the Kohistan comprising of sub-mountainous, and in the middle lies the canal irrigated tract which is further bifurcated by the Indus. The Registan and

Kohistan are the arid lands and are used as rangelands under the control of Board of Revenue, private people and Forest department. The central region is canal-irrigated area and its land use is predominantly agriculture.

The area located within the embankments of Indus is designated as flood plain area which occupies an area of about 2.1 million ha and the main land uses of this tract are agriculture on the flood plain and the riverine forests extending over 0.241 million ha owned by the Forest Department, Government of Sindh. Within the canal irrigated zone, irrigated plantations owned by the Forest Department occupying an area of 0.082 million ha, are located in the command area of barrages. Coastal forests are located in the Indus deltaic region occupying an area of 0.344 million ha.

Riverine forests and irrigated plantations are designated as productive forests, and the coastal forests and rangelands are the protected forests. In all, the area under the control of the Forest Department for managing as riverine, irrigated, mangroves and rangelands is 1.125 million ha, which works out to 8 percent of the total land area of the province. Figure 14 shows the location of all types of forests and rangelands on the Sindh map.

Figure 14: Rangelands, Riverine forests, Irrigated Plantations and Mangrove Forests of Sindh



Source: Sindh Forest Department Records, 2003

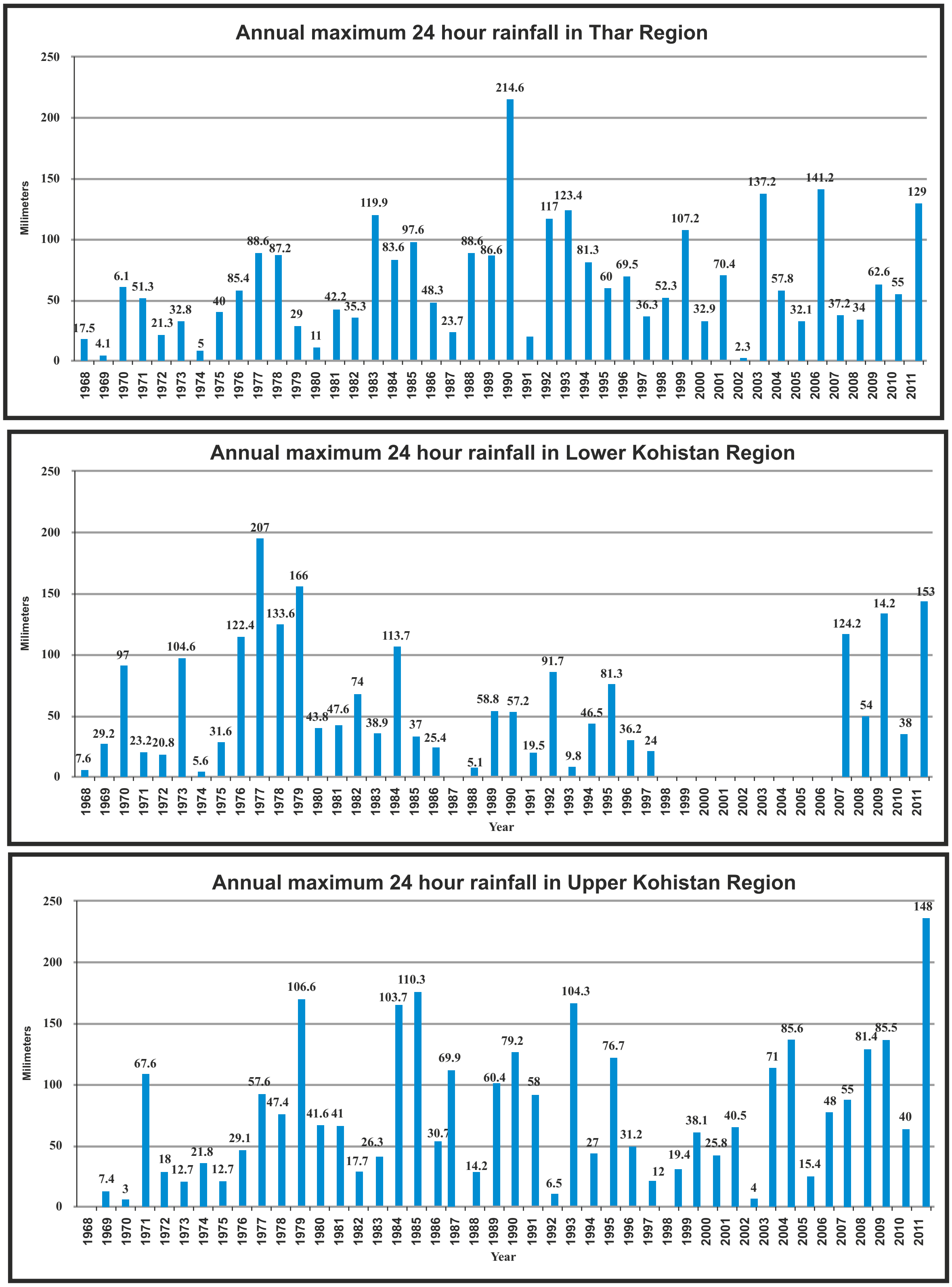
Biophysical environment of rangelands: The geomorphology of desert/ rangeland areas in Sindh differs in western and eastern arid lands. It is evident from their names, Kohistan and Registan mean the land of mountains and sands, respectively. Due to these basic characteristics the type of vegetation and land use are significantly different. Kohistan is divided in two distinct parts, i.e north Kohistan popularly known as Katcho located in Dadu, Jamshoro districts, and south Kohistan near Karachi located in Thatta and Malir districts.

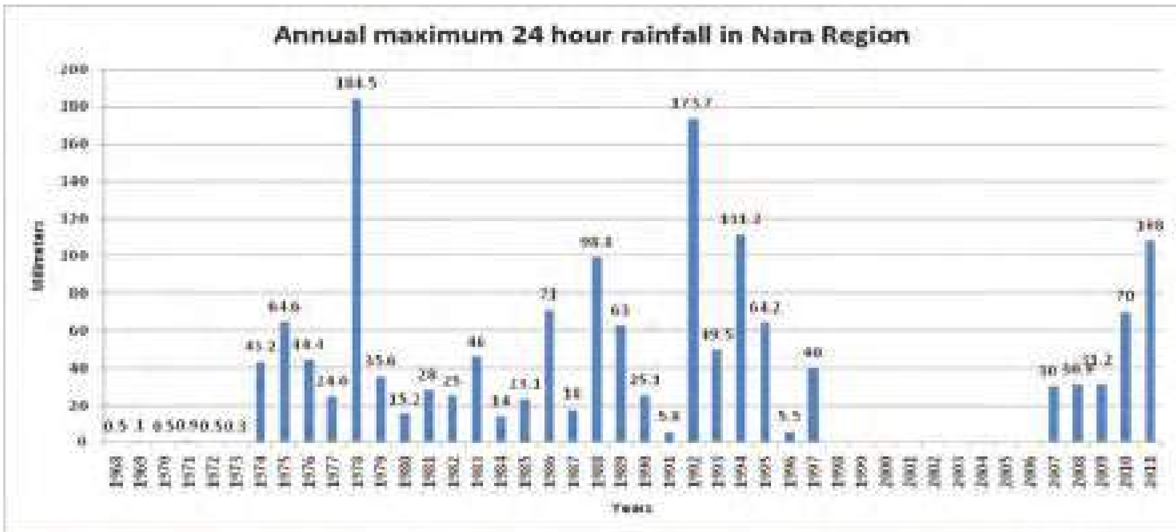
The topography of Thar and Kohistan areas is altogether different. The Thar area consists of the sand dunes running from south-west to north-east and narrow valleys in between. The parkar area is flat and includes Karunghar hills located near Nagar parkar town. The height of Karunghar hills is approximately 300 meters and maximum height of sand dunes is less than 100 meters. The topography of the Kohistan area is predominantly rocky as this area is influenced by Khirthar Hills, which are part of Suleiman Range. Nai Baran and Nai Gaj carry storm water from hills to the IndusThe topography of the Kohistan area is distinct and rugged. The topography of south Kohistan is mostly flat with scattered small calcareous hills. The soils of Thar and Nara deserts are predominantly sandy with sandy loam patches in the inter-dunal valleys of Kohistan area being generally calcareous but in the Katcho area of Dadu and Jamshoro districts they are clay loam. Compared to Thar and Nara areas, the soils are more fertile and fit for short term *barani* crops such as millet, maize, some oilseed crops and vegetables after rainfalls.

Climate: The general climate of the area is arid influenced by the rainfall pattern and adjoining Khirthar Hills. The climate of Thar and Kohistan regions is arid sub-tropical-monsoonal. In Thar, it is arid in the north and semi-arid in the south. The mean minimum and maximum temperatures vary from 5°C to 45°C maximum temperature when the season is dry. In Kohistan extreme temperatures are as high as 45°C in summer and as low as 3°C in winter. Rangelands in Thar and Kohistan subsists on the scant and erratic rainfall averaging 100-150 mm, mostly in monsoon season (July to September), whereas the other months of the year are almost dry. There are also periods without rains resulting in severe droughts in the area. Poor rains are encountered after every three to four years and a complete drought occurs once in every eight to ten years. Air humidity on an average ranges between 30-50 percent.
Dusty and violent winds arising from the sea blow from the south-west in the months of May to July. Thar and lower Kohistan fall in the belt where winds blow with a velocity of more than 40 km per hour and cause severe wind erosion, especially in cultivated areas and in areas that are subject to heavy grazing. The atmosphere is charged with dust and fine sand, which makes living conditions difficult for the inhabitants of the area.

Rainfall data of Thar and Kohistan tracts as recorded at the nearest Meteorological stations is shown in Figure 15.

Figure 15: Annual maximum 24 hour duration rainfall in four arid regions



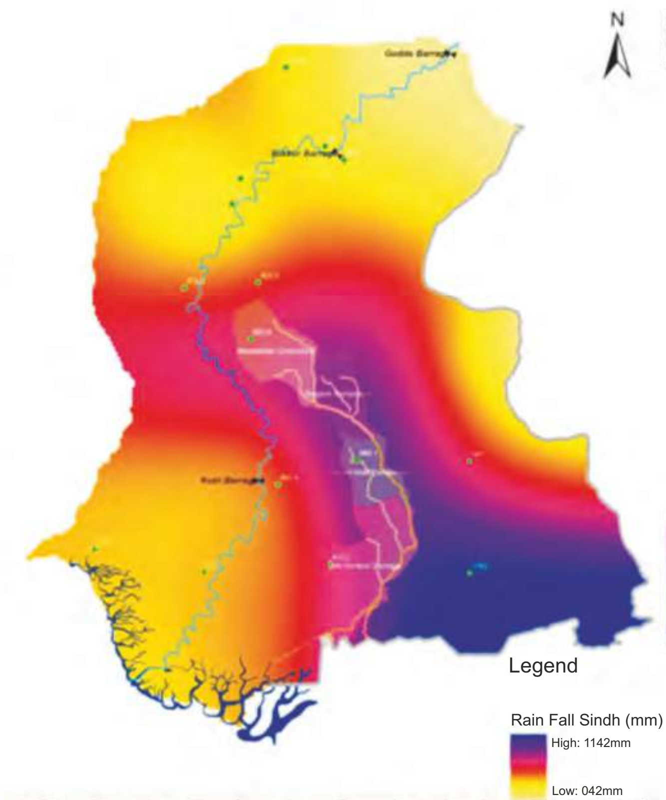


(Source: Meteorological department, 2012)

The data in Figure 15 shows that the rainfall has remained erratic during the last 40 years. During this period, there are very few years when rainfall has been above this level. The impact of rainfall results in an increase in average range carrying capacity immediately after the rains but drastically reduces it during periods of low rainfall. Although the rain occurs in the form of heavy showers, it creates no runoff. All the rainfall is absorbed by the dehydrated sandy soil. After the rainfall, the pastures regenerate and sub-soil aquifers are replenished. After February, when the dry period starts, the lands are completely grazed and the sub-soil water depletes and becomes saline. Sweet water is scarce through the year and drought re occurs every third year.

During the monsoon season of 2011, the lower part of Sindh including the Thar and part of Nara areas, received heavy rainfall. The recorded evidence shows that in the history of 150 years no other such quantity of rainfall occurred in the area. Although this degree of rainfall faced a lot of storm water drainage problems and caused damage to the habitations, crops, existing drainage infra-structure, loss of properties, breaches to existing irrigation, communication infrastructure, and loss of life, it was of significant benefit to the dry lands as these areas were recharged with underground and surface water and, ultimately, the rangelands and other biotic life benefited. The rangelands were abundant with plant life, grasses, mushrooms, crops and species diversity. The ultimate beneficiaries were the people, livestock, wildlife and biotic life forms. Although no study was carried out to assess the increase in the biomass in range areas after the rains, based on the above, and confirmation from the people, the rangelands were more productive after the rains than they were without them. Figure 16 indicates the rainfall distribution and quantity in various areas of the province.

Figure 16: 2011 rainfall distributionsin arid lands in Sindh



(Source: Sindh irrigation and drainage authority 2011)

General socio-economic environment: Thar, Nara and Kohistan areas have a rural setting with only a few major towns. The areas are sparsely populated, with about 62 persons per km, and scattered settlements of not more than 20-50 households on average. Located in sandy and mountainous environments with limited water resources, none of these settlements have any social development infrastructure. Rain-fed cultivation and livestock herding are the primary livelihood of the local population. The society in the area has a fairly typical rural structure. The local landowners have clearly defined areas of influence, both geographically and with respect to social groups. The educational and health facilities are limited to semi-urban settlements (Taluka headquarters)but are almost non-existent in the remaining areas. The Demographic Features of rangeland areas as per the 1998 Population Census and projected population as of 2012, and other demographic indicators of the districts where rangelands are located are also presented in Table 10 and 11

Table 10: District-wise human population and other demographic indicators

District	Area Sq. kms	Population 1998 Persons	Sexratio Males/100 Women	Density Persq. km	Rural Population %	Av. H.H size	Av. Annual Growth rate %	Literacy Ratio %
Tharparkar	19,638	914,291	120.6	46.6	95.64	5.6	3.13	18.3
Umerkot	5,608	663,095	111.6	118.2	83.19	5.4	3.28	24.8
Sanghar	10,608	1,421,977	110.4	134.7	76.70	5.8	2.77	31.0
Nawabshah	4,502	1,071,533	107.7	238.0	83.19	6.0	1.63	34.1
Khairpur	15,910	1,546,587	110.1	97.2	76.38	6.1	2.71	35.5
Sukkur	5,165	908,373	113.7	175.9	49.12	6.6	2.88	46.6
Ghotki	6,083	970,549	111.4	159.6	83.67	5.0	3.26	21.0
Thatta	17,355	1,113,194	112.5	64.1	88.79	5.1	2.26	22.1
Malir	1,764	1,971,264	116.6	558.9	5.25	6.7	3.56	67.4
Dadu/ Jamshoro	19,070	1,688,811	110.6	88.6	78.64	5.5	2.65	35.6
Larkana/ Qambar	7,423	1,927,066	106.4	259.6	71.09	5.9	3.14	34.9
Total	113,126	14,196,740	1,231.6	1,941.4	791.66	63.7	31.27	471.3
Average	10,284	1,290,613	112.0	176.5	71.97	5.8	2.84	33.8

(Source: Population census, government of Pakistan, 1998)

Analysis of the demographic features indicates that people in the Sindh rangelands area are poor but relatively content and feel a strong attachment to their soil. The settlements and culture in Nara and Thar seem to be homogenous. In Kohistan the social and economic differences appear to be bigger due to the feudal system with influential landlords and the prevalence of sharecropping. The data in Table 1 0 reveals that the total area of the districts in which the rangelands are located is 113,126 sq. kms (11.308 million ha). Except for the Tharparkar district, the rangeland area in the districts amounts to almost 50 percent and the rest is irrigated land. Thus an area of 66,382 sq. kms (6.636 million ha) falls under rangelands in Sindh. Similarly, except for Tharparkar district, almost 50 percent of the population is living in arid areas and the other 50 percent lives in irrigated areas. Thus, the total population in rangeland areas is 7,555,516 (7.6 million). The average ratio of males per 100 women is 112.0, and the density of the population averages 176.5 per sq km. The rural population comes to 71.97 percent, and the size of the average household is about 6 persons. The growth rate of the population is 2.84 percent per annum, and the literacy is, on average, 33.8 percent. Without a population census, by using the 2.84 percent population growth rate per annum, it is estimated that the present rangeland areas as of 2012 works out to 10.61 million people, which would indicate an increase of 3.0 million people from 1998 to 2012.

Table 11: District-wise projected population (2012) in rangelands

District	Population 1998 Persons	Average Annual Growth Rate (%)	Projected Population as of 2012	Projected 2012 Population in Rangelands
Tharparkar	914,291	3.13	1,314,922	1,314.992
Umerkot	663,095	3.28	967,588	483,794
Sanghar	1,421,977	2.77	1,973,419	986,709
Nawabshah	1,071,533	1.63	1,316,057	658,028
Khairpur	1,546,587	2.71	2,133,362	1,066,681
Sukkur	908,373	2.88	1,274,629	637,314
Ghotki	970,549	3.26	1,413,507	706,753
Thatta	1,113,194	2.26	1,465,408	732,704
Malir	1,971,264	3.56	2,953,742	1,476,871
Dadu/ Jamshoro	1,688,811	2.65	2,315,360	1,157,680
Larkana/ Qambar	1,927,066	3.14	2,774,204	1,387,102
Total	14,196,740		19,902,198	10,608,630

Poverty: Poverty in the rangeland areas of Sindh is a serious social issue when compared to other parts of the province. The main factors responsible for poverty levels are related to population, environment, land degradation, condition of natural resources, aridity, and the lack of employment opportunities and income generation. The environmental conditions are rapidly declining, and productivity of natural resources is decreasing. The basic facilities available are already insufficient, and the population continues to increase, and land degradation is rapidly picking up pace due to aridity and associated factors. The unemployment rate is increasing and access to productive resources is decreasing. The poverty level in the Katcho area of Kohistan is about 70 percent. The discussions with the stakeholders revealed that the realities of Thar and Nara on one side, and Kohistan on the other side are very different, from both an agro-ecological as well socio-economic perspective. Kohistan is ecologically less endangered, particularly when compared to Thar.

Rangeland Ecosystems

The main ecosystems in the rangeland areas of Sindh include sand dunes, valleys and flat lands, rocky mountain, and aquatic/marshy areas. The floral wealth found in these ecosystems varies from grasses, shrubs or xeric scrub vegetation, trees, and mazri palm to cultivated crops dependent on rainfall and lift irrigation both from underground sources and wetlands. A wide variety of fauna species are also available in these ecosystems. These ecosystems and their products provide food and livelihoods to a large population of rural poor, and fodder and grazing for livestock. The rangelands support local livestock as well as livestock migrating from irrigated areas that are mostly under crops.

Faunal biodiversity: Rangelands used to be rich in genetic, species, and ecosystem biodiversity, but due to diverse social and economic factors natural and man induced, this bio diversity has deteriorated. This is resulting in degraded ecosystems in Thar, Nara and Kohistan. In Kohistan the Khirthar National Park spreading over 3,000 sq. kms, is the second largest such park in Pakistan, providing sanctuary to wildlife. In the arid areas of Sindh there are several game sanctuaries and game reserves which have been declared as Protected Areas under the Wildlife Protection Ordinance, 1972. Nara and Thar deserts are the main protected areas for mammals, reptiles and birds which are listed in the paragraph on wildlife in this report. All the rangeland areas provide excellent habitat for wildlife consisting of mammals, reptiles and birds. The major wildlife species found in the rangelands are as follows:

Mammals: The important mammals in the range area include common gazelle, blue bull, Chinkara gazelle, Urial or wild sheep, Sindh ibex or wild goat (Sarah), Hyenas, Sindh bat, Sindh hare, Indian Pangolin and desert cat.

Reptiles: Important reptiles include Marsh crocodiles, Indian cobras, spectacled cobra, Indian python, and fresh water turtles.

Birds: Important bird species in the rangeland areas include peacock, jungle sparrow, Taloor, black partridge, grey partridge, Fakhta, Sarus Koonj, falcon, Kawa/kawa,and white eyed buzzard.
The Katcho area adjoins the Khirthar Mountain Range and near the Khirthar National Park. It is also rich in wildlife. Historically**,** the area, with its vegetation and its situation nestled among the mountains, used to be rich in wildlife. Leopards and black bears were known to be found here. Presently, Sindh Ibex and Urial (Sarah and Gadh) are found in abundance in the adjoining hills and visit this area in search of water from Nai Gaaj. Wild animals such as chinkara gazelle deer, desert cats, wolves, jackals, Indian fox, porcupines, lizards, snakes, etc. are all found in the Katcho area. The birds include chakor, partridges, and migratory birds (Houbara bustards).

Floral biodiversity: The present vegetation in Sindh Rangelands includes varied and valuable trees, shrubs and grasses that could potentially play an important role in the preservation of the rangelands. Overgrazed tracts with sparse vegetation and open, mobilized sand-dunes are constraining factors. Important flora of rangelands vegetation in Thar and Nara consists of scrub trees, shrubs and grasses: *Tecoma undulate, Capparis aphylla, Savadora persica, salvadora oleoides, Acacia senegal, Acasia seyal, Acacia nilotica, Acacia jacquemontii, Calotropis procera, Ricinus communis, Prosopis juliflora, Prosopis glandulosa, Prosopis cineraria, Zizyphus numularia, Zizyphus mauritiana, Cenchrus ciliaris, Cenchrus biflorus, Cenchrus colocunthis, Bilipherous cindicus, Coccinia cardifolia, Aristida depressa, Cymbopogan jawarancusa, Panicum turgidum, and Calligonum polygonides*. The vegetation in the Katcho area is comprised of scattered trees, shrubs and bushes and grasses. Main tree species include: *Prosopis cineraria (Kandi), Salvadora oleoides (Khabar), Acacia nilotica (Babul), Tecomella undulata and Zizyphus maritiana (Ber).* Shrubs include *Zizyphus numularia, Salvadora persica, Capparis aphylla, Tamarix aphylla (Lao),* Mazri palm, and *Aerva tomentosa.* The vegetation is sparse and heavily relied on for fodder for goats and sheep during winter.

Agro-pastoral Management System

The agro-pastoral management in Thar, Nara and Kohistan is very diverse and complex and determined by the availability of water and fertile soils. In Thar, rainfed, low input, low output (barani) agriculture is on the increase at the expense of livestock related activities. Low rainfall and poor soil conditions do not allow agriculture in Nara and people depend entirely on livestock. In Nara, good grasslands, distant from the settlements (ruhi lands), and stands of *Prosopi scineraria* (Kandi) trees are very important fodder sources in winter and spring. Some ruhi lands also serve as fodder reserve for droughts. After the adequate rainfalls the government wastelands are temporarily leased out for cultivation to private people for production of fodder and food crops. The qabuli lands are permanently owned by private people, who use their land for rain-fed agriculture, grazing, and vegetation.

The main land use of the rangelands of Thar and Nara is grazing followed by barani agriculture. The crops such as *Pennisetum ptyphoides* (Millet /Bajra), *Phaseolus mungo* (Mung), *Sesam umindicum* (Til), *Cyamopsis tetrag onoloba* (Cluster Bean/Guar), and Phaseolus vulgaris (Lobia) are generally cultivated in wet years in narrow valleys between the sand dunes. Small patches are also cultivated by lifting shallow sub-soil water in Nagarparkar area which receives comparatively more rainfall. The land use in Kohistan area is both grazing and agriculture. Sorghum, millet, wheat and cotton are grown either on rainfall or lifting water from Nais or wells. Except for cotton which is a fiber cash crop, all other crops are food and fodder crops. After harvesting, the grains are sold and the remainder is stored and used for stall grazing for the animals.

Ecologically, the Katcho area is part of the Tropical Thorn Forest Eco zone, and consists of extensive areas of flat lands with several gullies. The vegetation predominantly comprises xerophytic species which vary in terms of species composition and community structure. In general the vegetation is sparse but high in economic value. The primary influence on habitats in the area is the low rainfall, mostly confined to the monsoon period. Consequently the plant growth is slow and recovery from damage is slow as well. The species found in the area are adapted to the harsh climatic conditions. The Kohistan area located in Thatta, Malir (Karachi) and part of Jamshoro district, is different in land use, geomorphology, topography, soil, water availability, vegetation type and other socio- economic and biophysical factors. The climate is influenced by the coast as is the vegetation. Due to the closeness to the Nooriabad industrial area and Karachi megacity and industrial areas, there are more employment opportunities and sources of income for the people. People only use their lands during and after the rainfall and cultivate their lands for vegetables and dry agriculture and fodder crops, for sale in the Karachi markets. Due to calcareous soil the vegetation is less in density, poor in growth and stunted in height.

Livestock and Rangeland Statistics

Livestock plays an important role in the economy of the Rangeland areas of Sindh and represents an important component of the agricultural sector as the crop and livestock activities are to a great extent, interdependent upon each other for their functioning in the farm sector. The livestock herds in rangelands are mixed, consisting of cattle, goats, sheep, camels and donkeys. Table 12 shows species-wise livestock statistics in Sindh reported in different census periods. The district wise details of the livestock are given in Table 13.

Table 12: Number of livestock in Sindh, 1986, 1990, 1996, 2000 and 2006 census (in'000')

Type	1986	1990	1996	2000	2006
Cattle	3,874	2,792	5,464	3,946	5,968
Buffaloes	3,220	2,566	5,615	4,222	4,314
Sheep	2,616	1,194	3,710	2,220	3,363
Goats	6,755	4,618	9,734	8,913	9,599
Camels	218	140	225	261	64
Horses	76	30	63	49	76
Mules	5	4	12	10	67
Asses	500	302	694	533	560

Source: 1) Agriculture census, 1986, 1990, 1996, 2000, & 2006. 2) agriculture statistics of Pakistan, 2006. 3) development statistics of Sindh, 2008.

Table 13: Number of livestock by district on left bank of Indus (2006 Census)('000')

District	Cattle	Buffaloes	Sheep	Goats	Camels	Horses	Asses	Mules
Hyderabad	436	772	173	854	8	3	30	0.4
Badin	289	368	164	302	7	1	9	0.3
Thatta	339	314	170	241	11	1	24	0.2
M.Khas	364	300	201	1,000	6	4	24	0.4
Tharparkar	485	40	899	1,971	103	8	151	0.5
Sanghar	353	253	197	702	8	4	31	0.6
Nawabshah	328	355	136	500	4	2	19	0.7
N.Feroze	309	395	111	527	7	1	28	0.5
Khairpur	436	493	124	694	10	3	32	0.6
Ghotki	173	193	63	372	2	2	17	--
Jamshoro	136	130	93	256	2	1	21	0.1
Dadu	193	205	176	329	1	1	26	0.2
Malir	139	227	199	229	2	1	20	0.1
Qambar	145	269	191	264	2	1	23	0.1

Source: Development statistics of Sindh, 2006

Rangelands distribution: In Sindh the rangelands are the major land use in area, distribution and type. There are three distinct zones where rangelands are located namely Thar, Nara, and Kohistan. The ecological features of all three zones are different due to various ecological and environmental factors. There is significant climatic variation due to which there is also difference in the vegetation type and related aspects. An area of 7.785 million ha lying on both the eastern and western borders of Sindh is designated as rangeland. The areas declared as rangelands and protected forests are under the ownership of the Sindh Forest Department. The area under the control of the Board of Revenue and private individuals is designated as wasteland and as Qabooli lands. The District Taluka areas of the rangelands located in Thar, Nara and Kohistan areas are given in Table 14.

Table 14: District and taluka-wise area statement of rangelands (Thar, Nara & and Kohistan)

(million ha)

Area	District	Taluka	Wasteland+Private Ownership	Forest Ownership
Thar	Tharparkar	Chachro	0.405	0.024
		Mithi	0.391	0.043
		Diplo	0.419	-
		Nagarparkar	0.724	0.026
	Sub-Total		**1.939**	**0.093**
	Umerkot	Umerkot	0.500	0.016
	Sub-Total		**0.500**	**0.016**
	TotalThar		**2.439**	**0.109**
Nara	**Sanghar**	Sanghar/Khipro	0.926	-
	Sub-Total		**0.926**	-
	Nawabshah	Nawabshah	0.043	-
	Sub-Total		**0.043**	-
	Khairpur	Nara	1.126	-
		FaizGang	0.051	-
		Mirwah	0.012	-
		Kotdiji	-	0.044
	Sub-Total		**1.189**	**0.044**
	Sukkur	SalehPat	0.135	-
	Sub-Total		**0.135**	-
	Ghotki	KhanGarh	0.192	-
		Daharki	0.150	-
		MirpurMathelo	0.007	-
	Sub-total		**0.349**	-
	TotalNaraArea		**2.642**	**0.044**
Kohistan	Dadu	Johi/KNShah	1.359	-
	Sub-Total		**1.359**	-
	Jamshoro	ThanaBulaKhan	**0.958**	0.189
	Sub-Total		**0.958**	**0.189**
	Thatta	MirpurSakro	-	0.013
	Sub-Total		-	**0.013**
	Malir–Karachi	BinQasim	-	0.018
		Gadap	-	0.094
	Sub-Total		-	**0.112**
	Qambar/Shahdadkot	Warah	-	0.056
	Sub-Total		-	**0.056**
	TotalKohistan		**2.317**	**0.369**
	TotalThar+Nara +Kohistan		**7.262 51.5%ofSindh**	**0.522 3.7%ofSindh**
	Allrangelands		**51.5%+3.7%=55.2%**	

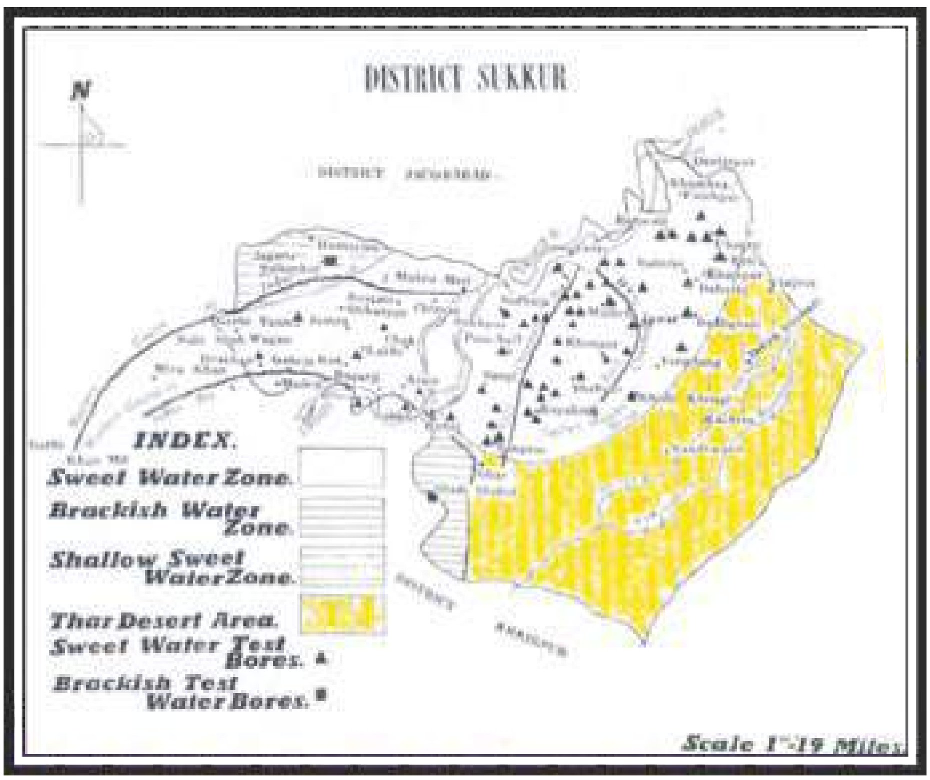
Source: Area statement of Sindh and forest department, Sindh

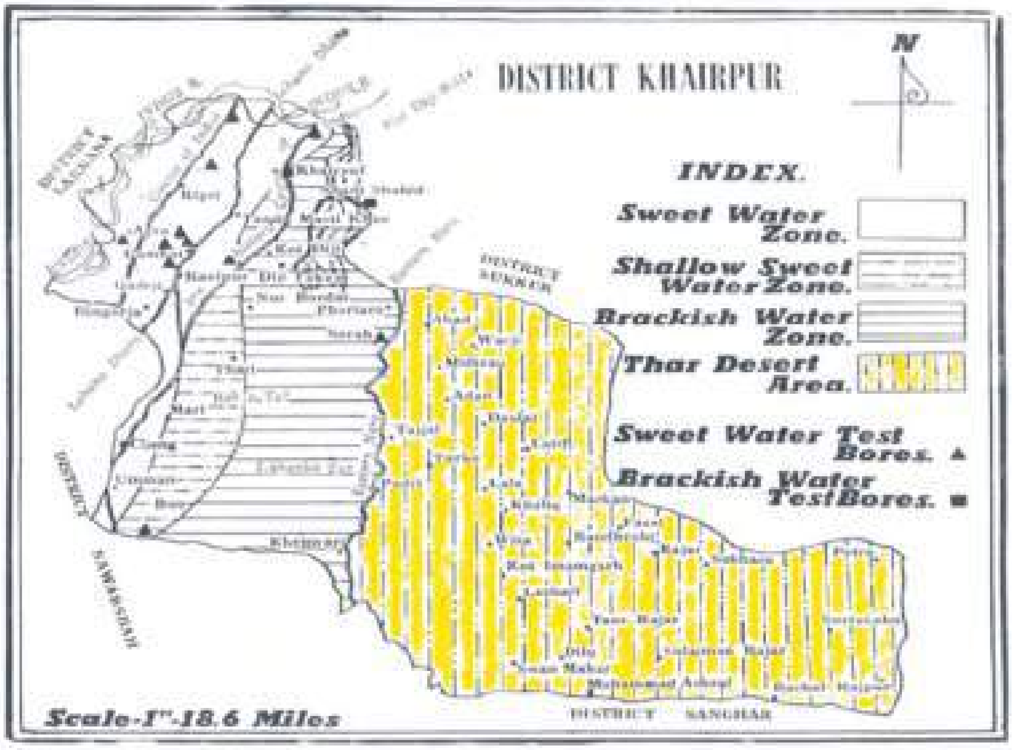
Type: There are three types of rangelands in Sindh based on the location and ownership, tenure and type. The climate of the rangelands is arid as the rainfall is highly erratic and inadequate. As touched upon previously, the ownership of about 55 percent of the province's total area lies with the government in the form of government wasteland and area under the control of the Forest department with approximately 5 percent held by private individuals. The government wastelands are primarily range which becomes productive after the rains, while the private lands are cultivated for rain-fed food and fodder crops. The area held by the Forest Department is managed under the Forest Act, 1927 and through development projects. The land use is primarily focused towards development grass seeding and reseeding, and protection of existing vegetation. The distribution/location-ecological zonation is as follows:

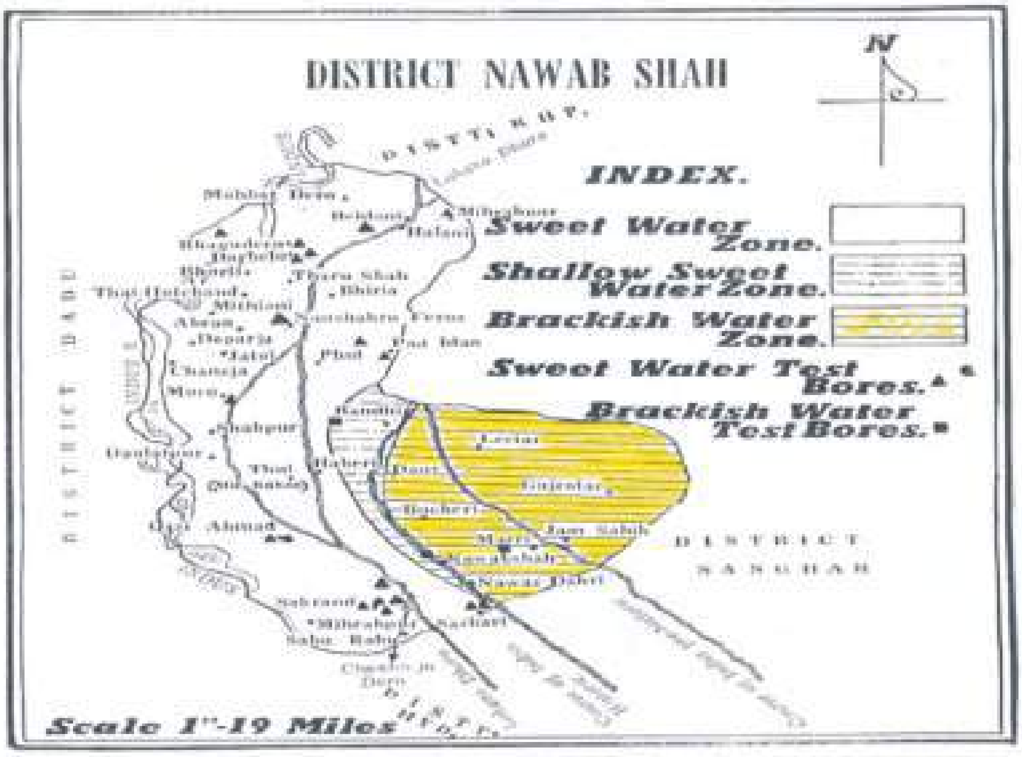
Thar and Nara rangelands: Thar and Nara range areas are located in Ghotki, Sukkur, Khairpur, Nawabshah, Sanghar and Umerkot and Tharparkar districts (M.H.Panhwar, 1964). These maps presented in this section of the document, thus far, clearly indicate the desert range areas and the irrigated areas. All the desert areas are predominantly range areas as their land use is range management.

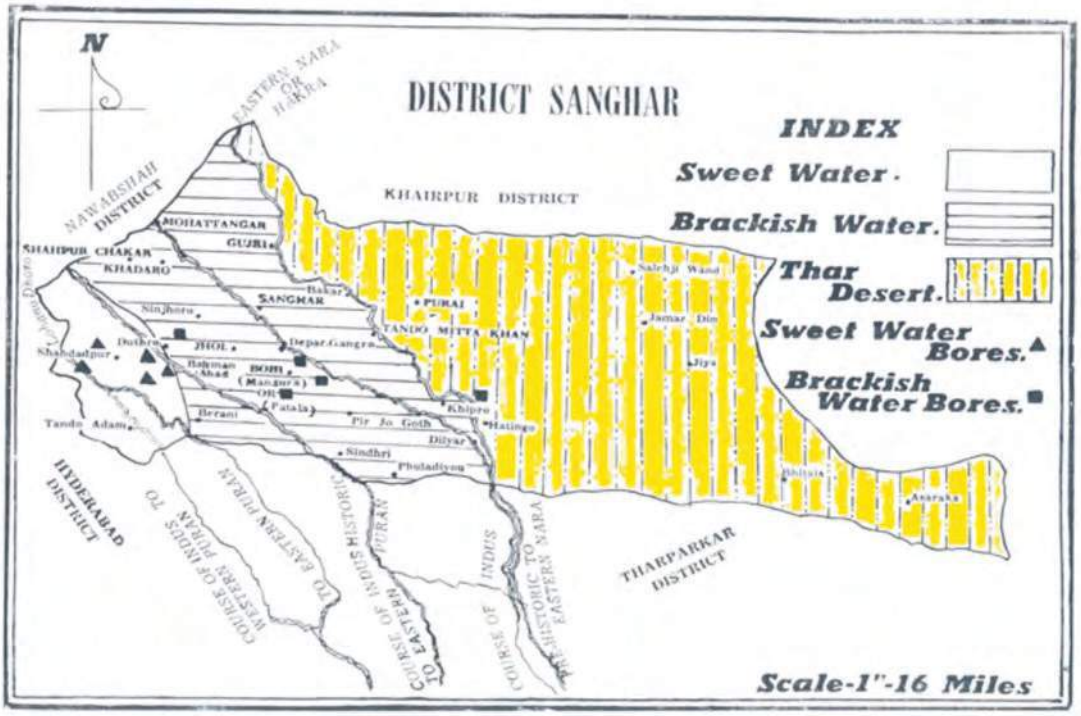
Kohistan rangelands: The rangelands of Kohistan area are distributed over Malir, Thatta, Jamshoro, Dadu and Qamber/ Shahdadkot districts. The rangelands are further divided among lower Kohistan (Districts Malir, Thatta and part of Jamshoro) and upper Kohistan popularly known as Katcho area (Districts part of Jamshoro, Dadu and part of Qambar/Shahdadkot). The area and distribution of rangelands on Kohistan areas is depicted in Table 14. The distribution of desert areas in various districts of Sindh is shown in Figure 17.

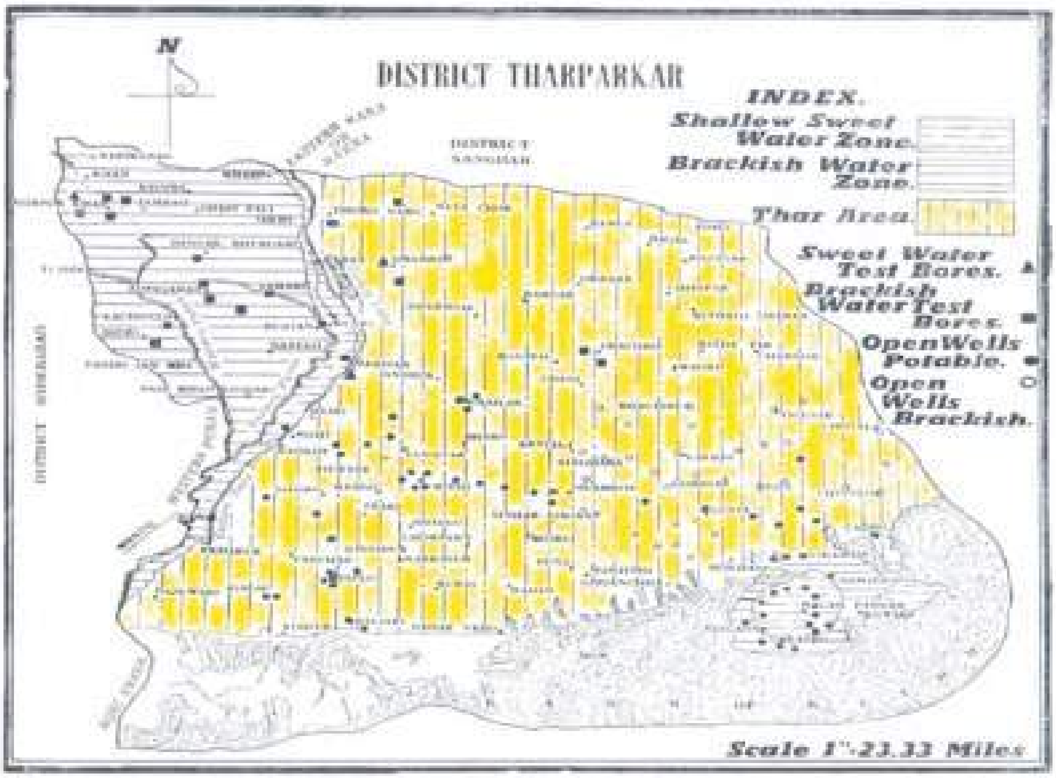
Figure 17: Desert areas of various districts




DISTRICT KHAIRPUR
N
INDEX.
Sweet Water Zone.
Shallow Sweet Water Zone.
Brackish Water Zone.
Thar Desert Area.
Sweet Water Test Bores.
Brackish Water Test Bores.
DISTRICT SUKKUR
DISTRICT SANGHAR
Scale-1"-18.6 Miles


DISTRICT NAWAB SHAH
N
INDEX.
Sweet Water Zone.
Shallow Sweet Water Zone.
Brackish Water Zone.
Sweet Water Test Bores.
Brackish Water Test Bores.
DISTRICT DADU
DISTRICT SANGHAR
Scale 1"-19 Miles


N
DISTRICT SANGHAR
INDEX
Sweet Water.
Brackish Water.
Thar Desert.
Sweet Water Bores.
Brackish Water Bores.
KHAIRPUR DISTRICT
NAWABSHAH DISTRICT
EASTERN NARA OR HAKRA
HYDERABAD DISTRICT
THARPARKAR DISTRICT
SANGHAR
TANDO MITTA KHAN
Scale-1"-16 Miles


N
DISTRICT THARPARKAR
INDEX.
Shallow Sweet Water Zone.
Brackish Water Zone.
Thar Area.
Sweet Water Test Bores.
Brackish Water Test Bores.
Open Wells Potable.
Open Wells Brackish.
Scale 1"-23.33 Miles

Range Productivity, Utilization, Condition and Trend

A critical review conducted during the study revealed that the rangelands productivity has a declining trend. This is a serious constraint in the management and development of this important resource. There are multiple factors in creating this declining trend including extremely arid conditions, overgrazing by the livestock population, over exploitation of existing range resources, lack of proper policy and importance placed on this resource, inadequate and insufficient capacity of management and protection staff, and a disturbing non-seriousness in adopting a policy regarding range carrying capacity. All these and other factors have resulted in the rapid decline in rangeland productivity. There is a dearth of data to ascertain the productivity. Therefore, only general factors are used to determine the productivity levels of the rangelands.

From the productivity potential point of view, it is essential to understand both favourable and unfavourable climatic conditions, human and livestock population and their degree of dependence on range resources, the accessibility of range areas, existing management practices and socio-economic and environmental influences. It has been observed that under favourable conditions the productivity of the area is naturally very positive. This indicates their potential for enhancing productivity. But even in the case of such favourable conditions no effort is being made to collect data to provide baseline information for determination of the forage and biomass aspects of rangelands in Thar and Kohistan areas.

Management of grazing in rangelands and adaptation of conservation options for fodder, biomass and water resources could be undertaken to plan the management of the range resources in a sustainable way. Since no such basic information has been gathered and recorded, it appears that the determination of rangeland potential will remain unscientific for the foreseeable future.
In cases where the natural factors such as climate and rainfall are not positive, the management options could focus on such possibilities as rotational grazing, harvesting techniques and identification of critical and potential zones, to initiate the process of improvement of rangelands.

In order to determine the range condition, a literature review was conducted, however, no specific data could be located. The information was thus based on consultations with the concerned stakeholders and expert observations of the officers and officials working in the area. Hence, current reports of the range condition and trend are based only on stakeholders' observations.

Generally the rangelands of Sindh are in a depleted condition in the areas where their dependence is only on rainfall. In places where the position of water availability is assured, their condition is moderate to good. Issues and problems which threaten the condition of the rangelands and its resources, and the degradation in growth, productivity, area, structure and ecosystem functions, are identified, analyzed and determined through different sources.

The natural vegetation in rangelands have been severely degraded due to harsh climate, scarce rainfall, improper management resulting in reduced productivity, ecological imbalances, environmental degradation, irregular rainfall patterns, extended droughts and several other socio-economic problems. People live in these areas and earn their livelihood through agro-pastoral farming system. They mainly depend on the natural resource base in the form of food for human beings, fodder for livestock, fuel wood for cooking and heating, water for drinking, and generation of income from sale of livestock, dairy products and barani crops.The vegetation in the Katcho area is comprised of scattered scrub trees, shrubs, bushes and grasses. The vegetation is sparse and heavily exploited for fodder for goats and sheep during winter. This vegetation is the main source of cooking, heating, house construction, and fencing.

The range condition has deteriorated due to extremely low and erratic pattern of rainfall, uncertain land tenure, lack of coordination between government departments and the people, poverty, overgrazing, and high growth rate of human and animal population. There is no designated wooded area in Kohistan, but the Katcho area used to be rich in wood, particularly Kandi and Khabar which have been ruthlessly cut, especially in northern Katcho. Kandi and Khabar still grow in south Katcho, where people protect them, even in agricultural fields.

Major Causes of Rangeland Deterioration

The arid areas of Sindh are home to diverse ecosystems, habitats, and species. Due to overgrazing, degradation of the soil cover and frequent droughts, the ecosystem and habitats of the wildlife of the arid regions are badly affected. The palatable species of grasses are vanishing rapidly, and being replaced by plant species not preferred by grazing livestock. The Ibex of Kohistan and the black deer and peacocks of Tharparkar, are animal species unique to this region. These species are in danger of extinction because of illegal hunting practices.Most of the rangelands in Sindh are overstocked, overgrazed and over harvested, suppressing the natural ability of palatable plants to re-grow. Persistent overgrazing naturally reduces the quality of pasture.

Livestock is an integral part of the rangelands and plays a pivotal role in range management. The number of livestock is far in excess of the carrying capacity of the rangelands. This results in overgrazing and compaction of soil ultimately depleting the range condition.

The valuable vegetation that has been mentioned in this report stands in danger of being lost. As previously noted, the rangelands of Sindh are mainly located in sandy Thar and Nara deserts and rocky Kohistan with scant and erratic rainfall averaging 100-150mm.

There are no designated pasture grounds in Katcho area, and instead the wastelands, the hilly tract and the areas vacated after harvest of agricultural crops are freely used for grazing livestock. At the time of rain-fed agriculture, the livestock grazing is limited to hilly areas and the areas where no crops are grown.

The land tenure system is a major constraint in the improvement of rangelands. Land tenure in Sindh’s rangelands is not balanced; it is either under the control of communal heads or the government. The government-owned lands suffer from mismanagement resulting from vulnerability to adverse forces and unjustified influence from private individuals, either legally or illegally.

Rangeland Ecosystem Services

Rangelands are an important ecosystem in Sindh contributing a variety of direct and indirect services to society. The literature search did not provide the monetary values but descriptive services were found in the literature and discussions with the stakeholders.

Household and livelihood services: The direct services of Sindh rangelands have outputs in the form of wood for construction and fuel wood, forage/food for livestock and wildlife, habitat for wild animals, a variety of medicines from vegetation, construction material for houses and huts in villages, furniture for houses, fencing material for protection of houses, agriculture lands and orchards, water conservation for drinking and cultivation of grasses and several other services.

Environmental services: The rangeland ecosystem also provides several environmental services such as improved physical environment and recreation for locals as well as tourists who visit rangeland areas after the rains. Tourists specially visit the Thar rangeland area after the rains, to enjoy the beauty of the greenery on the dunes and valleys.

Livestock pastoral services: Rangelands also support local as well as migratory livestock herds that descend from irrigated areas, contributing towards pastoral livelihoods in the form of food and forage for livestock, protection or refuge from predators, enhancing the productivity of livestock in the form of meat, skins, hides, wool, and direct sales and a variety of other direct and indirect products.

Household energy: People located in and around towns and villages use the vegetation for household energy. All the energy requirements for cooking, heating and other purposes are met from the rangelands vegetation and other biomass.

Wildlife: Wildlife is an important natural resource of the Sindh rangelands. The contribution of rangelands towards the wildlife is in the form of food, refuge and protection, sport, recreation, tourism and wildlife products, is significant.

Medicinal plants: Thar rangelands are important for medicinal plants especially shrubs and herbs, which grow extensively in dunes and valleys as perennials, as well as annual grasses and herbs. They gain impetus during *waskara*, rainfalls. They are propagated naturally through seed as there is no proper cultivation by the indigenous people. Most of the species yield ayurvedic medicine (in the form of seeds, leaves roots and bark) which has been used for centuries for the treatment of various diseases. These include cultural and historical treatments such as *suties* solvents, ph*ukies (*amorphous powder) and *julab* purgatives. Some of the species are used as *Vas* (fumigation). The most important herbs and their uses are nprovided below;

- *Abutilon indicum (Pelly booti).* It yields an important drug which is used by local druggists especially for quickening the flow of urine.
- *Acacia nilotica (Babul).* Its bark yields gum resin locally known as *Khaunr* (gum resin) which is used for relieving the orthopedic pains.
- *Acacia Senegal (Khumbat):* Used as Gum Arabic and for honey production.
- *Agaricus compastris (mushroom/Khumbhi):* Used in preparation of various medicines.
- *Alhaji maurorum (Kandero)*
- *Alloe vera (Kunwar – gandal):* Yields a resinous substance which is used in the treatment of skin disease.
- *Callotropis procera (Akk):* Yields milk as latex which is used in treatment of many diseases.
- *Cassia angustifolia (Sanna):* Used as purgative as well as laxative drug.
- *Citrulus colocynthus (Tooh or bitter apple):* Seed and pulp is mainly used for liver and blood sugar diseases.
- *Commiphora mukal (Gugar):* The gum of this species is very valuable in the market and the people extract it illegally and sell it in the market for a large profit.

- *Corchorus depressus (Munderi:* The extract of leaves has refreshing and cooling effects in the hot winds of the desert.
- *Cordia mixa (Liar):* Fruits are used in treatment of mouth disease.
- *Datura Alba (Dhatora):* Fruit is used to extract medicines for intoxication.
- *Ephedra foliate:* Used as pain relieving drugs.
- *Euphorbia caudicifolia (thoohar):* Capable of growing in odd conditions. It is used as latex for enhancing reproductive capacity.
- *Moringa oleifera (Suhangro):* The extract of the leaves are used in the treatment of blood pressure.
- *Savadora oloides (Tooth brush tree)*: Used for dental diseases.
- *Sesamum indicum (Til):* Oil is a source of vitamin D.
- Solanum nigram (Mukoh: The flower is used in homeopathic drugs.
- *Solanum xanthocarpum (kanderi:* Fruit is used in preparation of indigenous medicines.
- *Ricinus communis (castor erandi)*. Used in oils for purgative in constipation disease.

The medicinal products prepared from the above medicinal plants and other species found in rangelands are commonly available in the markets of all towns and shopping areas located in and around the rangelands.

The utilization of range services has been described under the topic of range ecosystem services. In this part of the report the important vegetation available in the rangelands is described, particularly the vegetation and trees which have economic, livelihood and social value.

- Lohiro (*Tecomala undulate*) is an important tree of Thar area and it is highly valued. The wood is sold 'like gold' in the Thar area as its quality is durable and resists deterioration with time. The main use of this timber is housing construction as well as decorative furniture. The tree's fragrant red and yellow flowers add to the beauty of the range areas in spring, attracting visitors to the area.
- Kandi (*Prosopis cineraria*) is another important tree of the rangelands. All of its parts, including flowers, fruits, wood, bark, seeds, and fruit (Sangar), are used by the people and their livestock. People usually go to the range areas daily to collect *sangar* and load it on to camels, and take to feed their livestock. The green fruits of *Kandi* are sold at Rs. 200 per kg. In the market the dry fruits are sold at Rs. 2000 per forty kg.
- Khabar (*Salvadora persica*) is a very useful tree found in larger quantities. The leaves are used as fodder for camels, and for medication by grinding and mixing with water and sugar and drunk, to reduce the effects cold during winter. The fruit of this tree is which is locally called *Perun*, is considered healthy and delicious, and becomes available in April. The pickle prepared from the fruit of this tree is sold at market at Rs. 200 per kg. Thari women and children rise early in the morning to collect *Perun* from trees, for consumption of both people and livestock. The wood of the tree is white and is used for valuable furniture in Karachi markets. Its roots are used for toothbrushes (*Miswak*).
- Kirrir (*Capparis aphylla*) is available in abundance. The wood is white and is used for the manufacture of furniture and wooden ornamental pieces, and musical instruments. The roots of the tree are cut and converted into coal and after mixing with *desi ghee* and used as adhesive material for wooden items. The flowers have medicinal value. The fruit tree is delicious and is sold in markets for the preparation of pickles which are used by the people throughout the year.

- Khombhat (*Acacia Senegal*) is more abundant than other trees and provides fodder for goats, camels and sheep. People sell the leaves in the market to earn money while the flowers are collected, dried and stored for feeding livestock during periods of shortage. The wood is also sold in the local and city markets as furniture wood, earning substantial revenues for the people.

Past Development Initiatives

Range management and development has been on the government agenda but is constrained by inadequate resources. The Forest Department has implemented ten development projects over a 50 years period (1962 - 2012). The main objectives of these projects were to enhance the range productivity through palatable grass seeding and/or reseeding, rainwater conservation through different rain harvesting techniques, and planting and regeneration of trees and shrubs that could sustain aridity conditions. Other areas of development have been:

- Runoff water collection and conservation for growing short rotation crops;
- Construction of water ponds for water storage for drinking of people and livestock;
- Construction of shallow wells for lifting of water for drinking and cultivation;
- Technologies for distribution of lifted water from wells to the fields through layout conveyance of water through small channels and trenches, and water applications to crops and trees;
- Planting of indigenous trees and shrubs and supplying minimum required water around the fields for protection from grazing and browsing animals; and,
- Techniques for water conservation and its use for kitchen gardening to grow vegetables for households.

The list of development projects is as follows:

1. Registan Range Management Scheme (1962-63 - 1970 -71)
2. West Pakistan Range Improvement Scheme (1962-63 –1965-66)
3. Kohistan Range Management Scheme (1965 -66 -1970-71)

These schemes were the pioneer development initiatives in rangelands which paved a way forward for future development scenarios. Later, the following development schemes were implemented:

Range management in Sindh (1973-79): Based upon the feasibility level study, a first development project on development of rangelands in Sindh was initiated from 1973 to 1979.This scheme was funded under the United Nations Development Programme (UNDP).

Sindh arid land management project (1983-84–1988-89): After gaining experience and success in the 'Range Management Project in Sindh', this five year development project was approved by the Government of Sindh. In this project, apart from range management practices in Kohistan and Registan areas, the activities were extended to other areas located in Khairpur and Larkana districts.

Range and livestock improvement project (1989-1993): This pilot project was initiated in collaboration with the Sindh Arid Zone Authority (SAZDA) and Swiss Development Cooperation (SDC).The main objective of the project was the development and testing of a strategy for sustainable and ecologically sound development of the livestock sector in the Arid Zone of Sindh. The project was implemented in three regions: Thar, Nara and Kohistan. The focus of the project was development of rangelands, promoting sustained management of communal grazing land, livestock development and animal health (vaccination), and reversing on-going process of desertification.

Range management and foragelands in Kohistan and Thar areas (2000-01–2002-03): A three year development project was initiated by the Government of Sindh. The main objectives of this project were to increase forage production by planting fodder trees, reseeding of grasses during the rainy season, provision of drinking water facilities for people and livestock through construction of open wells, water troughs and water ponds.

Increasing rangelands productivity through range management and poverty alleviation (2004-05–2008-09): This project was initiated by the Sindh Forest Department in Thar and Kohistan areas of Sindh. There were two focus areas of this project:

- Increasing productivity through range management activities such as grass seeding and reseeding, rainwater conservation, raising of nurseries of fodder trees and grass species to ensure meeting the fodder requirements of livestock;
- Mitigating the impact of poverty in the project area communities through the provision of sources of livelihood so as to improve their financial and economic conditions. This project directly focused on livelihood options of the pastoral communities.

Sustainable land management project–GEF, UNDP and GOP/GOS funded project: The Ministry of Environment, Government of Pakistan launched a national project to combat desertification in Pakistan in 9 districts of all four provinces. The project was jointly funded by the Ministry of Environment GOP, Global Environmental Facility (GEF), and the United Nations Development Program (UNDP). The overall goal of the project was to combat drought and desertification through pilot projects in the areas most affected by droughts and desertification in the form of land degradation. Phase-I of the project was implemented in Tharparkar and Katcho (Dadu district) through participatory management involving the main NGO, line department and local communities.

Sustainable land management project(2010-2012): Government of Sindh through the Sindh Forest Department, initiated a project titled, Sustainable Land Management Project to Combat Desertification in dry lands of Sindh in partnership with civil societies in Thar and Kohistan. The main objective of was the development of range and water resources in Tharparkar and Dadu districts. Local civil societies were involved in execution of the project under participatory process.

A review of development projects executed so far, indicates that the main activities in the development schemes have been on the development of water points and reseeding of palatable grasses (mainly *Cenchrus ciliaris),* and rainwater harvesting and conservation. Artificial seeding and reseeding of grasses has been attempted on a large scale but without considering the minimum annual rainfall requirements. It is a recognized principle, that for artificial reseeding of degraded rangelands, a minimum annual rainfall is 300 mm is required. For perennial grasses the rainfall requirement is 150 mm. Under these principles, the success of grass seeding/ reseeding in the rangelands of Sindh is not sustainable due to irregular and scant rainfalls. The other factor contributing to lack of sustainability of grass seeding and reseeding is climatic, i.e. long periods of drought.

In the livestock sector, the Department of Livestock and Animal Husbandry has implemented development projects for breeding, disease control, establishment of livestock dispensaries and hospitals, artificial insemination, capacity enhancement of livestock farmers through trainings extension services, and institutional strengthening of the department. There are, however, no exclusive schemes for forage and the marketing aspects of livestock for the major rangeland areas, other than some livestock dispensaries.

A development project initiated in collaboration with the PAK-SWISS Development Cooperation, and executed by SAZDA, was titled “Range and Livestock Improvement Project”. The main objective of this project was “the development and testing of a strategy for a sustainable and ecologically sound development of livestock sector” in Thar and Kohistan Zones. Regeneration of vegetation, establishment of trees and grasses, improved agriculture practices and other activities, and a livestock component were included. In no other projects were forage and livestock coordinated.

Rangelands Current Formal and Informal Use

Sources of income of range areas: Livestock resources of the rangeland areas are an important source of livelihood for the communities. Livestock in the province include cattle, goats, buffalo and sheep. In Thar and Kohistan areas the common animals are cattle and goats, although sheep and buffaloes are also found in small numbers. The main products sold in local markets and adjoining areas are meat, milk, hides, and wool. Animals are sold in the nearby livestock markets and to the brokers who conduct the purchase and sale of livestock.

Food and fodder production: Rangeland areas are used for food (crops and vegetables) for local population along with fodder production for their animals, and also for marketing externally. People also store fodder in the form of hay, wheat *bhoosa* and other parts of crops and sell them at appropriate times to earn money for their daily livelihood, and for other financial requirements such as marriages and various social and spiritual gatherings.

After the rains, the rangelands have substantial seasonal ground vegetation and other products which at maturity are a source of income. The products include fruits from the Salvadora tree, fruits and twigs from creepers, vegetables and mushrooms etc. They often serve as gift products which given to relatives and friends residing outside the range areas.

Forestry-wood and wood products: Trees grown on the private land, wastelands and forestlands in the rangelands are the primary source of wood for fuel, construction of houses, hedges for protection, livestock pens, making of implements for use in cultivation and houses, and small wood for fuel for cooking, heating and other purposes. Some people also legally or illegally cut the vegetative growth available in the rangelands for sale in the adjoining towns and nearby cities, earning substantial amounts from these sales. Fruits, leaves and flowers from vegetation are also used and sold to generate income. These products are in abundance only after the rainfalls. The rains signal a period of plenty and varied livelihood sources for the people of the range areas.

Mazri rope-making: The Mazri palm is grown in Kohistan area of Sindh. Rope-making from Mazri Palm is an important source of livelihood of people of Katcho. This plant grows naturally in the hilly area of Katcho, and is harvested by the people for rope-making and other handicraft articles. Almost each household is involved in mazri rope and handicraft-making, conducted by both men and women.

Good quality of Mazri is transported from Baluchistan province. Mazri ropes for knitting cots are made in almost all households by adults and children, traditionally. They purchase Mazri leaves from Johi or Wahi Pandhi village and after making ropes they sell them in Johi and Dadu towns.

Income through wages: Rangelands are also source of wage income from work such as land development for cultivation, sowing and planting, irrigation, harvesting, threshing, bagging, vegetable pricking, protection, harvesting, picking and other types of works. The landholders, with more areas under cultivation, need the labor force for all these types of work, providing the locals with extra income.

Co-management and Trans-boundary Issues

There is no concrete government policy to manage the rangelands through the adoption of an integrated and co-managed system to enhance productivity of range resources for the benefit of society and the government. There are no trans-boundary issues in the rangelands of Sindh but there are pressures of migration to and from the adjacent barrage areas. During the rainy season the livestock from the cultivated barrage areas migrates to the range areas. Conversely, in cases of extreme persistent droughts the livestock migrates to the barrage areas for better feed. It would appear that the best method would be to adopt a participatory approach in the range areas by involving the local communities to plan, manage and use, and share the benefits of range resources. This system of management would ensure the most positive outcomes and the beneficiaries would have a sense of participation and ownership as well as protecting the resource for future use.

Climate Change and Ecological Limitations

Like other natural resources, the rangelands have been adversely affected in area, productivity, species composition and potential benefits by climate change. Prolonged droughts resulting in inadequate moisture, dearth of grasses, biodiversity loss and hindering the productive ability of existing natural biomass, have caused significant deterioration of range resources.   Frequent and prolonged droughts have also had pronounced impacts on temperature and rainfall patterns. The 2010 rains and floods, and 2011 rainfall, are the most recent incidences of the climate change pattern which has adversely affected the people, yet had a positive impact on the rangelands. The data of August and September 2011 rainfall in Sindh is shown in Table 15.

Table 15:Rainfall in Sindh august- september 2011

District	Rainfall (mm)
Badin	612
Mirpurkhas	866
Mithi-Tharparkar	1162
Umerkot	641
Nawabshah	662
Hyderabad	402

This is the highest recorded rainfall for 150 years and is attributed to climate change impact. The rangelands of Sindh in Thar and Kohistan benefited in the form of biodiversity, ground water recharge, forage availability and sustainability, and several other socio-economic benefits. The concerned

organizations, however, have not collected data on the above parameters.
Among other ecological limitations, rainfall is a critical factor in arid lands development and livestock improvement. The entire province of Sindh is dry and receives less than 250 mm of rainfall. In the arid regions which fall outside the canal irrigation system, water scarcity is a serious constraint since the evaporation rate of water is more than twice the rate of precipitation. Some years the rainfall is adequate with the sufficient number of rainy days within the course of a few weeks. But if there are only a few days with heavy rains and then a long dry spell, forage cover cannot be sustained. Also, the growth cycle of plants remains incomplete limiting the sufficiency of biomass and causing the plants to die more rapidly.

Consequently there is a shortage of livestock feed available on the rangelands. If there are three to four spells of heavy rains one after the other at intervals of about a week, the situation of forage availability sustains grazing for a longer period. In years of longer stress, grazing continues for 8-9 months and the feed storage prevails for 3-4 months compelling the herders to migrate to barrage areas. Therefore, the ranges have limited carrying capacity due to the erratic nature of the rainfall in the province.

Policy and Institutional Gaps

This section of the report identifies the policy, management, and development and institutional gaps for the rangelands. It is widely acknowledged that most gaps stem from those areas on which there is not sufficient information accessible.

Policy gaps: Based on the critical review of existing documents as well as consultations, the following policy and institutional gaps have been identified in Sindh. The following policy gaps have been identified:

1. There is no separate National or Provincial Range Policy; rather rangelands are included in Forest policies.
2. Lease policy rules are not strict for range areas resulting in long and short term leases being awarded to influential people over large areas for longer periods.
3. There is no separate working plan for range areas. Due this lapse there is no clear range management strategy, no comprehensive development plan, and no range action plan.
4. The development of rangelands in the planning process at provincial, departmental, district and local level is low priorty. Rangelands are simply considered wastelands.
5. The existing Forest Act is mainly for management of riverine, irrigated and coastal forests and there are no explicit sections for the management of rangelands.
6. The transit rules are not separate for rangelands. Offences of a critical nature such as cutting, girdling and removal of gugar from trees growing in rangelands, and transportation of products from rangelands, occur frequently yet the forest managers take this aspect very lightly. Little, if any, action is taken.
7. There are no strict penalties for extinction of species and other offences in range areas.
8. Since 1975, no survey of range areas has been conducted to assess the range, wild life and livestock resources, to assist with better planning.
9. There is no initiative to attract international assistance.
10. The Land grant policy of 1930 is outdated and not being implemented.

11. There is no clear policy for gaucher registration.
12. There is no clear land tenure for rangelands.
13. There are no regular livestock and range resource surveys to determine range carrying capacity.
14. Due to habitat destruction, illegal hunting and poaching, over-grazing and associated factors, the wildlife population has been significantly decreased in range area.

Institutional gaps: The most glaring institutional gaps and shortcomings are listed below:

1. Lack of donor support**:** After the Pak-Swiss cooperation, Range and Livestock Development (RLIP), no foreign funded development project has been implemented. This indicates a lack of initiative and coordination with foreign development donors.
2. Although a separate circle and two forest divisions have been established, the financial allocations are too meagre to develop and manage ranges as compared to other disciplines of forestry.
3. There is no coordination between governmental and non- governmental agencies, and local community stakeholders.
4. Institutional and social contexts are not in place for rangeland areas.
5. There is no basic and applied research on any aspect of rangelands at provincial level.
6. There are no steps for the introduction of new forage species.
7. There are no set actions to assess ecological conditions.
8. There are no efforts for storage, use and/or diversion of storm water from inland storage areas.
9. There is a lack of technology transfer and lack of capacity building, of stakeholders, staff and institutions.
10. A participatory approach to management, development, and benefit sharing of range resources is lacking.
11. There is no adequate Monitoring and Evaluation (M&E) Mechanism

Lack of Sustainability in Development:

Lack of sustainability is the primary factor hampering attempts to mitigate the gaps that constrain development. Sustainability in management, development and range resource use is essential in Rangelands. The following are the five barriers identified by the sustainable land management project (SLMP Flyer,2010):

1. **Policy barriers:** This area is rife with impediments to policies, limitations to land use policy and issues relating to inappropriate subsidies.

2. **Institutional barriers:** The current state of affairs in rangeland devleopment is made more complex by the limited capacity of the institutions involved and the poor coordination between them.

3. **Financial barriers:** Improvement in the state of the rangelands is further hampered vy inadequate financing and investment in this resource. The lack of ample funds to develop this valuable resource is a serious constraint.

4. **Socio-economic barriers:** The communities that inhabit the rangelands are highly vunerable to periods of drought as these periods directly imact their livelihood. Additionally, the insecurity of land tenure coupled with inadequate safeguards for the rural poor and marginalized people are concerns which highlight the societal issues standing in the way of rangeland development.

5. **Others:** A number of other concerns play a part in the impediments to rangeland development, covering issues of law enforcement and governance as well as those of rangeland management and climate change. The importance of improving the economic viability of this resource cannot be overstated. Monitoring environmental services and a monitoring and evaluation mechanism are crucial to the success of this development.

Management Gaps

The barriers mentioned above are self explanatory and clear, and directly related to sustainability in rangelands. Furthermore, they directly relate to the following aspects which are lacking in management of rangelands:

1. Institutional Arrangements
2. Range Use Policy and Legislation
3. Grazing Management
4. Research and Adequate Reliable Data
5. Financial Resources
6. Integrated Planning and Sustainable Development
7. Habitat destruction, illegal hunting and poaching, over-grazing and associated factors have caused the wildlife population to decrease in the range area.

The rangeland resources are viewed from three perspectives viz. forage production, support to livestock condition and their role in maintaining the environment. Rangelands have deteriorated and ultimately degraded due to the influences of human activities and of the environment on vegetation and animals. The direct and indirect influences of various factors result in partial or serious levels of degradation of rangeland. This degradation impacts their productivity, area, performance, and services.

Category of influence	Impacting factors
Environment	Temperature, rainfall, soil and evapo-transpiration.
Vegetation	Type of vegetation (Annuals, perennials and weeds), new pasture (establishment, persistence and production) and groundcover (age), intra-specific and inter-specific competition.
Animals	Species, age and weight of animals, animal preference, level of production, stocking rate.
Human	Human population, pastoral use (nomads, semi-nomads, sedentary).

The rangelands of Sindh are under serious pressure from humans and livestock. The details of population and livestock have been identified in the previous sections of this report. Natural and man-induced issues and problems common to the rangelands are summarized below:

1. Over-grazing by local as well as migrating livestock from irrigated areas
2. Degradation of ecosystems due to low and erratic rainfall pattern
3. Uncertain land tenure
4. Lack of coordination between grazers and forest department.
5. Persistent poverty
6. Pressure of human and livestock population on rangland resources.
7. Migration of livestock from barrage area storage lands after rains resulting in grazing pressure and over-exploitation of palatable grasses and vegetation
8. Although rangelands have been declared as protected forests, no demarcation or settlement has taken place on the ground
9. There are no management plans for rangelands and inputs from reseeding
10. Revamping and scientific system of grazing are inadequate or non-existent
11. Free access to nomadic grazers
12. The burden is beyond the potential and carrying capacity of the pastures
13. Palatable grasses have given way to poor quality of grasses
14. Poor management by the concerned agencies to arrest the trend of deterioration of rangelands
15. Prolonged droughts
16. Deforestation and loss of vegetative cover in general and extinct species in particular
17. Burdened with rights and concessions of local communities for grazing, grass cutting, right of way and water
18. Increased competition for water and poor irrigation practices
19. Intensification of agriculture for meeting the food requirements of people.

These root causes have individually and collectively contributed towards land degradation in arid, semi-arid and dry lands of Sindh.

Conclusions and Recommendations

Conclusions: The study reveals that Sindh rangelands are a highly dynamic and fragile ecosystem. They have significantly depleted at an alarming pace due to natural, environmental and anthropogenic factors. The severest environmental and socio-economic stresses which the rangelands have faced have resulted in their deteriorating range condition and productivity. This report has described the major categories of influences and their impacting factors, types of challenges and threats both management and ecological and their forms of impact, and list of factors of different types responsible for the degradation of rangelands of Sindh. Most development activities have a direct impact on biodiversity. Demographic trends and socio-economic conditions in the range areas have far-reaching consequences on rangeland ecosystems. Population growth and poverty have exerted heavy pressure on the natural resources available in rangelands. Isolated interventions have not addressed the root causes of biodiversity loss.

It is concluded that due to factors and problems described and analyzed in this section of the report, the rangelands of Sindh, its biological resources and their productivity have been adversely affected to a significant degree. It is further concluded that the challenges and threats responsible for such trends in rangeland productivity fall into two categories: 1) Management Challenges, 2) Ecological threats.

Livestock is of considerable importance to the economy of rangeland areas of Sindh. These areas are characterized by having either too little or too erratic a pattern of rain to support forestry, range or permanent cultivation. The rangelands are mostly used by the pastoralists. Their grazing animals yield meat and milk for human consumption and products such as hides, skins, wool, hair, bones and manure. They also derive fuel, building materials, and medicinal and food plants from the same land. Rangelands also check soil erosion and ensure that water is of high quality. Furthermore, they also support a large proportion of Sindhs's remaining stock of wildlife potential sources of additional animal protein and, in some areas, constitute a significant tourist attraction particularly during and after rainy seasons. Stretching over 60 percent of the area, livestock grazing constitutes the biggest land use in the province.

Land, water, vegetation, agricultural crops, trees and shrubs, grasslands, livestock and wildlife resources, are presently managed according to conventional approaches in rangeland areas. This system has remained focused on managing the land and its resources without any systematic and specific Land Use Planning. Almost every natural resource is either overexploited or underutilized.

Recommendations

Range resource: The present vegetation in Sindh rangelands with a wide array of valuable trees, shrubs and grasses, has substantial potential to be utilized for the preservation of the rangelands, overgrazed tracts with sparse vegetation and open, mobilized sand-dunes being constraining factors.

In the Thar area, although the available genetic resources in crops have the potential to be improved, this potential has yet to be realised. They are highly adapted to the risk-prone environment but there are indications that varieties exist (particularly in India) which may give better results under these harsh conditions. An increased productivity of crop agriculture would probably further decrease the importance of livestock and ease the expansion of agriculture into marginal lands.

Livestock resources: In the livestock sector, there is scope for improvement in animal health; widespread morbidity and high mortality seems to prevail due to various diseases especially in young animals and small ruminants. This could be reduced through systematic vaccination campaigns. Given the harsh environment, the marginal production system, the absence of any infrastructure (including market outlets) and the much diversified use of the different livestock species, there is little scope for improvement of livestock productivity through breeding or better management. Any intensification would put an exponentially greater degree of strain on limited water and fodder resources. In good years, fodder is sufficient between July and March. Fodder and feeding are limited during summer and in drought periods, even though the safety valve of the barrage exists. Some potential for fodder collection exists in Thar and Nara and a possibility to increase fodder availability through increased temporary protection of fodder sources and reseeding. These measures would not lead to higher livestock productivity, but rather, would decrease the need of leaving the arid areas and of reducing flock sizes during periods of scarcity.

Water resources: The low and erratic availability of rainwater and groundwater, as well as its high levels of salinity, are the main agro-ecological constraints for the management and development of rangelands. In Thar, where the population density is approximately four times higher, rainfall is critical for the barani agriculture and replenishment of the more superficial aquifers. These are usually of good quality but dry up towards summer when people leave cattle to depend on much deeper saline ground water resources.

In Kohistan, on the other hand, with a population density as low as Nara's, aquifers at different depths seem to be replenished regularly despite the spread of irrigation agriculture and the use of diesel pumps a water shortage. Locally, however, there are indications of sinking ground water tables.
In all three regions water availability is a limitation as the water source is often not where the human settlements are (mainly Thar, less Kohistan) or where livestock graze (mainly Nara). A large human and animal work force is required to dig and maintain wells, to draw water from wells and to transport it.

Awareness creation: Awareness-raising on a massive scale is required to enlighten stakeholders, relevant agencies and local communities. At the administrative level, it will be necessary to ensure continuity in policy and long-term institutional support at every level. At the same time, cross-sectoral partnerships and community involvement will need intensive development. These efforts should be backed by biodiversity- specific legislation and widespread reform.The rangelands in Sindh are mostly state property and it is necessary that these are managed in an integrated way to ensure productivity in a sustainable manner.

Administrative actions: The issue of transit passes should be strictly banned. A complete ban should be imposed on extraction of gugar and other species such as Lohiro, Khumbhat, etc which are at the verge of extinction.

PUNJAB
PROVINCIAL REPORT

Punjab

Background

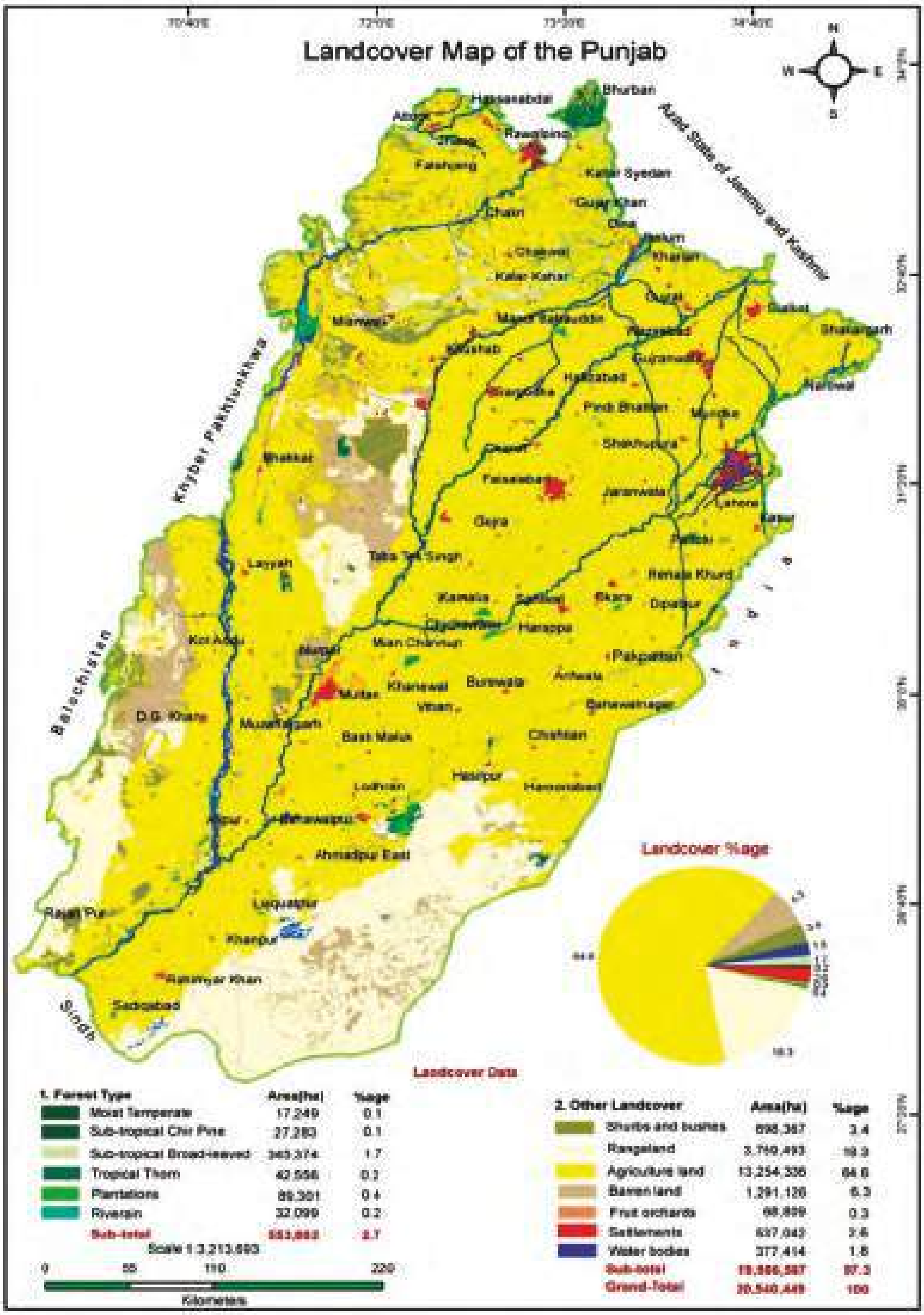
Punjab's rangelands cover nearly 8.28 million hectares. Potentially the richest rangelands are in the Himalayan forest grazing areas of Pothwar Scrub, Thal Desert, Cholistan and D. G. Khan. It indicated that the rangeland management situation in the Punjab is comparatively better than other provinces. However, sustainable rangeland management faces multiple constraints and bottlenecks including policy impediments and limited land use, insufficient financial resources for monitoring, lack of baseline data and absence of a sectoral and awareness policy especially for nomads and communities in the rangelands. The rangelands in the Punjab extend from temperate in the north to Mediterranean ranges in the western mountains of the Suleiman Range and arid and semi-arid desert ranges of Cholistan as shown in Figure 18.

Although Khan and Mohammad, (1987), reported that in Pakistan rangelands occupy about 65 percent of the total land area, a decrease in the area has also been reported, putting it at about 51 percent. Ashraf and Akbar (1989) reported that it may be more extensive (60 percent). About 18 percent of the country's rangelands are located in the Punjab, covering 8.2 million ha or 40 percent of the area of the province (Mohammad, 1989).

Extreme climatic variations are the result of correspondingly extreme variations in elevation and the occurrence of summer monsoon rains. The summers are extremely hot while winters are mildly cold to very cold. Precipitation varies from 100 mm in the southern deserts to more than 1500 mm in the northern mountains. The central and southern plains of the province consist of fertile soils but annual rainfall is low, averaging less than 250 mm. Northern snow-covered mountains of the Himalayas, Hindu Kush and Karakorum ranges are the main source of runoff water for the Indus River and its tributaries. As a result, water from the Indus and its tributaries is used to develop the canal irrigation system in Punjab for food and fiber production.

Although the high potential rangelands are located in the northern regions of the province, extensive semi-desert or desert ranges in the province of the Punjab are also another large resource which need to be harnessed. Most of the deserts in the province are man-made and have resulted from a long history of over grazing, mismanagement and vegetation deterioration. As a result of continued un-scientific use of rangelands, the current trend of retrogression is still ongoing (Quraishi et. al 1993; Younas, 1997).

Figure 18: Land cover map showing rangeland zones of Punjab



(Source: Courtesy of GIS lab, PFI, Peshawar)

In broad terms there are four major grassland types in Punjab according to their species composition (Johnstonne & Hussain, 1963 and Norman, 1968):

Dicanthium- Cenchrus-Elionurus associated with tropical thorn forests: This grass type is associated with the tropical thorn forest and is distributed throughout the alluvial basin of the River Indus complex and extends from KPK Province to Punjab and Sindh. It is characteristic of plains and low eroded hills. The precipitation, mostly received during summer months, varies from more than 500 mm in the north to less than 125 mm in the south and east. The associated species include *Dicanthium annulatus, Cenchrus ciliaris, Cenchrus setigerus, Elionurus hirsutus, Eleusine flagellifera, Cynodon dactylon, Sporoblus pallidus and Panicum antidotale*.

Chrysopogon in the tropical thorn forests: A number of forest types have been associated with this including the thorn forest at low elevations bordering the Indus Basin: the subtropical dry evergreen forest between 750 to 2000 meters; the dry temperate forest at the high elevations; and the Artemisia steppe that starts at about 1200 meters. The region is characteristic of dry low potential valleys of the Himalayas. Precipitation is mostly received during summer months and varies from more than 500 mm in the north to less than 175 mm in the south. The associated species are: *Chrysopogon aucheri, Stipa szovitsiana, Stipa linearis, Eusoapogon persicus, Oryzopsis equiglumis and Bromus tectorum.*

Themeda-Arundinella in the hilly northern areas: This has been found in the northern mountains at an elevation of 500 to 2500 meters. The principal grass species are: *Themeda anathera, Arundinella spp., Eulaliopsis bintas, Chrysopogon spp., Dimeria spp., Bothriochloa spp, Heteropgon contortus, and Pennisetum orientale.*

Saccharum on rivers and nullahs and alluvial floodplains*: Saccharum* spp. is characteristic of young alluvial soils along with river courses. The vegetation is influenced by frequent erosion and deposition of land as a result of shifting watercourses of the Indus river complex. The pioneer association was found to consist of: *Tamarix dioca, T.troupii,* with *Saccharum spontaneum, Cynodon dactylon and Saccharum arundinaecum* being characteristics of later successional stage.

Associated with these grasslands in the Punjab are five main forest types (Hussain, Chaudhry & Khan, 1999). Much of the original forest is in a degraded condition due to over exploitation and has been converted into scrub forest and the associated grasslands.

Rangeland Resources

The rangelands of Punjab consist of four zones: the Pothwar Plateau; Thal Desert; Suleiman Mountain Piedmont area (Dera Ghazi Khan Tract or Pachad Tract) and Cholistan Desert detail is available in table 16 and figure 18. The rangelands under the administration of the Punjab Forest Department consist of three million ha, which is 36 percent of the total area of rangelands of Punjab.

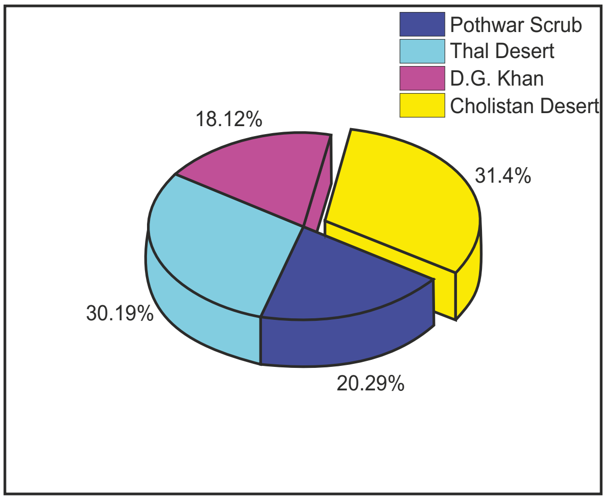
Table 16: Region-wise distribution of rangelands in Punjab

Million (ha)

S.No	Rangelands Zones	Public Sector Rangelands*	Total area**(Public +Private)Rangelands
1	Pothwar Scrub rangelands*	0.324	1.68
2	Thal Desert rangelands	0.063	2.50
3	D.G.Khan rangelands	0.028	1.50
4	Cholistan Desert rangelands	2.592	2.60
	TOTAL	3.009	8.28

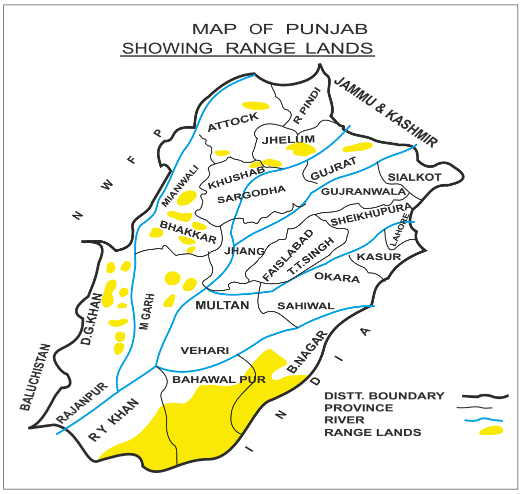
(Source : Government of Punjab, 1974. Mohammad, 1989)

Figure 19: Region / zone-wise distribution



(Source: Government of Punjab, 1974)

Figure 20: Public sector rangelands of Punjab



(Source: Punjab forest department)

Pothwar scrub rangelands: The Pothwar tract is located in the North of Punjab and lies between 32^0-30' to 34^0-0' North latitude and 72^0-74^0 East longitude consisting of 1.5 m ha falling within the districts of Attock, Islamabad, Rawalpindi, Jehlum, Chakwal, Gujrat, Mianwali and Khushab (Salt Range). It lies between the Jehlum and Indus rivers.

The Pothwar tract is sub-mountainous in character and altitude varies from 300 to 1500 meters. Geomorphologically, the plateau can be classified into mountains, hillocks, valleys, ravines, streams, plains, weathered rocks, piedmont plains, loess plains, and river plains. The rock formation is composed of tertiary sand stones and alluvial deposits. The sand stones apparently belong to the Sirmur and Siwalik series of the Sub-Himalayan system. The pebble ridges described as alluvial deposits are a peculiar feature. Large isolated boulders in many places indicate a glacial epoch in the Pothwar plains. The Pothwar plains were formed during the Quaternary Period and are composed of alluvium and groral caps (Soil Survey of Pakistan, 1978).

The soils of different areas have developed from a wide range of parent material. The agricultural soils have developed in wind and water-transported materials consisting of loess, piedmont alluvial and river alluvium deposits, mountain out wash and recent stream valley deposits. Some are derived from shale and sandstonee. The older soils are non-calcareous, whereas the relatively younger components are calcareous. Ecologically, it is located in the sub-tropical, semiarid to sub humid zone (Soil Survey of Pakistan, 1978).

The climate is sub-tropical continental low lands, sub-humid Pothwar Plateau (Ahmed, 1951) with a mean annual precipitation of 940 mm, most of which falls in the monsoon season during the months of July and August. The precipitation is erratic during two seasons which occurs from mid June to mid September and December to March. The summer monsoon rains are usually accompanied by thunderstorms and occur as a heavy downpour resulting in considerable runoff. Most of the annual precipitation in the semi-arid portion occurs during the June to September period. In the north and east about 70 percent occurs in summer. The winter rains occur as gentle showers of long duration and are more effective for soil and moisture replenishment than the summer rains. The tract is subject to heavy soil erosion and gully formation due to excessive land use and subsequent removal of vegetative cover.

January is the coldest month (mean minimum temperature 0.6C^0) while June is the hottest month (mean maximum temperature 45C^0). Beg et.al (1985) reported that mean annual precipitation ranges as being between 650 to 1000 mm and the mean annual temperature ranges between 18-24 C^0). Highest relative humidity of 83 percent and 76 percent was recorded in the morning in the coldest months of December and January and 51 percent and 45 percent in the evening. Table 17 shows the extent of Pothwar's rangelands.

Table 17: Detail of the public ranges falling in various districts of Pothwar

Name of Forest	District	Area in ha
Rasool Reserved Forest.	Mandi Baha-ud-Din	334.8178
Pabbi Reserved Forest.	Gujrat	15403.64
Phadial Reserved Forest.	Jhelum	4433.198
Ara Reserved Forest.	Chakwal	4325.911
Noorpur Reserved Forest.	Chakwal	1126.316
Mari Reserved Forest.	Chakwal	3055.87
Behiot Reserved Forest.	Khushab	3913.36
Pail Reserved Forest.	Khushab	1819.838
Gulial Reserved Forest.	Attock	6881.781
TOTAL		41294.74

(Source: Range management circle Lahore, 2012)

The vegetation of the tract is a dry deciduous scrub. Among the tree species Phulai *(Acacia modesta)* is found all over the tract, growing naturally. Phulai is browzed by goats and camels. Kao *(Olea cuspidata)* is found in major parts of the tract except Pabbi hills, some western low lying areas of Attock district and hotter areas of Jhelum. Kao is a very useful species, which provides wood for implements while its leaves are used as fodder. Lopping of kao is therefore a common practice all over the tract. The shrubs, grasses and forbs found in the tract are mentioned in this portion of the document. The predominant tree species, shrubs, grasses and forbs are:

1. *Kao* (*Olea cuspidata*), Phulai (*Acacia modesta),*Kikar (*Acacia nilotica*), Mesquite (*Prosopis Juliflora*), Ber (*Zizyphus Jujuba*), Shisham (*Dalbergia sissoo*), Kangar (*Pistacia integrima*), Iple iple (*Leucaena leucocephala*);

2. Pataki (*Gymnosporia royliana*), Mallah (*Zizyphus nummularia*), Snatha (*Dodonea viscosa*), Gunghair (*Monotheca buxifolia*) Garanda (*Carrisa spinarum*), Bahekar (*Adhatoda vasica*), Shamshad *(Buxus papilosa*);
3. Pharion (*Digitaria bicornis*), Palwan (*Brothriochloa pertusa*), Khar *(Chrysopogon aucheri*), Chimber (*Eleusine flagellifera*), Dhaman (*Cenchrus ciliaris)* Sariala (*Heteropogon contotrus*), Dab (*Desmostachya bipinnata*), Babbar (*Eragrostis superba*), Khawi (*cymbopogon Jawarancusa*), Lumb (*Aristida adscencionis*), Gorkha (*Elionurus hirsutus*), Dilla (*Cyperus eleusinoides*)Lumber, *(Cenchrus biflorus*), Tilla/Khar (*Chrysopogon ciliaris)*, Khabbal (*Cynodon dactylon*), Palwan *(Dichanthium annulatum*) Madhana , *(Dactyloctenium scindicum*) Gharam *(Panicum antidotale*) and
4. Bathu *(Chenopodium album*), Itsit (*Behavior diffusa*), Mako *(Solonum nigrum).*

The plant density on the whole is variable. It is poor on the south western slopes being dry and hot, whereas on the northern slopes the density is good. The topsoil has been practically washed away. Erosion has reached a very advanced stage in some parts and bare infertile rocks have been exposed which cannot support any type of vegetation.

Range condition is the present state of vegetation of a range site in relation to the climax plant community for that site. It is a measure of the status of current vegetation in relation to the climax vegetation of that area. In other words, it is the measure of the range health. Ecologically, climax composition is considered the best vegetation that nature can produce for a given area. If a given range is in excellent or good condition, then range managers try to maintain the range in a stable condition. However, if range condition is poor or bad, the range managers have to do something to improve range health. The most popular approach to determine range condition involves measurement of a given site in degrees of departure from the climax. Excellent or good range condition represents the climax and poor range condition represents deviation from the climax. The following ratings are generally used to determine range condition (Dyksterhuis, 1958).

Condition Class	Percent of present composition that is the climax for the site.
Excellent	76-100
Good	51-75
Fair	26-50
Poor	0-25

Range condition can also be measured by using the “site potential” approach (Humphrey, 1949). In this approach, the current condition or primary production status of a given range is related to its potential production capacity for a particular use. This approach has the flexibility for judging the range condition for a specified use, for example a site can be rated as excellent for a wildlife habitat but poor or fair for livestock grazing.

The primary purpose of determining range condition is to provide an approximate measure of the changes that have taken place in plant cover. This provides a basis for predicting the nature and direction of plant community changes to be expected from management and treatment measures.

The range condition of an area within a range site is determined by comparing present vegetation with the climax plant community. To facilitate this process, components of the vegetation are segregated according to their response to the kind of grazing use, on specific range sites. These component categories are classified as decreaser, increaser and invader plants.

Little work has been done to determine the range condition involving measurement in degrees of departure from the climax vegetation in Pothwar tract and other desert rangelands of Punjab. However, the forage production potential has been estimated, by determining forage production over time. The forage production can be co-related to determination of range condition classes. The forage production was estimated in Pothwar tract as 4350 Kg/ha on the high potential sites protected for two years, which is equivalent to 2 ha per animal unit per annum. Similar estimates have been made on moderate and depleted sites as 7 and 56 ha per animal unit per annum, respectively (Qurashi, 1993).

Raza and Ahmed (1990) estimated the qualitative and quantitative parameters of environmentally sound rangeland vegetation of the Pindigheb area of Attock district, where two ecological zones were established, based on climate and two types of physiographic soils. Four plant communities extracted for each ecological unit were integrated with climate and two types of physiographic soils and finally delineated into a vegetation and land use map, showing four range ecological units. Vegetation analysis in protected forests and unprotected open grazing areas showed considerable vegetation degradation and ecological destruction for low ground cover, density and frequency of major unprotected. Analysis of variance of quantitative forage production of dry matter between protected forest and unprotected open grazing areas for each ecological zone showed significant differences. The unprotected over-grazed areas showed a decline of up to 2.5 to 7.0 times, in forage production. The unprotected over-grazed areas have a development potential of 147 percent and 638 percent in each ecological zone, for carrying capacity in animal units per hectare per year provided it is protected from open grazing and improved by a system of grazing management. (Raza & Ahmad, 1990).

Range condition classifies the present vegetation of a range site in relation to its potential. Knowing the condition, however, does not indicate whether the range is improving or deteriorating. Trend is the direction of change in range condition (SRM, 1974). The rating includes ‘upward’, ‘downward’ or ‘stable’. Ecologically, upward trend corresponds to successional stages toward the climax and downward trend corresponds to retrogression or away from the climax. The most important technique to measure range trend is to use enclosures. Enclosures separate climatic effects from those caused by grazing. For periodic monitoring of ecological changes taking place in soil improvement and natural habits of fauna and flora, exclosures are erected in range ecological zones. Each exclosure has an area of over 50 x 100 meters. Three permanent transects are usually laid out inside the fence and three transects of the same length are marked outside the exclosure. Transects are the beginning point, marked with an aluminum cap, set in a concrete pier about four inches above the soil surface, or using wooden pegs. In hilly areas transects are laid out in north-south direction. The location of the marker and transect are noted on base maps. All trees located within two meters of the transect are identified by species and the stem diameter at one meter height, crown diameter and height are estimated for each tree. An estimate of vegetation condition and trend are made for the immediate area of transect. Soil surface is described with soil erosion characteristics, condition and trend noted. The following are among the more important characteristics of both vegetation and soil that indicate apparent trend in range condition – abundance of seedlings and young plants, plant residue, composition changes, plant vigor and condition of the soil surface. However, the relative importance of several factors mentioned above will vary with differences in vegetation, soils and climate.

Haider et.al (2011) studied the effect of grazing systems on forage production in the rangelands of Pabbi Hills, Kharian, Range Management Division Chakwal. The study period was four years i.e. from 2000-2001 to 2003-2004.They reported that in the open grazing system, the dry forage yield had a downward trend and it declined from 550 Kg/ha in 2000-2001 to 220 Kg/ha in 2003-04. They recommended a six-month seasonal period of deferred grazing to be practiced in this region. (Figure. 21)

Keeping in view the spirit and the recommendations contained in the federal document that is Rangelands of Pakistan, a study, National Range Management Committee, Government of Pakistan, Islamabad-1973 and 1974, a feasibility survey report (PC.II document) for management of the rangelands of Punjab for pre-investment purposes, was produced. The report looked in detail at the characteristics of the Pothwar, Thal, Cholistan and D.G. Khan tracts, and made specific recommendations for improvement and management operations for each zone. The recommendations in this document, along with those in the federal document, have been implemented to a great extent and have become the principle documents that have guided the undertaking of range management operations through various government-funded and donor assisted range improvement operations.

Therefore, following the recommendations of the Feasibility Survey Report, range improvement activities in Punjab were started in 1974, under a development project captioned “Range Management in the Punjab Pothwar Tract-Phase-I”, which was followed by phase two and other development projects.

Figure: 21. Decline in forage production over four years of study in rangelands of Pabbi Hills.

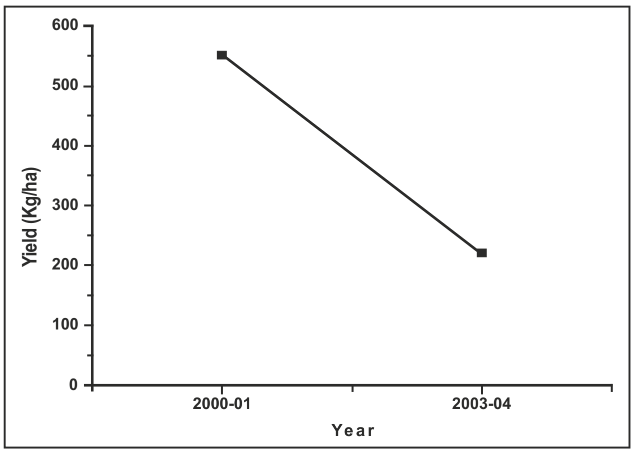


Table 18: Details of rangeland development intervention in Pothwar (1974-75 to 2011-12)

S.No.	Development works	Unit	Dev.	Non-Dev.	Total
1	Seeding of native grasses	Ha	8,498	2872	11370
2	Afforestation works	Ha	19335	2860	22195
3	Grass tuft planting	Ha	472	-	472
4	Development of watering points.	No.	252	5	257
5	Construction of pasture roads.	Km	97	-	97
6	Soil conservation works	Ha	1781		1781
7	Raising of grass seed nursery	Ha	6	4	10

Source: Range management circle Lahore, 2012

Although it has been estimated that against the productive potential of 4 tonnes per ha, the Pothwar rangelands at present are only producing 1.5 tonnes/ha, which is only one third of its productive potential (Mohammad, 1989). Various studies have revealed that it could be easily increased through scientific management. Chaudhry et.al (2010) determined the forage production on both the treated/ reseeded and untreated areas of the Mari Reserve Forest of Pothwar tract, at the end of the growing season during October 2007. The reseeded area produced about 16 times (7,733 kg/ha) more forage than the untreated area (491 kg/ha). The carrying capacity of the range based on dry biomass of grasses and herbs was found to be 0.07 and 1.18 Animal Units per ha per year in untreated and treated areas, respectively. In other words, the range having an area of 3,055 ha can support 3,605 AU per year if seeded; otherwise it will support only 214 AU per year. These results indicated that reseeding may be an important range improvement practice for the rehabilitation of the degraded rangelands of Pothwar.

Due to continued and unscientific grazing over a period of years and with for more livestock than the carrying capacity of the range, the seeded stands are easily over-grazed. As a result, there is no impact of range development. Therefore, it is important that more emphasis be given to the scientific management of the seeded stands for sustainable development.

Desert rangelands of Thal: The tract is bound by the piedmont of the Salt Range in the north, the Indus River flood plains in the west and Jhelum and Chenab River flood plains in the east. About 2.6 meter ha of arid and semi-arid areas of the Thal range receiving 150 to 200 mm annual precipitation, is located at an altitude of 200 m and lies between 31- 33^0 N latitude and 71.07^{0}E. It comprises large parts of the districts of Mianwali, Bhakkar, Layyah, Muzaffargarh and some parts of the districts of Khushab, Sargodha and Jhang, which are still out of the command of the canal irrigation system. The soil is moderately calcareous: alkaline clay loam, and alluvial with sandy texture. Sand is fine brown whereas sand dunes cover 50 to 60 percent of the area. The range area can be divided into four range sites: sand dunes slope and foots of sand dunes, flat areas and Kankor.

According to the Soil Survey of Pakistan (SSP, 1968), the geomorphology of the areas consists of sand ridges, abandoned channels and flood plains. Over the major part of the Thal desert, the alluvium has been blown into sand ridges and hollows or valleys known as *patties* in the local dialect. The soils of ridges are very deep, structure less fine soils of various degrees of calcareousness and colour gradations. All the sand ridge soils are highly drained and have a pH value of 8.4. Fine soil material from ridges has been drained into hollows and valleys and where allowed to settle down have made very deep, moderately calcareous and poorly structured soil.

The soils of valleys are mostly well drained with an average pH of about 8.4. The soils of the abandoned channels are water reworked sediment material, with a wide textural range (loamy sands to fine silty clays) usually have kankor, zone and are moderately calcareous with a pH ranging from 8.3 to 8.8. Soils of sub recent flood plains are moderately deep to dark, grayish-brown, silty clay loams and silty clays with weak to moderate structures 3 and weak lime profile but no kankor zone. In southern areas, reduced annual flooding and a high water table have resulted in alkalinization. The soils are alluvial with sandy textured sand dunes covering 50 to 60 percent of the area.

The north-eastern part of the range area receives more rainfall than the southern part (GOP.1974). Strong winds which cause severe soil erosion are very common. The temperature varies between 0^{o}C in winter to 44^{o}C in the summer months. The mean maximum and minimum temperatures recorded in the tract are about 44^{0}C and less than 0^{0}C respectively. The average annual precipitation varies from 385 mm in the north-east to 170 mm in the south. Approximately three-quarters of the annual rainfall is received during the monsoon season.

Table 19: Detail of the public rangeland falling in various districts of Thal Tract

Range Lands	Area (ha)
Rakh dagar Kotli	3267.206
Rakh Baba Hunda Lal	4138.866
Rakh Chikkan	2772.874
Rakh Gohar Wala	9814.575
Rakh Khew Yara	6727.53
Rakh chubara	5032.794
Rakh chubara	6852.632
Rakh Khere Wala	12483.4
Rakh Shergarh	12812.55
Total	63,902.43

(Source: Range management circle Lahore, 2012)

Ecologically, the range area, which covers an area of 2.5 million ha is a part of tropical and subtropical sandy plains and is considered one of the prominent rangelands of southern Punjab, (Muhammad, 1989; Quraishi et al. 2006).The predominant tree species, shrubs and grasses are:

1. Jand (*Prosopis cineraria*), Frash (*Tamarix aphylla*), Wan (*Salvadora oleoides*), Mesquite (*Prosopis juliflora*), Ber (*Zizyphus jujuba*);
2. Kikri (*Acacia jacquemontii*), Karir (*Capparis aphylla*), Phog (*Calligonum polygonoides*); and
3. The indigenous grasses like Dhaman (*Cenchrus cilliaris*), Khabbal (*Cynodon dactylon*), Khawai (*Cymbopogon jwarancsa*), Chhimber (*Eleusine flagellifera*),Malai (Panic*um antidotale*), Lumb (*Aristida depressa*), Gorkha (*Elionurus hirsutus)Dicanthium annulatum,sorghum halepense,Haloxylon recurvum*. (Khan, 1966; GOP, 1974, Muhammad 1989, Quraishi et al. 1993).

Range condition and trend has been discussed in detail in the preceding section however, the forage production and its variation over time has been recorded during various studies. Chaudhry et al (2000) reported forage production of reseeded areas of Rakh Dagar Kotli of the Range Management Division Bhakkar to be 581 Kg per hectare and reported heavy grazing pressure which resulted in downward trend of the range condition. Chaudhry et el. (2012) conducted a survey to assess the prospects of rangeland development in the Thal tract and found that 94-100 percent of respondents of all categories grazed their livestock in state owned rangelands, in spite of having low carrying capacity. The tract met 59 percent of the feed requirement of their livestock. Formulation of community organization is a pre-requisite for development of the rangelands of the area. The details of rangeland development interventions made from the year 1974-75 to 2011-12 are as shown in Table 20:

Table 20: Detail of development interventions in the Thal Tract.

S.No.	Development Works	Unit	Develop-ment	Non-Dev	Total
1	Seeding of native grasses	ha	21,013	678	21691
2	Afforestation works	ha	711.05	147	858.05
3	Grass tuft planting	No.	3,33,000	-	3,33,000
4	Construction of pasture roads.	Km	200	-	200
5	Installation of hand pumps	No.	382	-	382
6	Installation of tube well	No.	8	3	11
7	Sand dunes planting.	ha	1564	9.6	1573.6
8	Raising of grass seed nursery	ha	90	-	90

(Source: Range management circle Lahore, 2012)

Range improvement works were initiated in the Thal tract immediately after the implementation of the Maslakh range improvement project. Thal is the rangeland with the second highest potential in Punjab. Its soil is very fertile and the sub-soil water is fit for irrigation purposes. Range improvement practices have significant impact on the pastoral economy as it increases the forage quality and quantity which ultimately increases animal production, increased water yields on watersheds and reduces conflicts between multiple uses of range resources. However, due to decades of over-grazing and non-practicing of any specialized grazing system, the rangelands have deteriorated. In addition, these are the marginal lands and local people prefer to cultivate the Gram crop rather than choose range management on the private rangelands. This further accelerates soil erosion and causes environmental pollution.

Rangelands of Dera Ghazi Khan: The Dera Ghazi Khan tract is located between latitude 28^0.30’ to 31^0.15’ in the north and longitude 69^0.30’ to 70^0.75’ in the east. The tract lies in the Punjab Province and borders simultaneously with KPK Province in the north, Indus River in the east, Sindh towards the south and Baluchistan in the west. The rangelands of Dera Ghazi Khan tract has an area of 0.5 million ha between the Sulaiman Range and the Indus River. The average slope is gentle but a few sand dunes are also found.

The soil of rangelands is divided into two sub-regions. The piedmont plains – locally called “pachad” – are formed in the local alluvium derived from adjoining mountains. The topography of the area is undulating, with deep, well-drained, calcareous, medium-textured and low inorganic matter (Mohammad, 1984). The river plains locally known as “belas” are formed in the mixed alluvium originating from the Himalayas. These are sandy clay, calcareous, and low in organic matter.
The general climatic regime of the D.G.Khan tract is typical of a very arid sub-mountainous sub-tropical continental. Ecologically, it is tropical plain (non-sandy). The climate is broadly characterized by cold winters and very hot summers. The winter temperature occasionally reaches zero level, especially in January and February due to cold westerly winds. June and July are the hottest months with an average maximum temperature of 42^0C. Average annual precipitation varies from 75 to 162 mm. Most of the rainfall storms that move from the high mountains (1540-3400m) lose their moisture before reaching range areas which are situated at a relatively lower altitude (150 m). Annual rainfall at Dera Ghazi Khan, Taunsa, Fort Munro, Jampur and Rajanpur has been recorded as 132, 163, 202, 98 and 100 mm, respectively (Mohammad, 1989).

The total area under the control of the Punjab Forest Department was 28,217 ha which comprised 12 Rakhs located in D. G. Khan and Taunsa Tehsils. Out of this area, 404 ha of *Rakh Choti Dalana* was transferred to the Civil Aviation Authority for construction of the airport and 324ha was transferred to the Education Department for construction of the campus for the Agriculture University. An area of 1137 ha of *Rakh Rindwala, Kaluwala and Thatha Jhoke Bodo* was transferred to the D. G. Khan Forest Division for conversion of native vegetation into irrigated plantation as it came under the command of Chashma Right Bank Canal.The detail is in Table 21 below:

Table 21: Rangelands of Dera Ghazi Khan

Rangeland	Area (ha)
Rakh Choti Dalan	7315.385
Rakh Khitran Wala	727.1255
Rakh Rind Wala	408.9069
Rakh Kalu Wala	242.1053
Rakh Rurkali	814.9798
Rakh Berind	913.3603
Rakh Hamel wali	376.9231
Rakh chatta Maijata	486.6397
Rakh Thatta Jhoke Bodo	1004.049
Total:	28,217.41

(Source: Range management circle Lahore, 2012)

Rangelands which were recently formed or the young soils are colonized by *Saccharum spontaneum* and *Tamarix dioica* along the River Indus. These are replaced by *Acacia nilotica*, *Prosopis cineraria*. Wan *(Salvadora oleoides)* is probably the climax species of this region. The predominant trees, grasses and forbs are:

- Jand*(Prosopis cineraria),* Ber (*Zizyphus jujuba*), Wan (Salvadora oleoides), Kikar (*Acacia nilotica*), Kikari (*Acacia jacquemontii*), Phulai (*Acacia modesta*), *Acacia senegal*, *Alhaji camelorum, Calligonum polygonoides, Callotropis procera, Capparis decidua*, Kahjoor (*Phoenix dactylifera*), Lahora (*Tecoma undulate*), Malah (*Zizyphus mauritiana*); and

- Dhaman (*Cenchrus cilliaris*), Khabbal (*Cynodon dactylon*), Kahi (*Saccharum spontaneum*), Chhimber *(Eleusine flagellifera*), Malai *(Panicum antidotale*), Lumb (*Aristida depressa*), Gorkha (*Elionurus hirsutus*), *Cenchrus setigerus, Cymbopogon jawarancusa, Demostachya bipinnata, Haloxylon recurvum, Haloxylon salicornium, Kochia indica, Leptadenia pyrotechnica,Peganum hermala,Saccharum munja,Salsola foetida and Withania coagul*ans.

The available information on forage availability, quality, quantity and palatability of range plants of the D.G. Khan tract is limited. The forbs and secondary grasses usually increase as primary grasses decrease. Total cover may change very little and occasionally may increase due to the invasion of non-palatable plants. Deterioration of the rangelands has been associated with irregular grazing by nomadic and local livestock and illicit cutting of shrubs for fuel and fodder. Most of the rangelands are in poor condition. Estimated dry matter yields were 3 to 4 tonnes/ha from Lasiurus sindicus seeded stands at Rakh Choti Dalana and only about 400-500 kg/ha from non-seeded areas (Mohammad, 1989).

Khan et.al (1999) studied the effect of artificial reseeding on the forage production of the wild rangelands of Thatha Leghari of Dera Ghazi Khan and reported that the reseeded area produced

10 times (4000 kg/ha) more forage than the native range (425 kg/ha). Similarly in another study, Chaudhry (2009) determined the carrying capacity of different rangelands (Rakhs) of Dera Ghazi Khan. Details are in Table. 22.

Table 22: Carrying capacity of rangelands of DG Khan

Rakh/Range	Area in ha.	Year of Seeding	Carrying capacity (ha/AU/Yr)		
			Reseeded Areas		Un-seeded Areas
			Open for Grazing	Close for Grazing	
Choti Dalana	7548.58	2006-07	-	1.23	10.31
		2005-06	-	1.19	-
Shadan lund	4424.29	2006-07	-	1.77	13.36
		2005-06	5.54	-	-
Bela vidor	5255.46	2006-07	-	1.51	12.14
Rakh Barind	912.95	2006-07	-	1.44	12.95
		2005-06	3.64	-	-
Rakh Kathranwalla	727.12	2006-07	-	0.89	13.76
		2005-06	2.06	-	-

(Source: Chaudhry, A.A 2009)

The carrying capacity in un-reseeded areas ranged from 10.31 to 13.76ha/AU/Yr. The carrying capacity increased significantly in reseeded areas, was 0.89- 1.77 ha/AU/Yr in closed areas, and 2.06-5.54 ha/AU/Yr in the open areas (Figure 22). This study indicated forage production equivalent to 238Kg/ha. Therefore, it has been revealed from these two studies that the rangelands in Dera Ghazi Khan had a downward trend as forage production decreased from 425Kg/ha in 1999 to 238 Kg/ha in 2009 in the open areas (Figure 23).

Figure 22: Decrease in carrying capacity (herbage production) of rangelands of D. G. Khan

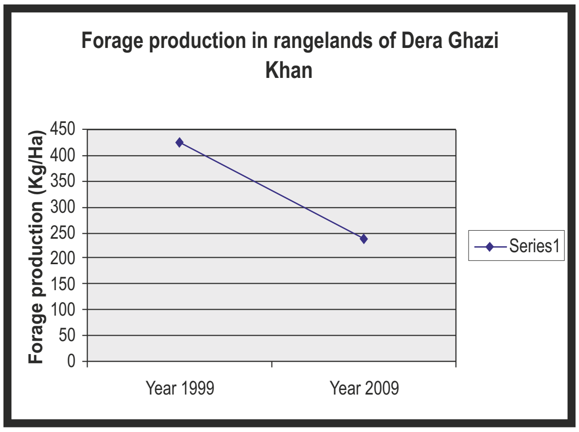
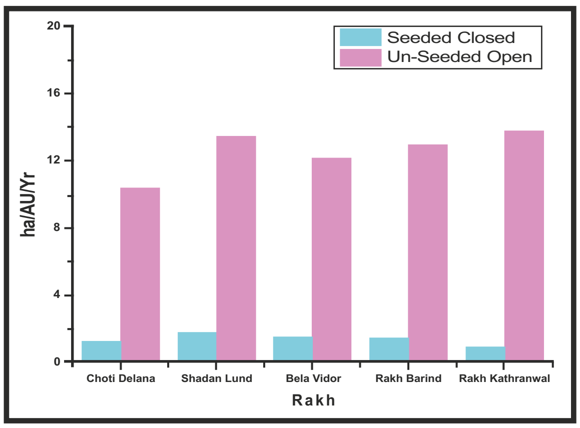


Figure 23: Area required per animal unit (AU) per year in different ranges of D. G. Khan



The details of rangeland development interventions made from the years 1974-75 to 2011-12 can be found in Table 23.

Table 23: Detail of rangeland development interventions in D.G.Khan (1974-75 to 2011-12)

S.No	Development Works	Unit	Development	Non-Dev.	Total
1	Reseeding of grasses	ha	9,130	122	9,252
2	Making of water spreading dykes	No	9550	160	9710
3	Construction of water ponds	No	141	-	141
4	Construction of Pasture roads	Km	300	-	300
5	Raising of potted plants	No	2,18,000	2,62,600	80,6040
6	Raising of bed nursery	ha	-	2	2
7	Raising of grass seed nursery	ha	14	-	14
8	Installation of tube wells	No	3	-	3
9	Installation of hand pumps	No	3	-	3
10	Dry Afforestation	ha	23624	-	23624
11	Planting around tobas	No	2,000	2500	4,500

(Source: Range management circle Lahore, 2012)

The first attempt for the scientific management of rangelands in Dera Ghazi Khan was made in 1960. The efforts failed to yield good results and the area being extremely arid was declared unsuitable for range Improvement (GOP 1970). Later, after creation of a range management circle in Punjab, range mprovement projects were launched which gave encouraging results. The herbage production increased up to 10 times. In 1982, an independent range management division was created with its Headquarter at D.G.Khan and scientific range management was started on a regular basis. Since then, these rangelands are under severe grazing pressure particularly from the nomadic graziers of Balochistan and there is no impact of range improvement practices in ecosystem rehabilitation or uplift of the socio-economic conditions of the local people.

Cholistan desert rangelands: The Cholistan desert is located in Southern Punjab extending through the Nara and Thar deserts of Sindh between latitudes 27° 42′and 29° 45′North and longitudes 69° 52′and 75° 24′East covering about 2.6 million ha. It has a length of 480 Km and width varies from 32 to 192 km (Khan, 1987). Based on topography, parent material, soil and vegetation the Cholistan Desert can be divided into two geomorphic regions; the northern region is called Lesser Cholistan bordering canal irrigated areas covering about 7,770 km^{2}and the southern region is called Greater Cholistan and covers about 18,130 km^2.

The old Hakra river bed (which dried out about 600 years ago) is the dividing line between the two regions. Lesser Cholistan comprises the desert margin and includes the area north of the Hakra, while Greater Cholistan is essentially the area south of the old Hakra river bed. The northern part of Lesser Cholistan includes an irrigation zone of 280,000 ha served by a canal network, where only 130,000 ha are commendable but only a small part is actually irrigated. It is spread over the district of Bahawalpur, Rahim Yar Khan and Bahawalnagar and covers two-third of the area of Bahawalpur Civil Division.

The soil survey of Cholistan was conducted by the Soil Survey of Pakistan in 1974. The soils of the tract are saline, alkaline and gypsiferous composed of granites, schists, gneiss, and slates. The area consists of shifting sand dunes. The dunes reach heights of about 100 meter in greater Cholistan. Four major land forms recognized by Baig et.al 1980 include sub-recent river plains, the first sandy terrace above the Hakra River (late pleistocene), the second sandy terrace above the Hakra River plain (late pleistocene) and the third sandy terrace above the Hakra River Plain (middle Pleistocene).The climate of Cholistan is extremely hot, and of the arid sandy desert type. Ecologically, it is tropical arid sandy desert. The area is subject to wind erosion. Precipitation is erratic and ranges from 100 to 200 mm. Mean minimum and maximum temperature are 20^oC and 40^oC respectively. Mean annual precipitation varies from less than 100 mm in the west to 200 mm in the east, mainly falling during monsoon season (July to September). Precipitation is very inconsistent in quantity and duration and prolonged droughts are common once every 10 years. Temperatures are high in summer and mild in winter, with no frost.

Cholistan desert consists of an area of 2,591,093.12 ha of old Bahawalpur Estate and is spread over Bahawalpur, Bahawalnagar and Rahim Yar Khan Districts of Bahawalpur Civil Division. The vegetation of Cholistan consists of xerophytic trees, shrubs and grasses. Johnstonne and Hussain (1963) characterized the Cholistan vegetation as Dichanthium-Cenchrus-Lasiurus type. Sheikh (1986) categorized Cholistan vegetation as sand dune and desert scrub. The three major range types found in Cholistan are Lasiurus-sindicus/Haloxylon-salicornicum; Eleusine compressa/Haloxylon salicornicum; Haloxylon recurum/Salsola foetida and Suaeda fruticosa (Government of the Punjab, 1974). The predominant tree species, shrubs and grasses are:

1. Jand (*Prosopis cineraria*), Frash (*Tamarix aphylla*), Wan(*Salvadoraole oides),*Mallah (*Zizyphus nummularia*), Ber (*Zizyphus jujuba),* Kikar (*Acacia nilotica*), Kikari (*Acacia jacquemontii);*
2. Lana (*Haloxylon saincoricum*), Karir (*Capparis aphylla*), Phog (*Calligonum polygonoides*);
3. Dhaman (*Cenchrus cilliaris*), Khabbal (*Cynodon dactylon*), Khawai (*Cymbopogon jwarancsa*);
4. Chhimber (*Eleusine flagellifera*), Murgha (*Dicanthium annulatum*), Lumb(*Aristida depressa*),Gorkha (*Elionurus hirsutus*).

The main vegetation types based on floristically dominant and structurally important species are:

Haloxylon-Calligonum Community: This is a widespread community type dominated by leafless shrubs of *Haloxylonstocksii* and *Calligonum polygonoides*. Other associated species include *Lasiurusscindicus*, *Cymbopogon, jwarancusa, Suaeda fruticosa*, *Dipterygium glaucum*, *Crotalaria burhia.* This type of community generally covers flat plains with compact soil and saline conditions. Several species of annuals and ephemerals emerge after rains, covering the ground but contributing very little biomass. The shrubs have strong root systems and hold the soil together, protecting it from wind erosion.

Acacia-Tamarix Community: The *Acacia nilotica* and *Tamarix aphylla* community is found in peripheral areas of Cholistan. *Acacia nilotica* is locally considered as the ‘poor man’s teak wood’ for its valuable timber which is used for cheap furniture and agricultural implements. Leaves provide forage for livestock. *Tamarix branches* are used for thatching rooftops and fences around livestock enclosures. Trees also provide shade for resting livestock which seek shelter from the strong sun. Several species of grasses and herbs are associated with these communities like *Cenchrus*, *Pennisetum*, *Eragrostis*, *Fagonia*, *Dipterygium*, *Indigofera.* Large hemispherical clumps of *Heliotropium crispum* are common in the peripheral regions of the desert which hold soil from erosion and conserve water.

Prosopis-Salvadora Community: The *Prosopis cineraria* and *Salvadoraole oleoides* community is generally found in Lesser Cholistan region where rainfall is not less than 100mm. *Prosopis cineraria* is considered as an excellent forage species with a very deep root system, very well adapted to the desert conditions. The branches are extensively lopped for feeding young lambs and goats not able to roam around for forage. Generally the top shoots are left for future growth and lower branches are cut for livestock. It also forms excellent firewood for cooking as well as charcoal making. *Salvadora oleoides* is an evergreen tree with a deformed trunk and a deep root system, heavily grazed by camels and goats. It is a very slow growing tree with poor regeneration through seeds but it produces suckers profusely forming large clumps. Sometimes only clump-forming large bushy structures are seen due to heavy browsing, tree-like shape is rare and ripe fruits are also edible. Other associated species include *Acacia nilotica*, *Zizyphus nummularia*, *Tamarix aphylla*, grass species like *Lasiurus*, *Cymbopogon*, *Sporobolus*, *Panicum*, *Cenchrus*, *Aristida*, etc. Some annuals associated with this community include *Zygophyllum*, *Dipterygium*, *Indigofera*, *Glinus*, *Fagonia*, *and Heliotropium.*

Lasiurus-Cymbopogon Community: Perennial species of clump-forming grass species like *Lasiurus scindicus* and *Cymbo pogonjwarancusa* are developed on poorer soils on flat plains with compact soil. This community type is generally poor in species diversity, having mainly annual short-lived species appearing after rains. These grass species are palatable at the earliest stage of growth; coarse hard old leaves are not generally grazed. *Lasiurus scindicus* and *Cymbopogon jwarancusa*are are abundantly distributed throughout the Cholistan Desert. Scattered shrubs of *Haloxylon*, *Suaeda*, *Crotalaria* and *Aerua* are also sparsely found.

Acacia-Pennisetum Community: *Acacia jacquemontii* and *Pennisetum divisum*are are generally associated with dry watercourses with better soil and moisture retention capacity. *Acacia jacquemontii is* a tall shrub by species with extensive branching from the base. It is a good forage species and a preferred firewood shrub in the desert. *Pennisetum divisum* is a tall large clump-forming grass with a good soil-binding ability preventing soil erosion from strong winds and flash floods. This is an excellent fodder grass relished by livestock, which produces green tender leaves in minimum moisture conditions. Other associated species include species of *Convolvulus*, *Launnaea*, *Indigofera*, *Tribulus*, *Trianthema*, *Neurada*, etc. Several grass species include *Ochthochloa*, *Panicum*, *Aeluropus*, *Stipagrostis*, *Cenchrus.*

Aerua-Crotalaria Community: This community is common in poor saline soils. Usually large shrubs and trees are absent. Grasses like *Sporobolus*, *Ochthochloa*, *and Desmostachya* species are found to have stiff leaves and are grazed when young. They are usually found in interdunal saline sandy soils.

Capparis-Suaeda Community: *Capparis aphylla* and *Suaeda fruticosa* are also found to be widespread in poor soils with inadequate moisture content. *Capparis aphylla*, a leafless shrub, sometimes attains tree-like form; its branches are used for thatching roofs. *Suaeda fruticosa* forms evergreen largesized bushy dome-like clumps, leaves are reduced to scales. Vegetation is very sparse, poor in species diversity. Short-lived annual plants appear after rains for a short period.

Leptadenia-Calotropis Community: The *Leptadenia pyrotechnica* and *Calotropis procera* community develops in poor sandy soils, not palatable for livestock. It spreads in areas with heavy grazing pressure. *Leptadenia pyrotechnica* is a many-branched leafless shrub not grazed by livestock. However, the branches are used for thatching roofs and fencing. The *Cyperus conglomerate is* compact clump-forming sedge with roots having good sand-binding ability, frequently found on sand dunes under poor moisture conditions and is grazed when young.

The vegetation in Cholistan is typical of arid and semi-arid climate, consisting of xerophytic species adapted to high temperatures, low humidity, moisture fluctuations and a wide variety of edaphic conditions. Compared to the hyper arid southern region, the vegetation cover is relatively better in eastern Cholistan (200mm rainfall zone). A wide range of nutritious and drought-tolerant plant species (128 species belonging to 33 families) of grasses, herbs, shrubs and trees, occupy this desert. Hardy species adapted to high temperature and low soil moisture includes *Lasiurus scindicus, Sporobolus iocladus, Aeluropus lagopoides* and *Cyperus onglomerates*.A study conducted by Akhtar and Arshad (2006) reported that some xeric plant species do survive in the Cholistan desert during severe droughts but undergo tremendous grazing pressure leading to partial eradication. As a result, the flora has been thinning out gradually with the increasing severity of desertification. Their report points to a downward trend in the range condition of Cholistan.The details of rangeland development intervention made from the years 1974-75 to 2011-12 are as follows:

Table 24: Detail of rangeland development interventions in Cholistan (1974-75 to 2011-12)

S.No	Development Works	Unit	Development	Non-Dev.	Total
1	Reseeding of grasses	ha	1027	171	1198
2	Afforestation works	ha	40	50	90
3	Construction of water ponds	No	613	135	748
4	Construction of pasture roads	Km	3627	1150	4777
5	Raising of bed nursery	ha	25	-	25
6	Raising of grass seed nursery	ha	14	-	14
7	Installation of tube wells	No	1	-	1
8	Installation of hand pumps	No	26	-	26
9	Grass tuft planting	No	3000	-	3000
10	Tibba Planting	Ha	1336	-	1336

(Source: Range Management Circle Lahore, 2012)

Rangeland Ecosystem Services

Rangeland ecosystems play a vital role in providing many direct services to society such as meat and milk products, forage, timber and fuel wood, medicines, building materials, industrial products and indirect services by maintaining the composition of the environment, mitigating climate and moderating weather conditions, soil and water conservation, disposing of wastes, cycling nutrients and storing, purifying and regulating water production from the watersheds.

Rangeland degradation in Punjab is a major issue which affects not only the direct users, pastoral communities' but also many others benefiting from its environmental services. Important indicators of rangeland degradation include reduction in vegetation cover, plant productivity, accelerated soil erosion, elimination of soil seed bank which leads to a downward trend in range conditions and an increase in desertification.

The economic valuation of the rangeland ecosystem services has many roles. Economic values may be used as an input into analyzing the costs and benefits associated with policies being proposed or already implemented. For example, with monetized values acting as a common metric, one could compare the benefits of converting a rangeland ecosystem into a commercial development resulting from that land conversion based on the potential value as opposed to the current value. Similarly, ecosystem service values can be used to determine the level of return on an investment. This is a primary objective for private land conservation organizations that typically have very limited resources.

Ecosystem service valuation can also have a role in damage assessments from untoward incidents that require compensation such as oil spills, waste dumping etc. Additionally, valuation can be very informative when investigating regulatory programmes that trade ecological assets such as wetland mitigation programs. Typically these programs do not take into consideration varying welfare values associated with that ecosystem. The ecosystem service valuation serves as a common tool of recognition for people of all backgrounds. Identifying and valuing the ecosystem goods and services of the rangland brings to light the value these natural assets have to human welfare that often remains hidden due to their public and non-market attributes. This type of recognition is vital to the preservation of rangeland ecosystems in the future and the many ecological benefits they provide (Ahmad et. al, 2012).

The contributions of the rangeland ecosystem towards pastoral livelihood, household energy, watersheds, water regulation, wildlife habitat and high value rangelands products are:

Pastoral livelihood: The rangelands consist of diverse ecosystem types such as Alpine Pastures, Himalayan grazing land, Pothwar Scrub Ranges and Desert Rangelands of Thal, D.G. Khan and Cholistan. These ecosystems provide an open space and habitat for wildlife and are a source of feed for the livestock, which is the second biggest economic activity in the country. It is the subsistence source of approximately a quarter (25-30 percent) of the population of the country. At present, the estimated number of head of livestock is 167.5 million (GOP, 2012).

The statistical data in the preceding chapter has shown that there is a 3 percent yearly increase in the livestock population– about 5 million animals. Accordingly, the feed and forage requirement of the livestock has increased significantly which is at present 115.9 million Animal Units, out of which 21.2 million are wholly dependent on rangelands. On the other hand, supply of cultivated green fodder has declined due to 11.6 percent decrease in cultivated area for fodder production (Sarwar, et al, 2002, Khan, 2003).

The population of sheep and goats the principal range animals, have also increased significantly from 12.37 percent and 10.04 (22.41) million from the year 1960 to 28.4 and 63.1 (91.5) million in the year 2011-12.This is more than a four time increase in animal numbers (Pakistan Economic Survey, 2012). Forage is a limiting factor in livestock production in the rangelands and desert ecologies. Therefore, livestock grazing pressure on the rangelands will continue as cultivated areas under fodder crops cannot be increased due to high competition with other crops. These rangelands have been heavily overgrazed in the past, which has reduced the carrying capacity by 10 to 50 percent of their potential (GOP, 1983). With the increasing population of livestock multiplying dis proportionately during the past, the resultant deterioration of range vegetation, low feeding, and livestock management standards, resulted in a decline in livestock performance and productivity. Deterioration of primary productivity has resulted in the reduced production of range livestock and their products.

The agriculture sector contributes 21 percent to the national GDP whereas the livestock industry contributed approximately 55.1 percent to the agriculture value-added and 11.6 percent to the GDP during 2010-12, against 54.6 percent and 11.6 percent during the same period the following year. The gross value-added of the livestock sector at constant factor has increased to 672 billion (2010-11) to 700 billion (2011-12) showing an increase of 4 percent when compared with the previous year (GOP, 2012).The value of livestock is 6.1 percent more than the combined value of major and minor crops. It is also worth mentioning that the value of milk (just one animal product) is more than the combined value of cotton and wheat (Anonymous, 2009).

Rangelands are major land resources that contribute directly to the pastoral and agricultural economy, and indirectly to the entire complex economy of Pakistan and in turn, to our national economy. There is no doubt that the productivity per unit area of our rangelands can be increased from 2 to 10 times under scientific management. This will boost the livestock production as well as provide food, cover and protection to wildlife resources. By harnessing the vast range of resources, properly motivated and devoted personnel can make the deserts bloom and provide better living conditions to the ever-increasing population of more than 180 million. About 35 million people earn their income mostly from livestock and 2.5 million families directly depend on grazing their livestock on rangelands (National Commission on Agriculture, 1988*).*

High value range products: The livestock sector has great importance as it provides high-value range products such as milk, meat, and hides and also renders various services to mankind (Table 25). It provides draught power and manure for the agricultural economy. Foreign exchange trade in livestock products contributes 11 percent of the total export value at $350 million. Livestock occupies a key position in the rural economy of Pakistan for bringing cash income to improving the living standard of small resource poor graziers and the other population (Khan et al., 2005). The contribution of livestock to the economy of the Punjab from these high-value range products meat, milk, wool etc was 1.74 billion rupees during the year 2012. The major portion came from meat and milk which contributed more than 98 percent (Punjab Board of Investment and Trade, 2012)**.** These rangelands are being used by both nomads and local grazers and provide 40 - 50 percent forage to their livestock (Wahid, 1984), thereby playing an important role in providing livelihood to the rural poor.

Table 25: Contribution of livestock to the economy of Punjab

Item	Production (000 tonnes)	Unit Price (Rs/kg)	Value (Rs. in million)
Milk	31294	40	1251.76
Beef	1174	160	187.84
Muttonne	782	360	281.52
Bones	384	3	1.152
Fat	143.5	12	1.722
Blood	49	12	0.588
Hide	9.1	1500	13.65
Skins	45.2	200	9.04
Total	33880.8		1747.27

(Source: Punjab board of investment and trade, 2012)

Medicinal plants: The rangelands support a variety of plants which are used for medicinal purposes particularly by the local people (Hakeems) in traditional and homeopathic medicine. Qurashi et al. (2007) carried out the ethno-botanical studies of plants of the Mianwali district of Punjab and revealed that during the investigation which was based on economically important floristic diversity of the district, a total of 23 species belonging to 16 families were collected. Interviews were conducted on their local uses, especially in medicines, but also for other economic purposes e.g. for furniture and timber. The data revealed that traditional and homeopathic medicines are cheaper and often more accepted by a large number of the people. The main source of medicinal plants is forests and rangelands.

Household energy: In Pakistan, per capita fuel wood consumption has been estimated as 0.213 cubic meters (World Bank 1991). For more than 180 million population, the total fuel wood consumption amounts to 38.34 million cubic meters. About 70 percent of the population of Pakistan live in the rural areas and 90 percent of the rural population use biomass as the only source of energy. About 50 percent of the urban population is also reported to use biomass as the main source of energy (Jan, 1989).

Fuel wood is an important component of household economies in the country. It covers about 53 percent of total annual domestic energy needs (GOP, 1997). It has also been estimated that 70–79 percent of Pakistani households use fuel wood as the main source of energy (Hafeez, 2000; Siddiqui, 2000). This reliance on fuel wood is expected to remain high in Pakistan in the future because the country's economic development is not strong enough for a shift from traditional fuel wood to modern fuels (Siddiqui and Amjad 1993). The high demand for domestic fuel wood is believed to be the cause of Pakistan's rapid depletion of forests and rangelands (Government of Pakistan 1992).

The current forest area is only 4.7 percent of the country's surface (GOP 2003) and is depleting due to a number of threats including continuous commercial over-exploitation. For a number of financial, technical, administrative and political reasons cutting trees in forests is in excess of replanting and regeneration rates. Current output is not sufficient to fulfill the demand for timber and fuel wood, raw material for industries, energy requirements of the agricultural sector and fodder for livestock (ERNP, 1999).It has been estimated that the damage caused due to rangeland degradation and deforestation is 7 billion rupees annually (World Bank, 2006).

The destruction of the rangelands is not only due to over population and the grazing pressure of livestock on the land but also because of overuse of native trees, shrubs and bushes as fuel. It has been estimated that around 75 percent of the fuel need in rural areas is met by plants in rangelands. According to one estimate, every household uses 15 kg of wood to cook food daily. In winter, every household uses 35 kg of wood. However, tree plantation is very slow as compared to cutting of wood at a large scale in such lands. There is a need to plant the maximum number of trees. Alternate energy sources such as solar, wind and biogas should also be developed to reduce tree cutting from rangelands (Hussain, 2011).

The Household Energy Strategy study (HESS) found that 91 percent of the households in rural areas consumed fuel wood at an average rate of 6.7 Kg/household/day. Based on these estimates, it was projected that 52.15 billion kg of fuel wood would be required during 2010 with a substantial gap between demand and supply. The results further showed that 56.3 percent of the households used dung as fuel. About 86 percent of the dung consumed as fuel is utilized in the rural areas of the country. The majority of the dung users (79.5 percent) were cattle owners.

Qambar and Bhattacharya (1999) reported that total biomass consumption of Pakistan is estimated to be about 67.7 billion kg (44 percent of the total energy needs) out of which the share of firewood is 56 percent. The household sector is the major end user and consumes 86 percent of total biomass energy (UNDP, 1993).

Watershed values: The rangelands consist of the watersheds of two big reservoirs, Tarbela and Mangla Dams. In view of the importance of range vegetation in controlling soil erosion, storing, purifying and regulating water production from watersheds, the role of rangelands assumes prime importance. Over-grazing and mismanagement of these rangelands will not only upset the livestock industry but will seriously endanger the entire ecosystem complex and the economy which is dependent upon big reservoirs constructed for irrigation as well as for hydro-electric power generation. This role can be appreciated from the fact that annual loss due to silting of Mangla and Tarbela reservoirs has been estimated to be 112 million rupees on these dams. A similar threat can plague other major power and irrigation projects. (Khan, 1987)

It has been reported that problems like degradation of watersheds cause annual losses of 40 million tonnes of fertile soil due to soil erosion, siltation of Tarbala and Mangle water reservoir, reduced hydropower generation, devastation by floods causing an estimated loss exceeding Rs. 205 billion per year, desertification, declining agricultural and livestock production, wildlife and biodiversity and increased environmental pollution, reduced supply of regulated water from the watershed areas, and inadequate ground water recharge in dry temperate regions (FSMP, 1997). Approximately 11 million ha are affected by water erosion and 40 million tonnes of soil brought into the Indus Basin each year (Hussain and Irfan, 2012).

The northern hills of Pothwar tract and Suleman Hills of D.G. Khan are two important watershed areas of Punjab. The Pothwar tract mainly consists of scrub rangelands. Its streams, nullahs and tributaries drain into the river Indus near Attock, Chakwal and Mianwali districts in the upper riparian of Chashma Barrage. It provides water to hundreds of small dams located throughout the region which are not only a source of drinking water for human population but also a lifeline for the pastoral economy of the area. A study was conducted in Chakwal to determine the effect of vegetated cover on run off and soil loss from the watersheds. A quantitative vegetation assessment of the Dhrabi watershed, Chakwal in the Pothwar range zonewas conducted to determine the productive potential and carrying capacity during winter 2008-09 (Haq et al, 2011). Twelve sites of watershed were selected on the basis of variation in altitude using stratified sampling with line transect method.

Overall average grass cover was 64.09 percent. In the area the highest value (73.41 percent) was in the upper zone and lowest (56.33 percent) in the lower zone. Average trees and shrub cover was 19.74 percent with the highest value (29.72 percent) in the middle zone followed by upper (21.54 percent) and lower zone (7.95 percent). The range was found to be in good condition with an overall carrying capacity of 2.41 ha/AU/4month. The main dominating plant species found in the area were *Heteropogon contortus* (Sariala ghaas), *Cynodon dactylon* (Khabbal), *Desmostachya bipinnata* (Dab) and *Acacia modesta* (Phulai). (Haq et al, 2011). The overall watershed management actions should priorities to satisfying the livelihood needs of the involved communities. This will ultimately improve the natural resources of the catchments and ensure that alternative, sustainable sources of fuel materials are available to all households.Thus must be a primary component of watershed management activities (Virgo et al, 2006).

The Suleman Hills are another watershed area in the south west of Punjab, which brings in flash floods of shorter duration and higher magnitude. There are more than 200 hill torrents in the area which originate from the Suleman Range, of which 13 are major hill torrents. The hilly region of watershed consists of steeply sloping lands with deep incised drainages. Traditional agricultural and grazing systems, along with complete removal of trees, shrubs and grasses for forage and fuel wood have severely depleted the vegetative cover. Erosion of the land surface is in an accelerated state with severe sheet, rill and gully erosion occurring throughout the catchment and even light showers of rain cause flash floods in the hill torrents bringing havoc in downstream areas. The flood flow reaching D.G. Khan canal is generally in excess of the capacity of the hill torrents crossing. The accumulated flood water breach the canal banks and cause heavy damage to the canals, crops and other infrastructures.

In the year 1994, the Mithawan Watershed Management Project funded by the Japan International Cooperation Agency (JICA) under the Grant Aid Program, was implemented by the Government of Punjab and FAO for 52 months. The project was designed to use the participatory approach concept for the integrated watershed management in the hill torrent watersheds. Scientific range management was carried out and the range area was divided into four pastures for rotational grazing. Soil conservation works, planting and reseeding of palatable grasses were conducted in consultation with the local community organizations. The project interventions improved flood control, reduced the flood damage in the canal-irrigated areas and increased the agricultural productivity. The establishment of vegetative cover in the catchment area increased the water holding capacity of the soil and reduced water and soil erosion. The livestock production increased due to enhanced production of forage for their animals (Government of Punjab, 1999).

Another study was conducted in the Hilkot watershed, (a catchment of Tarbela Dam) by the People and Resource Dynamics Project, in 1998 (Zohkaib and Naser, 2011). The objectives of this study were to calculate annual runoff and soil losses from different land uses and compare their seasonal distribution. Four experimental plots based on land use classification such as degraded, forests, agricultural and pasture lands were established. The area has precipitation level of about 38 percent occurring in the monsoon period (July to September), while in the pre-monsoon (March to June) and the winter period (October to February) 35 percent and 27 percent of total rainfall was received, respectively. The annual rainfall in the watershed was 1160 mm. In all the erosion plots, almost 50 percent of the runoff and soil loss occurred during the monsoon period and was negligible during winter. The mean maximum runoff was from the degraded plot (674 m^3/ha/yr), while minimum was observed from the pasture plot (310 m^3/ha/yr). Average runoff on other land uses was 529 and 460m^3/ha/yr from the forest and agriculture plots, respectively. Annual soil loss from all land uses ranged between0.3 to 16.3 t/ha. Average maximum soil loss was recorded from the degraded plot (6.5 t/ha/yr) and average minimum (1.8 t/ha/yr) on the pasture plot. Similarly, average soil from other plots was 3.3 and 3.4t/ha/yr, measured from the forest and agricultural plots respectively.

Bari et al (1995) studied the impact of livestock grazing on interrill erosion in Pakistan and concluded the following:(1) that the residual phytomass level significantly affects the sediment concentration and total sediment loss(2) The exclosures resulted in the lowest sediment production among all treatments(3) the treatment with lowest residual phytomass resulted in the highest sediment loss(4) standing phytomass was the most important variable followed by foliar and basal cover which greatly affected sediment production and(5) the potential biomass changes from year to year and therefore the watershed manager should rely on the residual phytomass level rather than removing the fixed percentage of forage.

Water regulation from the watersheds: Major parts of Pakistan are arid and semi-arid such as Southern Punjab, Sindh and Balochistan. The human population is growing rapidly. Due to prevailing arid conditions water is not only a limiting factor but also has great importance for drinking purposes. The northern areas of Pakistan which are mainly forests and rangelands are the primary source of water for agricultural, industrial and domestic purposes. Rangelands play a key role in enhancing sustainable water flow downstream, and reducing soil erosion. The conditions of vegetation and soil on which the precipitation falls can have a major influence on the quantity and quality of water availability for human consumption and other uses. Range management practices can significantly affect the flow of water in the main rivers and tributaries, flooding, siltation of dams and quantity of runoff water that can be stored in the Mangla and Tarbela reservoirs.The alpine rangelands and forested areas of northern

Pakistan have considerable potential for increasing water yield from overland flow by vegetation modification through logging, grazing and soil conservation practices.

Wildlife habitat: The rangelands of the Punjab are the primary habitat for all the wild animals, providing a vast complex of natural habitats and biological niches to endangered wildlife species. Increased forage production, development of water points and their judicious distribution, saving the natural habitats from destruction, etc. are only a few of the many examples of compatibility with and of direct contribution to wildlife development. Increased awareness to protect and develop wildlife resources of the province makes the case of natural rangelands more imperative.

These habitats support a variety of wild animals. The areas are difficult for human beings to access hence most wildlife is present in reasonable numbers though some are endangered for other reasons. The Himalayan foothills and the Pothwar region, including the Salt Range and Kala Chitta Range are covered with scrub forests which have been reduced to scanty growth in most places. Medium-sized animals like the Punjab Urial, Barking Deer, goral, Chinkara, partridges (grey and black), Seesee and chakor are supported in these habitats. A variety of songbird fauna also occurs in these areas.

Little vegetative cover, severity of climatic conditions and the great numbers of grazing animals on the deserts have left wild animals in a precarious position. Parts of Thal and Cholistan are now being irrigated, with the situation almost identical to that of the flood plains. Chinkara is the only animal which can still be found in average numbers in Cholistan, but rarely in Thal. The Black buck, once plentiful in Cholistan, has now been eliminated. However, efforts are being made to reintroduce them back into their natural habitat. A small number of Blue bulls are found along the Pak-Indian borderand some parts of Cholistan. Grey partridge, species of sand grouse and the Indian courser are the main birds of the area. Peafowl occur in some areas in Cholistan.

The Houbara Bustard is a regular winter visitor to the desert. Visiting diplomats have hunted and reduced their numbers. The great Indian bustard is occasionally sighted in the deserts. The imperial sand grouse is another migrant visiting these areas. Grey partridges are frequently sighted. The python is also threatened with extinction.

The Sulaiman Range habitat has unique characteristics. It supports the straight-horned Markhor, Chinkara and Urial. The Chakor, Seesee and Grey partridge are birds commonly found in the tracts. The reed beds and tamarisk bushes along the rivers support hog deer and black partridge populations. However, due to occasional heavy floods, their numbers have also been reduced. The Indus Dolphin (National Marine Mammal of Pakistan) fishing cat and the smooth otter are found in the Indus River waters below the Chashma Barrage. The gavial has become extinct in Pakistan. The Indus Crocodile (National Reptile of Pakistan) is found in small numbers in lower Sindh. Wild boar numbers have increased in irrigated plantations because of the immunity they enjoy in a Muslim society that forbids consumption by humans.

Maan and Chaudhry (2001), studied the wildlife diversity of Punjab and found that the irrigated forest plantations are rich in wildlife diversity as compared to the sub-mountainous tract. Changa Manga Wildlife Sanctuary (WS) was highly diversified with 74 wildlife species. In Kundian (WS) 65 species were identified. In Chichawatni (WS) and Lal Suhanra National Park 60 and 58 species were observed respectively. Only 35 species were observed in Shorkot irrigated plantation (WS). In the sub-mountainous tract, 38 species were observed in Kala Chitta Game Reserve (GR) Attock and 33 in Kathar

(GR). A variety of insect species were also noted during the study. It was observed that the forestry operations such as grass cutting, kana stubbing, and livestock grazing were major threats to wildlife. The forestry operations with the objective of wildlife management will be helpful for the conservation of diversified fauna.

Frisiana et.al (2001), studied the status of the Punjab Urial (*Ovis orientalis punjabiensis*) population. In Kalabagh, Salt Range of Punjab, there were 259 Urial observed during the survey as the total population. The following recommendations were made: (1) Urial population is viable for both population and genetic processes and sustainable use for trophy hunting quota of 5 rams from the class IV age group, could be established for the 2001 hunting season without a negative impact on the population; (2) an intensive survey using the protocol developed for this survey should be conducted during fall 2001 to establish the baseline for determining the population trend and future trophy hunting quotas and; (3) a detailed analysis of the Kalabagh Urial population habitat should be conducted. This should include the variety and extent of plant communities present, the diversity of plant species and ecological conditions of soils and vegetation. This is essential for determining the habitat carrying capacity of the Urial.

Combating desertification: Desertification is described as the “diminution or destruction of biological potential of land which can ultimately lead to desert like conditions”. It is an aspect of widespread deterioration of ecosystems with diminished or destroyed biological potential that is plant and animal production for multiple purposes, at a time when increased productivity is needed to support the growing population

Desertification contributes to other environmental crises such as the loss of biodiversity and global warming. The deterioration of productive ecosystems is an obvious and serious threat to human progress. Over exploitation gives rise to degradation to vegetation, soil and water. These three elements serve as the natural foundation for human existence. In exceptionally fragile ecosystems such as desert rangelands, the loss of biological productivity through the degradation of plant, animal, soil and water resources can easily become irreversible and permanently reduce their capacity to support life.

Pakistan is predominantly an arid and semi-arid country and majority of its people depend on these dry lands or the rangelands to support their livelihood mainly through agro-pastoral activities. Desertification is a serious phenomenon which is threatening the fragile arid land ecosystems and the people depending upon these resources. It will continue to degrade the biological activities in Pakistan if measures to combat it are not taken in time. The degradation in the environment of the country has occurred not only because of the world wide meteorological desertification phenomenon originating from air pollution, volcanic activity and solar variation but has been further intensified due to changes in the terrestrial geography of the Indus plains (Abbasi, 1990).

Like other provinces of Pakistan, arid and semi-arid rangelands in Punjab are severely affected by land degradation and desertification caused by overgrazing, unsustainable land management practices and increasing demand from natural resources. The people in their quest for food and livelihood pursue land management and cultivation practices that deplete soils of its nutrients, organic contents and promotes soil erosion, overgraze the rangelands, cut trees and bushes for fuel wood and other purposes. Land degradation is both a cause and a consequence of rural poverty. Therefore, desertification leads to poverty and poverty leads to further desertification. These are also causing enormous environmental problems, including degradation of rangeland ecosystem, loss of soil fertility, flash floods, loss of biodiversity, reduction in land productivity, soil erosion and many other associated problems.

Hussain and Irfan (2012) reported a study to combat desertification at Din Garh, Cholistan Desert and concluded that four tree species planted showed 75 percent as established and survived successfully. Another study was conducted in the Pothwar tract for gullied land management through soil conservation and water harvesting. The surface runoff was reduced 19 percent with an eyebrow land shaping technique. The growth rate of Luecaena tree species was best by 23 cm per month. Eucalyptus, popular, mulberry, guava, apricot, loquat and ailanthus were also planted productively.

Utilization is the proportion or degree of current year's forage production that is consumed or destroyed by animals (including insects). Utilization may refer either to a single plant species, a group of species, or the vegetation as a whole (Interagency Technical Reference, 1999). This definition is virtually identical to that of the SRM (Society for Range Management 1989), and is generally accepted by range professionals. Stoddert and Smith (1955) described range utilization as:

"Utilization of a range means the degree to which animals have consumed the usable forage production expressed in percentage. This production should be based on animal-months consumed compared to animal-months available when the range is correctly used. When dealing with an individual plant, however, utilization has a different usage and is defined as the degree to which animals have consumed the total current herbage production expressed as a percentage. These two uses are confusing and will require clarification whenever the term is used. It is suggested that range use might be a better term for the first meaning and percentage utilization better for the second meaning."

Grazing Patterns

In Punjab there are a number of different grazing patterns including traditional nomadic, semi-nomadic (transhumance) and sedentary. Nomadic grazing practices occur in the Thal, Cholistan and D.G.Khan areas i.e. in the more arid parts of the province. These systems are characterized by complexity, variability and uncertainty and therefore management options for them are not simple. In the arid rangelands people respond quickly to changing conditions, opportunities and challenges, practicing an opportunistic form of resource utilization.

Grazing patterns in desert ranges: In the desert rangelands the major forms of livestock include goats, sheep, cattle and camels. Despite adapted breeds, the economic condition of nomads is very poor. During droughts large numbers of animals die of thirst and starvation or are sold for a pittance during migration and the pastoralists have to start building their herds all over again. The livestock keepers appear to know the best places to move their livestock. They change locations when vegetation is depleted in a way that allows use of the marginal areas that would not normally be used, to meet different circumstances. Migration starts in winter towards irrigated crop lands and then animals are brought back to desert rangelands at the beginning of the monsoon. In the Punjab pastoralists are allowed to use most state owned rangelands at very low grazing fees, this has led towards an over-grazing problem developing in these areas. During the dry period high livestock concentrations near croplands also cause considerable degradation to village grazing areas; the village shamlats.

In the desert rangelands, especially in areas such as the Thal Desert, the opening up of new desert irrigation schemes from canal water has irrevocably changed the life of these pastoral communities (Iqbal, 1991). Their lives are also being affected in that they are beginning to receive increased market incentives to off-load their surplus livestock and also because increasingly crop farmers are not allowing them to bring their animals near crop land.

Areas such as D.G.Khan are on the receiving end of the nomadic movement of pastoralists, who move as they have for centuries from Balochistan and Afghanistan. During winter, these nomads pass through less productive more open rangelands in warmer lower lying areas where they may sometimes remain for few weeks at a time. The migration timing and route passage decisions must coincide with rainfall and vegetation growth to ensure their animals have food supplies during their passage. Their arrival in warmer crop growing areas is also related to the crop harvest time when the additional labour demand is very high and cheap agricultural by-products are also available and which are crucial to their livestock survival.

In the Cholistan Desert a form of transhumance is practiced, with livestock being taken out to desert rangelands for the monsoon period and then returning to their home village rangelands for winter. They can be allowed to wander quite freely over an extensive area as they always have to return to the same well.

Grazing pattern in Pothwar: There is transhumance of animals from the Pothwar in summer to higher ranges to the north then returning back to their home village ranges in the Pothwar. The Pothwar Plateau is also at the lower end of a sweep-through by nomads from Jammu &Kashmir in winter (Bakarwals) who return to the high areas of Jammu & Kashmir in summer. These Bakarwals enter Punjab through Jehlum, Chakwal and Attock District and move deep inside the province. They are generally constantly on the move never staying at any place for more than a few days. Their livestock mainly consists of goats and sheep which feed on the browse from scrub rangelands. The Government has attempted to control and regulate the movement of these nomads through the enforcement of such legislation as the Goat Restriction Act (1961) but it could not be implemented due to the pastoral livelihood of the people.

Grazing pattern in farmlands: Sedentary livestock occurs in agricultural farmlands of Punjab, i.e., villages in which agriculture crops are grown and animals get their feed from fallow lands and nearby rangeland. The supplementary raising of livestock may sometimes account for major portions of family income, especially for those families who concentrate particularly on livestock rearing rather than crop production. They are mainly to be found in the rain fed barani areas of the Pothwar Plateau, although other higher rainfall barani areas of the Punjab may be somewhat similar. Forms of sedentary pasture and zero grazing are most common in irrigation areas. The animals in these systems are always closely herded.

Rangelands: Current Formal and Informal Use

The introduction of appropriate measures to control grazing within the natural limits of the rangelands will be crucial in halting the degradation of rangelands. Protection from grazing is the cheapest means of range recovery and reclamation. It was seen from the experiment that protection from grazing alone has the potential to increase herbage biomass and ground cover. Most rangelands in Pakistan are overused due to certain practices, customs and problems. The rangelands in tribal or village property areas are not conducive to the regulation of proper grazing. Nomadic grazing also leads to over exploitation of their sources with little rehabilitation and regeneration efforts. The rapidly increasing demands for meat and livestock products and the resulting pressure on livestock production could cause enormous pressure on these rangelands and may result in more environmental degradation in the country, if science-based regeneration and rehabilitation measures are not adopted (Government of Pakistan, 2007). Rafi (1965) recommended a minimum period of five years of complete protection before initiating proper grazing management practices.

Mohammad (1986) reported that a one-year closure resulted in four times forage yields and reseeding increased the density of grasses by 15 percent, and increased plant cover by about 30 percent in alpine pastures of Pakistan. Heady and Child (1994) suggested that moderate intensities of grazing may be stimulatory and beneficial to the continued well-being of rangeland ecosystems.

Participatory management: Participatory management of the rangelands may be a better option as it is a situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, rights and responsibilities for a given territory, areas or set of natural resources.

Participatory management of the Public rangelands was practiced in the Pothwar and Thal zones of Punjab under a development project namely Social Range &Scrub Forest Management, a component of the Punjab Forest Sector Development Project (PFSDP) from the year 1995 to 2000. Under this project about 100 community organizations (CO) were established and range development interventions such as reseeding of native grasses, watering points and range management plan of each village were prepared in consultation with the local community. The communities were empowered for decision-making and overall development of their villages. It was the responsibility of the community to protect the seeded stands from uncontrolled grazing and adopt rotational grazing system for proper utilization of the range.

Efforts were made to improve public rangelands by understanding the existing range livestock production system, capacity building in participatory management concept of rangelands and involvement of all the stakeholders in the planning and implementation of the range management and improvement practices. Range herbage production was assessed to determine the productive potential of heavily grazed rangelands, by protecting the seeded areas from unscientific grazing. Fodder plants such as Iple Iple *(Leucaena leucocephala)* and Phulai *(Acacia modesta)* were also planted for establishment of forage reserve blocks for winter grazing. Forage production at community-protected seeded sites increased more than 10 times. The results indicated that improvement in community rangelands is possible, provided an integrated approach of range livestock management and improvement is made through community participation and collaboration of various stakeholders. These community organizations could not be sustained after the expiry of the gestation period of the project because there was no financial or technical back up to the communities.

Another successful model of participatory range management was developed in Mari Reserve Forest, Chakwal Range Management Division and Khushab Forest Division of Thal range under Sustainable Land Management (SLM) Project funded by the Ministry of Environment, Government of Pakistan. The project followed an integrated, cross-sectoral and participatory approach to combat desertification and poverty alleviation among rural communities to ensure cross-sectoral integration and sustainable benefits. It required a long-term commitment so this project was planned for implementation in two phases. Phase-I, which was implemented from the year 2008 to 2012, focused on creating an enabling environment, institutional strengthening, and mainstreaming SLM principles in land use planning and implementation of 9 pilot projects for promoting SLM practices for improving local livelihoods. The interventions identified through a consultative process in Punjab, Chakwal and Attock District were for integrated management of water resources and in Bhakkar District for poverty alleviation through soil conservation measures.

The project emphasized the adoption of appropriate technologies and management practices for integrated natural resource management, including testing and selection of drought resistant crops, adoption of an appropriate improved livestock production system, soil and water conservation measures, dry afforestation, developing cost effective agronomic practices and integrated pest management.

Trans-boundary grazing: In the province of Punjab, trans-boundary grazing mainly takes place in the Pothwar region. The graizers enter this region from Azad Jammu & Kashmir during the winter season. The main grazing areas are the adjoining districts of Chakwal, Jehlum, and Gujrat. The graziers also utilize the rangelands of Attock, Mianwali and Khushab Districts. In a few districts of the Cholistan desert, wildlife species of Chinkara, Blue bull and Blackbuck also cross the border from adjoining areas in India.

The graziers from other provinces also utilize the rangelands of Punjab. The nomadic graziers (Powindas) enter KPK and Balochistan to graze on the rangelands of Attock and D.G. Khan Districts respectively. Similarly the livestock graziers from the Federally Administrated Tribal Areas (FATA) enter Punjab from Dera Ismail Khan and graze on the rangelands of Thal during the winter season and move deep into the province.

The frequency and intensity of tran-boundry grazing is dependent upon climatic conditions, availability of forage and natural calamities. Therefore, all short-term efforts to enforce controlled grazing have failed, which led to the firm belief among administrators and planners that rangelands in tribal areas of Pakistan could not be scientifically managed (Ahmad and Khan, 1988).

Policy and Institutional Framework

National range policy: The Principles of the Policy as enumerated in Chapter 2, Sub-Section (1) of the 1973 Constitution of Pakistan are reproduced below:

“The Principles set out in this Chapter shall be known as the Principles of Policy, and it is the responsibility of each organ and authority of the State, and of each person performing functions on behalf of an organ or authority of the State, to act in accordance with those Principles in so far as they relate to the functions of the organ or authority”.

All policies of the Government draw strength and authority from these Principles of Policy as enshrined in the Constitution (Jan, 1992).

The purpose of a national Range policy is to enumerate basic principles and goals for the conservation and development of range resources in the country to meet social, economic and ecological needs. These needs could include high value range products meat, milk, and goods and services for the society and environmental benefits. The policy statement is necessary to:

1. Obtain maximum benefits from the range resources on a sustainable basis

2. Fix short and long term goals and identify strategies to achieve those goals
3. Promote and ensure cooperation between government and private agencies having land use responsibilities that affect rangeland activities directly or indirectly.

Rangelands play an important role in providing livelihood to the majority of the rural people, particularly to the poverty stricken communities of the society through rearing of animals and obtaining a variety of products and services. It also contributes to the ecological stability of the important ecosystems of the country. Therefore range policy must be guided and influenced by the social, economic and environmental needs of the country both present and past.

Review of past policy directives and recommendations: The necessity of having a national range policy leading to conservation, improvement and scientific management of rangelands has been recognized since independence in 1947. A review of the past policy directives and recommendations are set out as follows:

Resolution in 1955: A resolution was made by the Government of Pakistan in 1955 which stated that over the greater part of (West) Pakistan grazing was of prime importance and it required an important place in the forest policy of the country. The recommendations of this resolution included controlled land use under a coordinated program of soil conservation, land utilization enlisting public support for the execution of policy through education, awareness and demonstration and classification of state forest (cum range lands) on the basis of their utility and objectives. In addition organization of forest (cum range) research and education was stressed.

Policy Directive of 1962: The Ministry of Agriculture and works issued a policy directive in 1962 for management of rangelands in Pakistan. The salient features of the directive are as follows:

It is necessary to develop pilot projects for experimentation in the best methods of development of these areas. It was further directed that these pilot projects should be started in different social and ecological zones to permit establishment of working methods, which can be extended to larger areas. These pilot projects should also aim at finding out if possible the necessary provision of facilities in an area owned by a party or a whole tribe, to enable that tribe to lead a settled life and to prevent the over exploitation of the area. In view of the difficult nature of this work and the difficult terrain in which the people will have to operate, pilot projects should cater for distribution of Government land to private parties with different types of incentives such as tax free leases and provision of other leases.

The Government was aware of the fact that in many of these areas grazing and other rights belong to certain tribes. Therefore, they directed that some of the pilot projects should aim at the establishment of tribal ranges where the unity of the tribes may be maintained and facilities provided to the tribe as a whole.

The Provincial Governments should take decisions about the agency which is to be charged with the responsibility of developing this program. The Agricultural Development Corporations were charged with this in their charter. If their provincial Governments felt that it was not possible for them to make a start they may organize this program through a Board consisting of representatives from the Departments of Animal Husbandry, Forestry, Agriculture, Cooperatives and Revenue etc. It may be necessary to carry out a survey of record of rights in some range areas and the Government wished to reiterate that this work should be taken in hand as quickly as possible.

Recommendation of CENTO – 1964: CENTO emphasized the need of a range management policy for Pakistan in 1964. They recommended that the government should define the types of public lands that should be used for range purposes. They recommended restrictions on the conversion of rangelands, which are sub-marginal for agriculture, to agri-lands.

Range Management Conference – 1966: The First West Pakistan Range Management Conference was organized by the Pakistan Forest Institute (PFI) in 1966. The Conference recommended the formation of Grazing Advisory Committees, including representatives of the Public at provincial, divisional, and district levels, to lay down the outlines of a range management policy and program and to look for ways to implement these decisions. Unless a range management policy is framed by associating the representatives of the public, it would not be practicable in the field. The following recommendations were made:

1. Steps should be taken by the Forest Department to carry out a range survey for evaluation and condition classification to serve as a basis for Range Management Planning in Pakistan
2. Early steps are taken by the Soil Survey Project for Pakistan, to map soils in range areas with a view to producing accurate soil and vegetation maps for Pakistan
3. The Geological Survey of Pakistan, WAPDA, be urged to carry out a detailed survey of underground water resources in tracts as early as possible
4. Immediate steps are taken to carry out the census along with collection of other needed data about livestock dependent on range areas so as to ensure correct and scientific management of rangelands to specify the areas under control of the Forest Department
5. The settlement of rights of the local populations be carried out as soon as possible
6. A separate legislation be enacted to regulate management of range lands
7. Grazing advisory committees (including the representatives of public) be formed at Provincial, Divisional and District levels to lay down outlines of range policy and program and to look into the implementation of these decision
8. All the Government wastelands be transferred to the Forest Department in order to manage them under a proper scheme of Range Management
9. Forest Departments in their management plans and operations thereof should provide for the use of forests by the livestock of the adjoining village communities, to the permissible grazing capacity of the area
10. A separate Range Management Wing be created within the Forest Service and charged with the responsibility of Range Management Programs
11. Grazing associations be formed with powers and responsibilities for planning and implementing Range Management Programs at the village level
12. The curriculum of the College of Forestry be re-evaluated with the aim of bringing the curriculum into harmony with the current needs, that Range Management should be considered as equal to other major Forestry subjects and that provision be made for an adequate program in Range Management
13. The staff assigned to the Range Management job be given special additional emoluments
14. The Government be requested to provide the necessary facilities for accomplishment of range research and that personnel already trained in range management be assigned to the Forest Institute to implement the range research program

CENTO Recommendation – 1971: In 1971, CENTO especially invited the attention of the Government of Pakistan and stressed the urgent need for a national range management policy that should give full regard to the diversity of conditions in Pakistan. They emphasized the importance of the formulation and implementation of range management policies with a free and open-minded dialogue between government officers and livestock owners.

NRMC – Policy Guidelines, 1973: The Minister for Food, Agriculture and Under-developed Areas, Government of Pakistan, formed a National Range-Management Committee in 1973. The committee suggested the creation of independent and effective organizations at provincial as well as central level for the development and management of vast rangeland resources. They also recommended suitable economic incentives to enlist the people's cooperation and to encourage their participation in the range management program (Government of Pakistan, 1973).The following policy guidelines were recommended by the National Range Management Committee (Government of Pakistan, 1973):

1. All rangelands will be developed primarily for livestock production consistent with multiple land use concept
2. Indiscriminate and unscientific practices of shifting cultivation and breaking of rangelands for agriculture have proved unrewarding and do considerable harm by impoverishing the lands reducing their productivity for support of semi-arid zones and steep slopes
3. Regulated scientific methods would be adopted whereby fodder crops could be cultivated for supporting maximum number of livestock compatible with correct land use and relatively higher economic returns
4. To provide the required legal framework for support to Range Management Agencies and their programs, range legislation will be promulgated
5. To develop and manage vast rangeland resources, independent and effective organizations will be created at the provincial as well as central levels. These organizations will be responsible exclusively for planning, developing and implementation of range management schemes
6. To ensure co-operation by the people, their support and participation will be encouraged at all levels of project formulation and execution. Suitable technical as well as economic incentives will be provided to enlist their co-operation and to encourage participation in range management programs
7. To optimize economic returns from rangelands, efforts will be made to ensure proper feeding, management marketing and upgrading of livestock through selection and breeding
8. Preparation of livestock feeds from agro-industrial wastes and by products will be encouraged In order that overgrazing of the rangelands be eliminated or minimized, the surplus livestock should be utilized by creating facilities for maximizing the off-takes. This would require streamlining of management, marketing, processing and packing and even export of livestock/livestock products. Fattening yards or feed-lots will be organized
9. A balanced integration of rangelands, croplands and forestlands is imperative to ensure yearlong optimum provision of forage and fodder to livestock
10. Scientific range management will result in the economic improvement of stockmen. Range development programs will be divested of considerations that have hitherto been concerned with projects with negative results and direct financial returns to the state.

Sub Committee on Range Management- 1983: In 1983, the Minister for Food, Agriculture and Cooperatives, Government of Pakistan, convened an inter-provincial meeting of the range and livestock experts. On their recommendation, the Government of Pakistan constituted a "Sub-Committee on Range-Management" to streamline the institutional arrangements and to determine the guidelines for the formulation of a strategy for range development in the country. The experts reviewed various constraints, including, technical, institutional, social and economic. They endorsed in principle the comprehensive recommendations of the National Range Management Committee (1973) and urged for their immediate implementation. They also recommended the post of Range-Development Commissioner along with the necessary technical and secretarial staff to be immediately created in the Food and Agriculture Division, of the Ministry of Food, Agriculture and Cooperatives. A National Range Development Board for policy making, inter-provincial coordination and review of programs was suggested under the chairmanship of the Federal Minister for Food, Agriculture and Cooperatives. Similarly, independent organizations under the relevant administrative secretaries of the provincial governments were recommended. They also urged the recognition of range-management as a distinct land-use as well as a separate sector or a sub-sector for budget allocation (GOP, 1983).

Pakistan Forest Policy-1991: In 1991, the Pakistan Forest Policy recommended stall-feeding of livestock as a replacement for rangeland grazing. According to their policy, more fodder from the farms and feed from the agro-industrial wastes should be produced and grazing allotments should be created on an experimental basi, and legislation should be introduced to support range management agencies.

Driving forces in formulation of range policy: The main driving forces that have affected the range sector in the past, and are likely to affect it in the future are complex and inter-related. For example, changes in income can lead to changes in demand that are then amplified by changes in government policies. The driving forces in the rangeland sector may be described as follows:

Exogenous factors: The main exogenous factors affecting the range sector are socio-economic developments (e.g. changes in population and income) and changes in environmental factors. Traditionally, most analyses, trends and outlook for the range sector tended to focus almost exclusively on economic variables particularly contribution in the GDP and GNP. However, changes in other variables can also have a more subtle effect on the sector.

Population: Changes in population affect the rangeland sector in several ways. On the demand-side the increase in the population of Punjab at a rate of 2.64 percent (BOS, 2012) is resulting in expanding markets for range products and services. On the supply-side greater competition for land (for a variety of alternative uses) is created that also leads to an increasing workforce for the range sector to supplement the low employment rate of Punjab i.e. 6.8 percent. In addition to total population, another factor that influences the demand for land is the location where people choose to work and live. The urban population of Punjab has increased from 24.704 to 30.844 million from the year 2000 to 2012. Increasing trends in urbanization result in a decrease in availability of the work force in the rural areas for the range sector. Another important population variable that affects the range sector is the age-structure of the population. This affects the demand for range products and services because income levels and consumer preferences change, as people get older. The population of Punjab between 50 and 65 years of age is 5.772 million. However, a more important effect of the changing population age-structure is likely to be the effect that this will have on the young and efficient workforce for the range sector services that constitutes about 40 percent of the total population of Punjab. It may result in some upward pressure on labour costs but it is also likely to lead to a further increase in the mechanization of range operations. The value addition will be an increase in the need for investment in machinery and training of human resource in the rural areas.

Income: Economic growth is probably the most important factor that influences the outlook for the range sector in Punjab and will lead to increased trade, investment and a rise in personal incomes resulting in stronger growth in demand for all range products and services. However, it may also have a detrimental effect on range resources if demands exceed the biological capacity of rangelands. Most official forecasts of economic growth for the province of Punjab only cover the next five to ten years. It is desirable that an analysis of historical perspectives of economic growth also be conducted for range sector services from the four range zones of Punjab, as it is a long-term investment on a highly degraded land and will impact the diversity of income generation.

Accessibility to rangelands: The accessibility of rangelands in Punjab is another factor that has increased due to the extended road network and this is likely to increase in the future. People have legal rights of access to much of the rangeland as recorded in the Register of Rights, Revenue Record. In addition to this, socio-economic trends have also increased the ability of people to access range areas for a variety of purposes. This increase has occurred due to a combination of factors, such as:

1. Increased leisure time (e.g. shorter working hours and longer holidays
2. The most obvious effect of these trends will be an increase in the use of rangelands for leisure and recreation in the future, such as desert safaries in Cholistan
3. Improved rural infrastructure (e.g. improved road networks, accommodation, etc)
4. Increased means of transportation.

The improved rural infrastructure and transportation facilities in Punjab have resulted in an increase in the number of people working in urban areas but choosing to live in the countryside where the living environment is better. This will reinforce the gradual shift towards greater demand for range products and services in the rural areas.

Environmental factors: Environmental factors encompass a number of climatic, biological and geographical factors that affect rangelands. Changes in some of these factors are short-term and occur infrequently and erratically. For example, short-term variations in climate can lead to a sudden change in damage to range vegetation from drought, floods, fires, storms and outbreaks of pests and diseases. The occurrence of flash floods during 2010 brought an influx of graziers in the Thal and D.G. Khan range zones. During the drought season, livestock in Thakparkar Desert moves to Cholistan and southern Punjab.

In the case of these short-term environmental factors, it is very difficult to analyse trends or to produce projections on how they might affect range resources in the future. The precautionary principle would suggest that individuals in the range sector should continue to monitor their effects and investigate options for reducing their impact on range resources in the future. In addition to the short-term environmental factors discussed above, there are also some environmental factors that have changed more gradually and are likely to have more of a long-term impact on range resources. The most prominent is change in the growth rate of range resources. Climate change has affected growth rates and altered the optimal locations for growing different range species. The existence of a few of the endemic species has become threatened due to climatic impact, Including Salvodora, Prosopis cineraria, and others.

The extent and likely impact of future climate change is still a subject of intense scientific debate. However, the changes that may occur are likely to be very gradual and appear over several decades.

Therefore, it does not seem likely that global climate change will have a significant impact on the range sector abruptly.

Demands of society: The demand for range products is probably still the most important factor for the inhabitants of Punjab. It is certainly the most important demand in terms of income for the livestock owner. A total of Rs. 1.74 billion was contributed to the economy of the Punjab by livestock, from high value range products such as meat, milk, wool etc. Historical changes in this demand have to be examined for market trends and based on this analysis, future projections for range products markets have to be produced. The two important changes in demand that may affect range products markets are changes in human needs and industrial demand for range products, such as dairy products, leather goods, woollen hosiery and other items.

Institutional Framework:

The institutional framework of rangeland management is described in this section of the document

Background: The underlying forces that have affected the sector in the past and will do so in the future are strongly linked to changes in government policies and market frameworks. The policies that affect the range sector are not only the policies specifically designed for the sector but also policies in other sectors, such as: forest, energy, environment, trade and agriculture. Often these "external" policies have cross-sectoral impacts (i.e. they lead to unintended or unexpected consequences outside the sectors where they have been implemented). The range sector is relatively small in size compared with some of the huge policy initiatives in other sectors (e.g. education, health, trade and commerce and agriculture policies).

The interactions between different policies are often complex and difficult to understand. This is because different policies often have different (and possibly conflicting) objectives. Furthermore, they may cover different geographical locations and they may be implemented with little co-ordination. They may also have unexpected or unintended impacts on markets. These complexities make it difficult to analyze the full range of policies that could have an effect on the range sector. However, it is important to attempt to understand some of these forces, as they present both challenges and opportunities for the range sector in future. Primarily, the range sector policy may be impacted by the following five main scenarios:

Greater emphasis on biodiversity and nature conservation: The importance of biodiversity and nature conservation in Punjab has already been described in various sections of this report. In order to sustain and enhance these values, most governments have implemented a variety of biodiversity and nature conservation policies over the last few decades. In particular, governments have made specific commitments to enhance biodiversity and nature conservation in several international policy processes, such as the Convention on Biological Diversity. The level of commitment by the Government of Punjab has also increased subsequent to the enactment of the 18th Constitutional Amendment to the Constitution of Pakistan.

The Rules of Business for the Forestry, Environment and Agriculture sectors have been amended to strengthen their commitment towards implementation of international agreements in conservation of nature and biodiversity. While there is general agreement about the objectives of these policies, some conflicts have arisen about their implementation. In particular, concerns have been expressed in some parts of the range sector about the economic consequences of such policies, which tend to reduce livestock population and increase wildlife and range vegetation. The population of Black Buck and Chinkara will have to be increased and reduction in livestock population will be compromised in Lal Sohanra National Park if provisions of CBD are to be strictly implemented. The following three policy directions may be considered for the future, which would probably be supported by a variety of activities and policy measures.

More emphasis on nature conservation and the promotion of biological diversity of range ecosystems: This trend would include increases in the area of range protected for nature conservation and a reduction of harvesting in such areas. Ecological networks (e.g. core areas, corridors, buffer areas and restoration areas) would be expanded. Diversification of species composition and structure of ecological communities in range would also occur. It would be preferable if each range zone is divided on the basis of natural factors that signify different regions such as Urial and Chinkara in Pothwar range tract.

More emphasis on nature-oriented range management: This trend would include eliminating or reducing free grazing and replacing this with more selective range vegetation harvesting, preferably with the specialized grazing systems particularly in the Cholistan range zone. It would also include regenerating range areas with endemic and indigenous species, especially in high potential rangelands of the Pothwar tract.

Increasing demand for certification of range management and range products: This would include increased certification of range management activities such as use of certified seed, internationally recognized grazing systems, etc. and high value range products.

Forest, agricultural, rural and regional development policies: The policy trends and recommendations related to range sector have already been described in a previous para of this report. It explicitly described how forest, agriculture and land-use change has strongly influenced government policies during the last six decades and that also impacted the rangelands of Punjab. In the past, forest and agricultural policies formulated in Punjab have largely been implemented in isolation, leading to various negative cross-sectoral impacts. It was increasingly evident that policy makers wish to consider forestry and agriculture together within the broader context of rural development.

The main objective of rural development policy in Punjab is to protect the rural population, economy, and landscape from multiple threats posed by an increasingly urban society that has a minimal understanding of (or sympathy for) rural concerns. An example is that of the Goat Act of 1961 that emphasized restricting the grazing of goats in forest areas without realizing that the animal is of significant importance in the pastoral economy of rural areas. It would be naïve to enact such acts that have consequences towards the rural economy. A strong political will to modify forest and agriculture policies of Punjab is required, to move away from measures that have stimulated forest and agricultural production instead of focusing on improvement of rangelands as sources of feed for the increasing livestock population. The following future policy directions and possible supporting measures may be considered:

- Incentives for social and environmental benefits from rangelands and range products use. This would include economic incentives for rangeland protection and production of range services to convert them into nature conservation areas. The graziers of Cholistan may be encouraged to support trophy hunting of wildlife species like Chinkara and Black Buck as a sustainable use initiative.

- Changes in forest, agricultural, rural and regional development policies. This would include changes in the subsidies for forest, agricultural production and exports, to cover range rehabilitation activities (e.g. range reseeding, animal health improvement).

Conclusions and Recommendations

Conclusions: The process of transition from federally planned to provincial market economies after the 18th Amendment has been the most profound social and economic structural change in Punjab in the recent past. The following future policy directions may be considered:

- Strengthened policies to develop the market framework in Punjab. This would include the changes in rangeland ownership for production of range resources and products. An initiative will be to standardize the sale of livestock in local markets. Furthermore, the collection of milk and other dairy products would also be required to be certified according to international standards.

- Increase stakeholders. This would result in accelerated enlargement of the resource producers and users at local level. It would include the increased role of livestock owners, buyers, wildlife experts, vegetation producers, veterinarians, etc.

Scenarios are used to bring together a package of future trends and choices that will tend to improve the range sector. For example, trends towards a greater emphasis on the environment could be amplified by policy changes in support of environmental objectives. They may also result in changes in the market, such as changes to range product prices and investment in alternative technologies. A brief description of these three alternative scenarios is given below:

Baseline scenario: The baseline scenario assumes that the long-term historical relationships in range product markets will remain the same in the future. It assumes that population and economic growth will follow the baseline projections. It should be mentioned that the last population census of Punjab was conducted in 1998 and the trend devised at that stage is being projected in all policy and developmental perspectives until now. Similarly, it will be presumed that same trend will persist regarding livestock population, availability of range land, and consumption of range products shall remain consistent. The livestock population increased 3 percent annually during the last three years in the province of Punjab and the same trend will continue in the future as well.

Conservation Scenario: The conservation scenario assumes that there will be a major shift towards environmental enhancement and conservation of range resources in the future. This will be driven by an increase in public awareness, demand for environmental benefits and supported by policies that will move society towards conservation issues related to rangelands. The existence of Kalar Kahar, Khabbaki and Uchali lakes in Soan valley of the Pothwar range zone, creates awareness about the rangelands that exist in the catchment areas of these lakes and symbolizes the environmental benefits accrued from range resources.

Integration scenario: This scenario assumes that there will be more rapid economic integration and market liberalization in future. This will result in higher economic growth resulting in higher economic growth projections. It also assumes that integration will encompass some of the trends internationally. The implications of WTO will also affect the export and import of rangeland products of Punjab.

Recommendations: This section deals with the recommendations of experts for the improvement of sustainable rangeland management.

1. Need for policies to stimulate the sound use of Range products (Governments, Industries, Range owners):
   - Range vegetation is an ecologically friendly and renewable resource; Governments and institutions should develop a policy and legislative framework to support and promote the sound use of rangelands as an integral part of overall sustainable development considering long-term sustainable development of the resources
   - All major range sector stakeholders should identify and implement new financial mechanisms to support these actions
   - Policies and resources should be devoted to stimulating and facilitating the creation of multi-stakeholder partnerships to promote the sound use of rangelands
   - Procurement policies for range products must encourage the sustainable management of rangelands and vegetation
   - Governments should provide information and promote the use of, environmentally friendly consumer products and encourage research into the sound and innovative use of rangeland resources and take this information into account when formulating policy.
2. Urgent need to address threats to sustainability (Governments, Donors):
   - Although the ecological conditions in most of the rangelands of Punjab have remained consistent over the past five decades, it is clear that poverty, civil disturbance or war on terror, combined with weak institutions, have put a few of the rangelands in an unsustainable situation with over-exploitation of range resources, erosion and even desertification. Sufficient political priority to range issues is required in the development programs of such volatile areas.
3. Need to devote policy attention to the consequences of the dynamic developments (Governments):
   - The depth and duration of these developments will depend on the level of investment in the range sector. Further policy analysis is needed to assist with the sustainable development of range sector and to avoid any undesirable outcomes
   - Government and other stakeholders in the province need to be adequately involved in the policy dialogue
   - Mutual economic opportunities and challenges should be analyzed more consistently in order to provide a basis for reliable strategic decision-making
4. Improve the economic viability of range management (Governments, Livestock industry, Research Institutions).

   There is a significant structural threat to the economic viability of range management, arising from falling revenues from sales of range products, constantly rising management costs, and the inability to transform the multiple services provided by the rangelands into secure revenue streams. A series of policy measures may be considered for implementation:

- Support sound enabling conditions for sustainable range management that encourage investment and economic activity in the range sector
- Promote the use of range products from sustainably managed rangelands
- Work towards common approaches to the practical application of the valuation of the full range of goods and services provided by rangelands
- Enhance the competitiveness of the range sector by promoting innovation and entrepreneurship among all relevant stakeholders
- Support research as well as mechanisms for the dissemination of generated knowledge
- Enhance the quality of education, training, extension and skills
- Strengthen the support of institutions concerned with workforce safety and education, as well as related research
- Enhance inter-sectoral co-ordination and collaboration; promote the incorporation of sustainable range management into rural development policies and strategies
- Promote the use of innovative economic instruments for achieving range related goals and targets
- Promote the development and encourage the participation of associations of range and livestock owners.

5. Rangeland Management and Climate Change (Government, Research institutions):

   - Given the complexities of the climate change policy and the potential for significant change in the range sector, institutions should be proactive in analyzing the consequences of climate change policy decisions for the sector and urgently take measures to reconcile provisions of climate and energy policies, strategies and commitments with national rangeland programs.

6. Law enforcement and governance (Governments, all stakeholders):

   - Inadequate law enforcement and governance poses a threat to rangelands. It has a negative impact on economic development as taxes are not provided to the public budgets. Government should ensure that domestic law enforcement and governance are at an acceptable level.

7. Monitoring environmental and social benefits from rangelands and range management (Governments, International Organizations, Research Institutions:

   - Although the importance of environmental and social benefits of the rangelands is widely recognized, there is still little reliable quantitative and policy relevant data available to policy makers. If trends are to be monitored and the correct decisions taken, there is a need for a continuing monitoring network for parameters related to sustainable rangeland management.

8. Necessity of a cross-sectoral approach (Governments, all stakeholders)

   - The sector stakeholders should intensify the policy dialogue, proactively drawing the attention of other policy areas such as forest, agriculture, trade, environment and energy, to the social and environmental benefits of sustainable range management, as one component of the overall sustainable development of society

- The policy dialogue between the range sector and other parts of society, should be strengthened by organizing various forums (e.g. “Round tables”), with representatives of all stakeholder groups.

9. Employment and the work force (Governments, Employers, unions):

- The continued decline in employment in the sector will further reduce the visibility of the sector and partly its direct benefits to society. Rural livelihoods will be most affected as the losses are concentrated in small firms in the other sub-sectors. If the range industry is to make a contribution to rural development, growth patterns need to be reviewed and altered. Small enterprise development is required at rural level.

10. The range sector in the global context (all stakeholders):

- In a period of general globalization of companies, NGOs, economic, social and environmental agreements and processes, one of the principal questions is: How can range policy-making still focused at the national level respond to the changing global environment benefits of sustainable rang management, as one component of the overall sustainable development of society.

KHYBER PAKHTUNKHWA & FATA

PROVINCIAL REPORT

Khyber Pakhtunkhwa (KP), and Federally Administered Tribal Areas (FATA)

Background

Khyber Pakhtunkhwa (KPK) and the Federally Administered Tribal Areas (FATA) have different topographic rangeland areas and diversified ecosystems. The main categories are alpine pastures, Trans-Himalayan grazing land, Himalayan grazing land and arid/semi-arid grazing lands. It is noteworthy that rangelands provide forage, water, tourism opportunities, wildlife, medicinal plants, biodiversity, fuel wood, and carbon stock in Khyber Pakhtunkhwa and FATA.

Lack of rangeland management policies, low prioritization by the Forest Department, land tenure (owners versus users), non-uniform grazing, accelerated soil erosion, spread of weeds and poisonous plants and conversion of rangelands into agricultural land, are some of the major issues which have a negative impact on rangeland management. Recommendations for KP and FATA included a proper survey and geographic position system mapping, preparation of an integrated management plan, mapping of land use, and conducting an awareness and advocacy program especially for the nomad community and users, in order to improve rangelands of the province. In Khyber Pakhtunkhwa, 4.639 million hectares is under rangeland and pastures, which constitutes more than 50 percent area of the province.

Table 26: Area of rangelands in Pakistan (million hectares)

Province	Total area	Rangeland area	Percentage of provincial area
Balochistan	34.7	27.4	79
Sind	14.1	7.8	55
Punjab	20.6	8.2	40
Khyber Pakhtunkhwa (including FATA)	10.2	6.1	60
Gilgit Baltistan	7.0	2.1	30
Azad Jammu and Kashmir	1.3	0.6	45
Total	88.0	52.2	51

(Source: NCA 1988, and FSMP, 1991)

Unfortunately, at present the range management sector especially in Khyber Pakhtunkhwa and FATA is not getting its fair share in the development programme. The focus of the Livestock Department is only on livestock health and breeding. Fodder production activity is very limited and mostly confined to the official livestock farms. Nomads and herdsmen are not benefiting from their program, except at the health centers where treatment is provided to ailing animals. In FATA the range and pasture resources amount to about 1.4 million hectares. (Table 26).

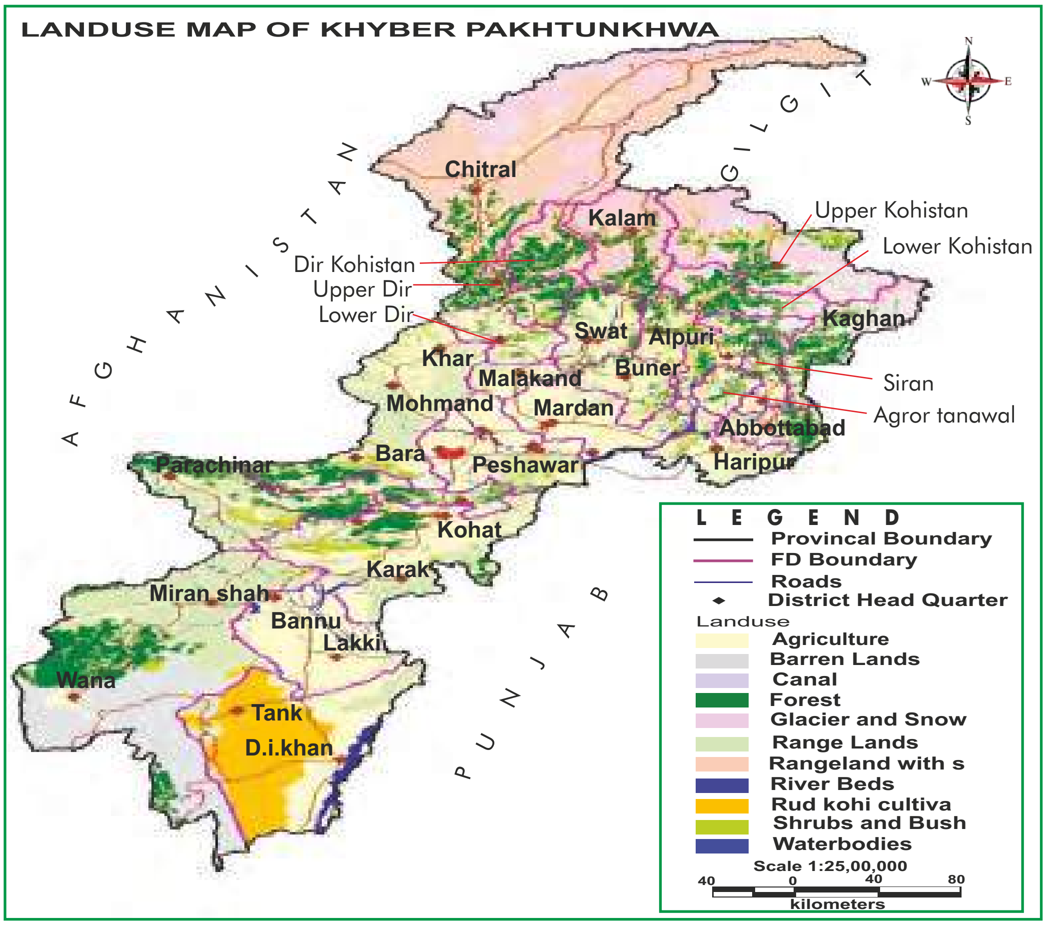
Rangeland Resource of KP and FATA

Khyber Pakhtunkhwa: Table 27 below indicates that the area classified as rangeland in KPK is 48 percent. Forest areas and other waste lands used for grazing, grass and fodder cutting account for a major portion of required fodder. Therefore, rangelands cannot be considered as the only source of fodder. Figure 24 describe the land use in KP.

Table 27: Land use statistics of KPK

S. No.	Land Use Class.	Area (Million he)	% age.
1.	Agriculture	1.5459	15.0
2.	Forests / Trees	1.6835	17.4
3.	Range Lands	4.8887	48.0
4.	Others	2.0478	19.6
	Total	10.1659	100

Figure 24: Landuse map of KPK



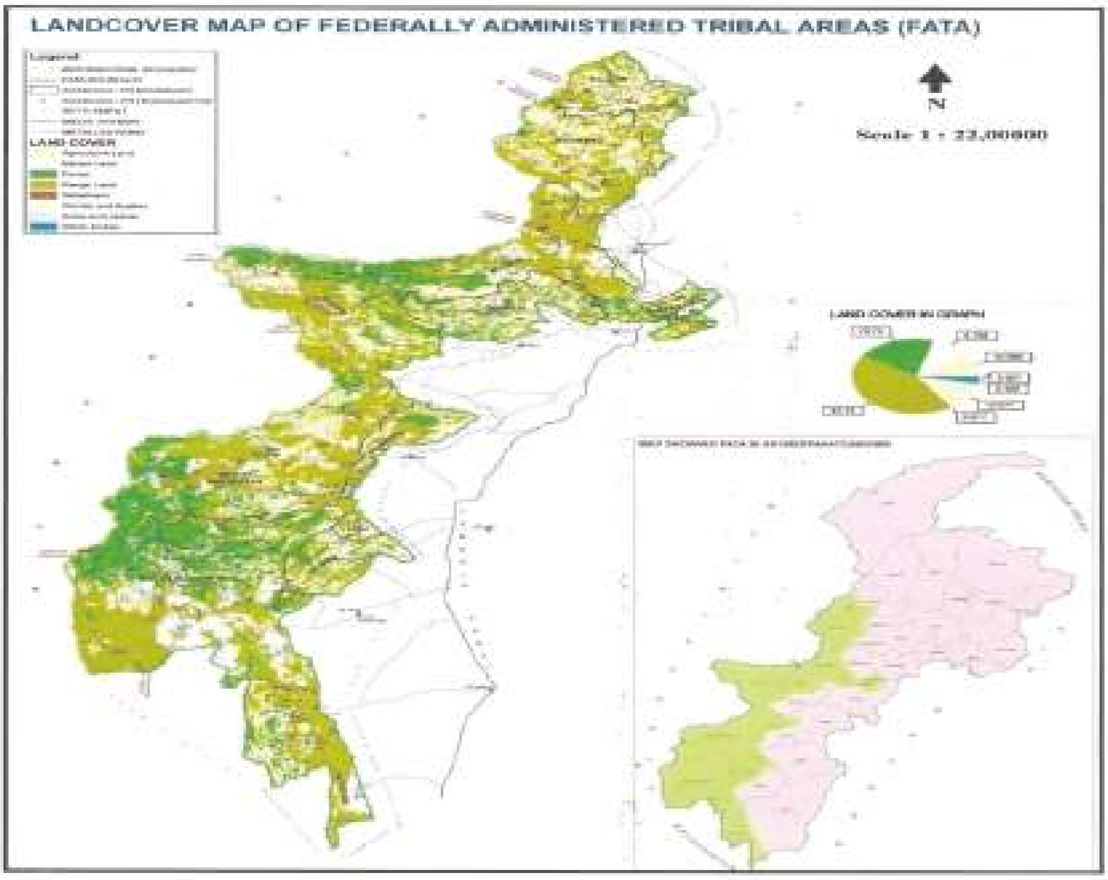
Federally Administered Tribal Areas: Forest areas, as well as rangelands in FATA are communal lands. The entire local population has equal rights of grazing, cutting grass and firewood and collection of minor forest produce. These tribal communities have a strong social system, known as the "Jirga". This Jirga has the power to decide all local issues and make decisions in the best interests of the community. Their decision is final and the local implement it in letter and spirit. These communities sometime impose ban on forest harvesting and grazing to provide protection to natural regeneration.Detail of landcover in FATA are available in Figure 25 and Table 28.

Table 28: Land cover statistics of FATA-2012 (Area in hectares with % in parentheses)

S.No.	Name of Agency	Total Area	Agriculture	Forests	Rangeland
1.	Bajawar	137,401 (100)	45,037 (32.8)	10,188 (7.4)	569,892 (50.9)
2.	Mahmand	226,115 (100)	65,574 (29.0)	7,495 (3.3)	141,051 (62.3)
3.	Khyber	282,732 (100)	38,550 (13.6)	50,690 (17.9)	159,924 (56.6)
4.	Orakzai	136,679 (100)	25,208 (18.4)	30,929 (22.6)	60,572 (44.3)

(Total area includes water bodies and habitations which are not tabulated above).

Figure 25: Land cover map of FATA



These pastures and rangelands are a source of forage for free ranging, native and domestic animals. It is also a source of wood products, water and wildlife. Rangelands play a significant role in providing livelihood of poor and disadvantaged people by supporting their livestock. In addition these ranges play a key role in enhancing the infiltration process, leading to sustainable water flow down streams.

Livestock Population of KPK and FATA

Khyber Pakhtunkhwa: In Khyber Pakhtunkhwa, the total projected livestock population in 2012 was 25.950 million (Table 29). More than 60 percent of the total required forage is obtained from range and pasture resources. Due to the large number of animals and its importance to livelihoods, livestock has emerged as a leading sub-sector of the agriculture sector in the province.

Table 29 : Livestock position in KPK (2006 & 2012)(Projected @ 2.8 % annual increase)

S.No	Type.	Year 2006 (No. in Million).	Year 2011 (No. in Million).
1	Cattle	5.97	7.160
2	Buffaloes	1.93	2.320
3	Sheep	3.36	4.030
4	Goats	9.60	11.520
5	Camels	0.064	0.077
6	Horses	0.076	0.091
7	Mules	0.067	0.080
8	Asses	0.560	0.672
	Total	21.624	25.950

Federally Administered Tribal Areas: In FATA the total number of livestock is 6.4 million, the detailed breakdown is provided in Table 30.
There are 3.18 million goats (49.2 percent) while the second category of sheep falls at 23.5 percent. The type of livestock composition indicates a dry arid zone where goat and sheep are most suited to survive. Due to its proximity to Afghanistan, the FATA rangelands are also utilized by nomadic grazers.

Table 30: Agency / Frontior Regions wise livestock data of FATA

Area	Cattle	Buffalo	Sheep	Goats	Camels	Horses	Mules	Asses	Total
Bajawar	132274	15207	53025	173358	417	50	129	4407	378867
Mahmand	232544	3439	133887	378245	431	221	454	18178	767399
Khyber	155817	10274	190478	529147	826	15092	28216	31448	961298
Kurram	121457	3171	76698	113588	47	673	901	3966	320501
Orakzai	64336	12979	48202	107932	250	190	277	13390	247556
N.Waziristan	210480	18716	233561	263979	2746	1080	436	16826	747824
S.Waziristan	134611	14677	313639	399137	9356	314	1416	23022	896172
FR Peshawar	22803	345	24477	115838	236	79	-	2097	165875
FR Kohat	16367	261	6970	52457	41	-	24	252	76372
FR Bannu	97429	11522	128448	639587	910	53	39	5055	883043
FR D I Khan	104509	373	167838	199095	2086	63	24	4498	478486
FR Lakky	64921	-	39421	105579	467	18	9	1863	212278
Tank	104330	856	107443	110207	3970	73	33	6147	333059
Total.	1461878	91820	1524087	3188149	21783	17906	31958	131149	6468730
Percentage	22.60	1.42	23.56	49.29	0.34	0.28	0.49	2.02	100

(Source: Livestock department FATA)

Range Types in Khyber Pakhtunkhwa

Alpine pastures: These areas are above 3000 meters and below the zone of perpetual snow. They are above the timber line and receive the maximum winter precipitation in the form of snow which stays for a longer period of time, often as long as June in some high altitude areas with a northern aspect. The growing period is very short. Alpine areas are characterized by a short, cool growing season and long cold winters. The vegetation is mostly slow growing perennials, herbaceous and shrubby vascular plants with extensive mosses and lichens. Much of the landscape is rugged and broken with rocky, snow capped peaks, cliffs and slopes. However large chunks with sloping to plain topography also exist, and are of paramount importance to tourism, they provide several scenic camping sites for the tourists. Champion et al. (1965) classified alpine vegetation into the following three major types:

Alpine Scrub Type consisting of moist deciduous alpine scrub, dry zone alpine scrub, moist alpine pasture, dry alpine plateau pastures, dwarf juniper scrub and dwarf Rhododendron scrub forests

Moist Alpine Scrub comprises dry alpine scrub and moist alpine scrub

Alpine forests contain alpine fir birch forests, Rhododendron species and high level blue pine forests.

Hussain (1968) recorded the following type of vegetation in this zone covering trees/shrubs, grasses and forbs:

Trees and Shrubs: - *Juniper communis*, *Rosa webbiana*, *Berberis lycium*, *Berberis spp*; and *Cotonneeaster spp*.

Grasses:

- *Phleum alpinum,*
- *Trisetum spp,*
- *Agropyron dentatum*
- *Festuca ovina,*
- *Dactylis glomerata*
- *P. filaccidum,*
- *Clamagrostis pseudopharagmites*
- *Oryzopsis spp;*
- *Carex spp.*
- *Agrostis gigantean,*
- *Poa spp.*
- *A. caninum.*
- *Alopecurus gigantean.*
- *Pennisetum lanatum.*

Forbs:	- *Plantago ovata,*	- *P. major.*
	- *P. lanceolata.*	- *Trifolium pretense.*
	- *T. repens.*	- *Fragaria vesca*
	- *Medicago spp.*	- *Potentilla spp.*
	- *Rumex nepalensis.*	- *Polygonum alpinum.*
	- *Anaphalis contorta.*	- *Thymus serphyllum.*
	- *Astragalus spp.*	- *Taraxicum officinalis.*
	- *Iris hookriana.*	- *Nepata spicata.*
	- *Saxifraga jacquemontiana.*	

These areas are used for grazing mostly by nomads from the lower areas and the villages at the bottom of the valleys. The majority of these areas are communal and they are rarely individually owned. They are rich in palatable as well non-palatable and toxic species. These alpine pastures are found in Mansehra, Batagram, Kohistan, Shangla, Swat, Upper Dir and Chitral Districts of KPK.

Sub-alpine pastures:. These sub-alpine pastures are situated in Mansehra, Batagram, Kohistan, Swat, Upper Dir and Chitral districts. The sub-alpine zone receives maximum snowfall which stays for a longer period of time and is a source of permenant water supply for the streams and springs. The area is also rich in medicinal herbs, which provide an additional source of income for the nomads who collect and sell these plants to local shopkeepers at low rates. They, in turn, sell the stock to the main dealers in major towns like Mingora, Dir, Chitral and Balakot. Fodder growing in this zone consists of perennial forbs and grasses belonging to the *genera Poa*, *Festuca*, *Stipa* and *Agropyron.*

Trans-Himalayan grazing lands: Trans-Himalayan grazing lands are spread over the northern mountains in Swat, Dir and Chitral. The region consists of a series of high mountain ranges of Karakoram, Hindu Kush and Pamir. The altitude varies from 1500 to 8600 meters. Due to an unstable terrain, land sliding is a common phenomenon. The climate of the area is that of mountain deserts with cold winters and harsh dry summers. The area between 2300 and 3300 meters receives sufficient snow because of temperate climate. Areas above 3300 m are extremely cold with a limited growing season. Rainfall occurs only in winter and early spring, averaging 100 - 300 mm. The following plants grow in the area:

Trees and Shrubs:	- *Juniperus macropoda.*	- *Quercus ilex.*
	- *Pinus girardiana.*	- *P. wallichiana.*
	- *Cedrus deodara.*	- *Fraxinus xanthoxyloides.*
	- *Artemisia maritime.*	- *A. sacrorum.*
	- *Indegofera spp.*	- *Ephedra spp.*
	- *Daphne oleoides.*	- *Sophora spp.*
	- *Cotonneeaster spp.*	- *Parrotia jacquemontiana.*
	- *Salix spp.*	- *Jasminum spp.*
	- *Sorbaria tomentosa.*	- *Caragana spp.*
Grasses:	- *Chrysopogon spp.*	- *Cymbopogon spp.*
	- *Dichanthium annnulatum.*	- *Pennisetum orientale.*
	- *Aristida spp.*	- *Oryzopsis spp.*
	- *Poa spp.*	- *Bromus inermis.*

	- *Agropyron dentatum.*	- *A. caninum.*
	- *Agrostis spp.*	- *Dactylis glomerata.*
	-*Rottboellia exaltata.*	- *Phacelurus speciosus.*
	- *Eragraostis spp.*	
Forbs:	- *Iris spp.*	- *Tulip spp.*
	- *Polygonum spp.*	- *Astragalus spp.*
	- *Sambucus ebulus.*	- *Lotus cornicultatus.*
	- *Medicago spp.*	- *Plantago lanceolata.*
	- *Lathyrus spp.*	- *Thymus serphyllum.*
	- *Nepata spicata.*	- *Viola spp.*
	- *Taraxicum officinalis.*	- *Ferns.*

Himalayan forest grazing lands: Himalayan forest grazing lands cover Siran, Gallies and Kaghan Valley in Hazara. Ecologically these areas are sub-divided into the following two categories:

Moist temperate: the moist temperate (wet temperate) zone occupies areas from 2000 m up to the timber line. The zone is covered with Deodar, Blue Pine, Fir and Spruce, with thick under growth. Snowfall ranges from 3 - 4 m. This snow is a source of regular supply of water to the rivers, Daur, Siran and Kunhar. Major Grass spp; are: *Agrostis gigantean, Poa alpine, Plantago ovate, Trifolium repens,* and *Taraxacum officinale.*

Sub tropical humid zone: Sub-tropical humid zone falls within the elevation of 1000 - 2000 m. The major tree species is Chir pine but Blue pine is also found in the upper reaches and on cooler aspects. Rainfall in this zone is above 1000 mm. Prominent grass spp are*; Imperata cylindrical, Themeda anathera* and Thymus spp.

Local communities carry out burning of grasses in the months of May and June, before the onset of the monsoon, to achieve the maximum production of grass for storage and stall feeding in the months of October and November, just before to winter. However, careless burning sometimes results in uncontrolled forest fires causing huge losses to regeneration and the young pole crop which is highly sensitive to fire and extreme temperatures.

Champion et al (1965), Hussain (1968), Khan (1971), and Mohammad (1987) reported the following vegetation types in Trans Himalayan grazing lands:

Shrubs:	- Vibernum nervosum.	- Indegofera spp.
	- *Rosa webbiana.*	- *Salix spp.*
	- *Cotonneeaster spp.*	- *Pistacia spp.*
	- *Berberis lyceum.*	- *Prunus cornata.*
	- *Rhododendron arboretum.*	- *Sarcococca saligna.*
	- *Rubs spp.*	- *Desmodium spp.*
	- *Strobilanthus spp.*	
Grasses:	- *Dictylas glomerata.*	- *Agropyron dentatum.*
	- *Phacelurus speciosus.*	- *Rottboellia exalatata.*
	- *Alopecurus gigantean.*	- *Pennisetum flaccidum.*

	- *Oryzopsis spp.*	- *Poa spp.*
	- *Stipa sibirica.*	- *Bromus inermis.*
	- *Bothriochloa pseudoischaemum.*	
	- *Chrysopogon echineulatus.*	- *Themeda anathera.*
Forbs:	- *Plantago ovata.*	- *P. major.*
	- *P. lanceolata.*	- *Senecio spp.*
	- *Rumex nepalensis.*	- *Astragalus spp.*
	- *Trifolium repens.*	- *T. pretense.*
	- *Lotus corniculatus.*	- *Fragaria vesca.*
	- *Medicago spp.*	- *Geranium colllinum.*
	- *G. nepalensis.*	- *Thymus serphyllum.*
	- *Polygonum aviculare.*	- *P. parencoides.*
	- *Phlomis bracteosa.*	- *Taraxicum officinalis.*

Based upon ecological zonation in KPK Province, moist temperate forests are found in Abbottabad, Mansehra, Batagram, Tor Ghar, Kohistan, Shangla, Swat, Buner, Lower Dir and Upper Dir districts.

Suleiman mountain ranges: The Suleiman mountain range extends along the Pak-Afghan border in the tribal belt and between the Zhob District of Balochistan and D.I. Khan (Frontier Region) of KPK. The elevation of Suleiman Range is 1540 meters up to 3400 meters creating wide ecological zonations for different vegetation communities. Most of the area is composed of barren rocks. The highest peak is Takht-i-Sulaiman. The climate is arid mountainous, sub-tropical continental. Annual rainfall is 200 - 250 mm. About 50 percent of the rainfall occurs during the months of July and August. Since the rocks are mostly barren with little soil in some areas, all rain water flushes down to the plain areas in the form of floods, causing huge loss of life and property. The entire road infrastructure in D I Khan district is with in reach of floodwater (monsoon floods) and results in traffic disruption due to damaged roads. In the upper parts of the district, water from flash floods is conserved and utilized under a century-old water conservation system called Rodkohi Irrigation System. Dry land farming is the only agriculture practice followed in the area. The region is rich with dry land scrub spp which has created opportunities for livestock rising, as a major source of livelihood. Natural vegetation consists of the following trees and shrubs, grasses and forbs spp:

Trees / Shrubs:	- *Acacia modesta,*	- *Acanthophyllum squarrosum.*
	- *Berberis lyciuum.*	- *Caragana ambigua.*
	- *C. ulcinia.*	- *Daphne oleoides.*
	- *Olea ferruginea.*	- *Perowskia obrotonneoides.*
	- *Zygophyllum atriplicoides*.	
Grasses:	- *Aristida funiculate.*	- *A. adscensionis.*
	- *Chrysopogon montanus.*	- *Cymbopogon schoenanthus.*
	- *Dactylactenium scindicum.*	- *Desmostachia bipinnata.*
	- *Dichanthium annulatum.*	- *Pennisetum orientale.*
	- *Saccharum ravannae.*	- *Stipa Arabica.*
Forbs:	- *Ebenusstellatus.*	- *Cassia holosericea.*
	- *Indegofera oblongifolia.*	

Range Types in FATA

The Western part of the country bordering Afghanistan consists of the Federally Administered Tribal Agencies (FATA). This region is a chain of mountains and narrow valleys of the Hindukush Series, which emerges as a spur in Kurram, North and South Waziristan and subsequently in the Frontier Region of D.I. Khan. The Suleiman Range ultimately descends into the plateau of Afghanistan (Zhob District).

These areas are situated above 3000 meters and below the zone of perpetual snow. They are areas above the timber line and receive the maximum winter precipitation in the form of snow which stays for a longer period, sometimes up to June in the high altitude and northern aspect of the areas. The growing period is very short. The Alpine areas are characterized by a short, cool, growing season and long cold winters. The vegetation is mostly slow growing perennials, herbaceous and shrubby vascular plants with extensive mosses and lichens. Much of the landscape is rugged and broken with rocky, snow capped peaks, cliffs and slopes. However large chunks with sloping to plain topography also exist. These are of paramount importance for tourism, and provide scenic camping sites to the tourists. In FATA, these alpine pastures are limited and exist only in Kurram (1.3 percent) and North Waziristan (0.2 percent).

Champion et al. (1965) classified alpine vegetation into the following three major types:

Alpine scrub type: consisting of moist deciduous alpine scrub, dry zone alpine scrub, moist alpine pasture, dry alpine plate and pastures, dwarf juniper scrub and dwarf Rhododendron scrub forests.

Moist alpine scrub: comprises dry alpine scrub and moist alpine scrub.

Alpine forests: contain alpine fir birch forests, Rhododendron spp and high-level blue pine forests.

Hussain (1968) recorded vegetation of the following types in this zone:

Trees and Shrubs:	- *Juniper communis, Rosa webbiana, Berberis lycium,*	
	- *Berberis spp; Cotonneeaster spp.*	
Grasses:	- *Phleum alpinum,*	- *Agrostis gigantean,*
	- *Trisetum spp,*	- *Poaspp.*
	- *Agropyron dentatum*	- *A. caninum.*
	- *Festuca ovina,*	- *Alopecurus gigantean.*
	- *Dactylis glomerata*	- *Pennisetumlanatum.*
	- *P. filaccidum,*	
	- *Clamagrostis pseudopharagmites*	
	- *Oryzopsis spp;*	- *Carexspp.*
Forbs:	- *Plantago ovata,*	- *P. major.*
	- *P. lanceolata* .	- *Trifolium pretense.*
	- *T. repens.*	- *Fragaria vesca.*
	- *Medicago spp.*	- *Potentilla spp.*
	- *Rumex nepalensis.*	- *Polygonum alpinum.*
	- *Anaphalis contorta.*	- *Thymus serphyllum.*

- *Astragalus spp.*
- *Iris hookriana.*
- *Saxifraga jacquemontiana.*
- *Taraxicum officinalis.*
- *Nepata spicata.*

These areas are used as range, mostly by nomads from the lower areas and nearby villages of the mountains. The majority of these areas are communal and seldom individually owned. Areas are rich in palatable as well non-palatable and toxic species.

Arid / semi arid grasslands: Bajaur, Mohmand, Khyber and Orakzai Agencies, lower part of Kurram, North and South Waziristan Agencies, fall within the arid and semi-arid rangelands. The majority of the mountains are extremely degraded, with barren rocks and without prominent vegetation. Only trees and shrubs of xerophytic nature are found here and there.

No proper survey of the vegetation has ever been conducted in these agencies except a few studies in Kurram Agency to ascertain the present and potential productivity. Thus production of cereals from existing farmland is meager and local communities mostly depend upon income from livestock. However, the productivity from livestock is limited because of scarcity of fodder. Vast rangelands and waste lands exist but there is no concept of range management. The following vegetation is found in areas of these Agencies:

Trees and Shrubs:

- *Acacia modesta,*
- *Berberis lyciuum.*
- *C. ulcinia.*
- *Olea ferruginea.*
- *Zygophyllum atriplicoides.*
- *Acanthophyllum squarrosum.*
- *Caragana ambigua.*
- *Daphne oleoides.*
- *Perowskia obrotonneoides.*

Grasses:

- *Aristidafuniculate.*
- *Chrysopogon montanus.*
- *Dactylactenium scindicum.*
- *Dichanthium annulatum.*
- *Saccharum ravannae .*
- *A. adscensionis.*
- *Cymbopogon schoenanthus.*
- *Desmostachia bipinnata.*
- *Pennisetum orientale.*
- *Stipa Arabica.*

Forbs:

- Ebenus stellatus.
- Indegofera oblongifolia.
- Cassia holosericea.

Alpine pastures: GIS mapping of PFI reported alpine pastures in two agencies namely Kurram and North Waziristan. These are on a very small scale an described in Table 31.

Table 31: Alpine pastures in Kurram and North Waziristan

S. No	Name of Agency	Area (ha).	% of Agency Area
1.	Kurram	4343	1.3
2.	North Waziristan	899	0.2

Livestock graze openly in these forests, except for the areas closed by communities for specific reasons, i.e. protection, regeneration or local disputes. Local communities in these tribal areas are very strong in making communal decisions and in their implementation.

Water resources are meagre so there is a scarcity of drinking and irrigation water. Usually, the locals bring drinking water from far away. Therefore, watershed management can play a key role in rain-water harvesting, storage, ground water recharging, natural regeneration and increasing farm productivity. In December 2010, the National Centre of Excellence in Geology, University of Peshawar, arranged an International Workshop on Watershed Management & Land Rehabilitation in the Northwest Frontier Region of Pakistan, sponsored by the Higher Education Commission Pakistan and the US Department of Agriculture. The key focus was the watersheds of Suleiman Range which cause, huge floods in the monsoon season, destroying habitations, farmlands, wastelands and infrastructure all the way down to D. G. Khan. Participants highlighted the importance of implementing an Integrated Watershed Management Plan to:

- Harvest run-off water
- Construct big ponds to utilize water for irrigation during the drought season
- Increase water table recharging
- Increase natural regeneration
- Carry out afforestation of multipurpose tree species according to site suitability
- Planting and sowing of grasses to minimize soil erosion and increase fodder production
- Increase of soil fertility level
- Control flood disasters

Trans-Boundary Nomadic Grazing

Nomadic grazing has a long history in both Khyber Pakhtunkwa and FATA. This is a system in which the livestock moves from one location to another in search of feed and more suitable climatic and weather conditions. In this process, agreements are made between the owners and users for utilizing certain pastures for a specified period. The nomads pay a nominal grazing fee to the owners/community in cash or kind (livestock and dairy products). The nomads may either be Ajar or Gujar. The herds of Ajar mainly consist of sheep and goats, while the herds of Gujar mainly consist of cattle. There are different types of nomads found in Khyber Pakhtunkhwa and FATA. The internal nomads move from one place to another in the Malakand civil division, but they do not take their animals out of the boundaries of the division. The second category is the summer nomads, who are mainly utilizing the high pastures during summer. Some of the nomads may be locals (living in the vicinity of the pastures), while others come from lower districts (Mardan, Buner, Swabi). To some extent trans-boundary Afghan nomads also come to alpine pastures in Swat. Due to the closure of the Chitral border, Afghan nomads have no entry in Chitral. Afghan nomads permanently residing in Pakistan particularly in Peshawar, Nowshera and Attock areas move their herds to alpine pastures in Hazara. On their return, they stay in lower areas during the winter season. They normally stay for 4 - 6 weeks and then move on in search of a new fodder site. For the local summer nomads, their main source of income is rearing livestock.

The nomads are very dependant on the ranges and pastures for feeding their animals. During summer they get sufficient forage for their livestock, as they move freely from one place to another and they even graze freely within the forests. However, in winter they face an acute shortage of fodder in their places of origin (plains). Some of them move to warmer areas like Buner, Charsadda, Mardan, Haripur, Attock, Peshawar and Khyber Agency, where nomads pay to use rangelands for the winter season.

Besides grazing the animals, they also buy crop residue and hay to supplement their animal feed. Some of them stay in the lower warmer part of the valleys. They depend a lot upon fodder obtained from oak forests, which are also very important for fuel wood collection and watershed protection. The livestock of the local people are also dependant upon the oak forests, crop residue, hay and free grazing on agriculture land after crop harvesting. These agricultural fields are available for free grazing, as only one crop can be grown due to the colder climatic conditions. Moreover, farmers prefer grazing or camping of animals to increase soil fertility. Local farmers keep limited number of cattle for their domestic needs and commercial purposes while nomads and ajar keep large herds and enjoy shifting from place to place in search of major pastures. Due to grazing of local and nomadic animals, the pastures are overgrazed and degraded.

Due to the diverse climatic conditions In Khyber Pakhtunkhwa and FATA, a number of distinct ecological zones exist. In the southern part, the climate is warmer and the precipitation is low, while in the more northern parts of Hazara and Malakand, the climate ranges from sub-tropical to moist and dry temperate. Livestock is one of the major sub-sectors of agriculture in these areas, as it is the main source of income and livelihood for the poor and vulnerable farming community. Based on the grazing pattern there are mainly two types of livestock: local and nomadic. The local livestock are an integral part of the farming system and almost each household has at least some livestock to fulfill their requirements of milk and also as a ready source of cash in times of urgent need. Generally, this type of livestock would consist of one or two buffaloes, a few cows and some bulls. These animals depend upon fodder availability from the agricultural residue and hay. They also graze freely when the agriculture fields are not under cultivation. During winter, the dry feed (crop residue and hay) is supplemented with oak leaves. Overtime the number of these animals has reduced. The main reasons for this reduction is the modernization of agriculture, easy availability of milk and milk products, labor shortage and above all the limited availability of grazing lands due to urbanization and conversion of pastures into agriculture lands. Irrigation practices added more waste land to the farming system. On the one hand, new farming technologies have decreased grazing areas but on the others, high value fodders are being produced as a by-product of improved farming.

The nomads start their movement towards pastures in late April, from the districts which are hot and face a scarcity of fodder. If they travel on foot, it takes about one month to reach the bottom of the valley.There they graze their animals in the scrub forests for about one month (May). Afterwards, they enter the coniferous forests where they spend one more month (June). Most of the animals reach the pastures in late June and they stay there till the end of August. The animals start moving back to the coniferous forests and later on to the oak forests. They reach the plains (warmer areas, winter ranges) in October and November. The maximum of livestock movement to the summer pastures is in the month of May, while the peak month for the downward movement is late October and early November. Nomads follow their own seasonal grazing calendar which directly correlates to weather conditions, i.e. snowfall and snow melting timing. With the start of the spring season, the nomads begins movement from the warmer plains to the alpine pastures. They move gradually and their movement is directly related to the melting of snow. Depending upon the altitude, fresh vegetative growth starts after a few days of snow melt. The nomadic herds graze in newly grown nutritious forage and move upward along with the snow melt till they reach the sub-alpine and alpine pastures.

This type of nomadic grazing has a negative effect on the establishment of vegetative cover (forests) and on the compacting of wet soil which results in increased runoff. It also damages forest regeneration. An interesting phenomenon is that nomadic herds stay in certain locations for about one-week. These areas are overgrazed and non-palatable seasonal shrubs and forbs prevail. Due to complete weed cover, seeds of conifer species cannot reach the soil, hampering regeneration. Such gaps within the forest gradually increase in size due to continuous over-use and poor regeneration. Therefore, it seems advisable to reduce the number of days for grazing within the forests and ensure that specified routes are followed.

The nomads go to specified pastures each year and they have contractual arrangements with pasture owners. They pay pre-fixed amounts for using the pasture, but the number of animals is not considered. The grazing fee is paid in kind or in cash on their return from the pastures. The number of animals is decided according to fodder availability in winter. The pasture owners (rights-holders) also authorize the nomads to graze the animals within the coniferous and oak forests of their respective jurisdiction.Nomadic and trans-boundary grazing is a strong factor, which has to be considered in range and pasture management.

Rangeland Trend and Condition

In order to clearly understand the key issues in pasture management and to set the benchmarks for periodic monitoring, it is necessary to elaborate on a few fundamental concepts. These are used for assessing the health of the resource and the level of pressure it can sustain. Pasture condition and pasture trend are important parameters to be clearly understood for the formulation and design of sustainable management programmes.

The pasture condition is the present state of vegetation of a pasture site, in relation to the climax (natural potential) plant community for that site. It is an expression of the relative degree to which the kind, proportion and amount of plants in a plant community resemble that of the climax plant community for that site. Thus pasture condition is an ecological rating of the plant community. Air-dry weight is the unit of measurement used in comparing species production of the present plant community with that of the climax community.

The primary purpose of determining pasture condition is to provide a basis for predicting the extent and direction of changes that can result in the plant community, due to specific treatment or management interventions. The pasture site indicates the potential, pasture condition represents a starting point for management towards the potential, or towards the objective selected by the pasture managers.

Condition classes*:* Four classes are used to express the degree to which the composition of the present plant community reflects that of the climax. It is expressed in the percentage of present plant community, that is climax for a given pasture site. If the percentage is in the range of 76-100 percent, then the condition class is termed as excellent. While for good, the percentage is in the range of 51-75 percent. The pasture condition is termed fair and poor if the parentage is in the range of 26-50 percent and 0-25 percent respectively.

Dynamics of pasture condition*:* Plant communities are dynamic. They are ever responsive to changes in their environment, to their use and to the stress to which they are subjected. Species change in proportion and amount in the plant community. Climatic cycles, fires, insect attacks, grazing and physical disturbances are some of the many causes of changes in plant communities. Some changes such as those resulting from seasonal drought or short-term heavy grazing, are temporary, while others are long lasting. Individual species or groups of species in the plant community respond in a different manner or degree to the same stress. All species in a native plant community are seldom equally palatable to grazing animals. Unless grazing is extremely heavy, some plants are cropped more closely and frequently than the others. Most plants are sensitive to stress during some period or stage of growth. They may be severely affected by moderate grazing during short but critical growth periods but tolerant of much heavier use during other times.

Many plants respond to changes in the micro-environment, independent of grazing. The response of some species depends on what happens to their associated species. Some kinds of plants are destroyed by fire, but others thrive and respond quickly following a fire. The same weather conditions may favor the growth of some species in the plant community but may be unfavorable for others. Similarly, different species respond differently to the grazing stress. Thus many complex factors contribute to changes in the composition of the plant communities. All changes are not related to grazing of livestock. Various terms are used for a group of plants, how they respond to overgrazing, which are decreasers, increasers, and invaders. The system of classifying plants as decreasers, increasers, and invaders is sometimes useful in explaining the species changes that takes place in the plant communities and in predicting changes likely to take place under alternative resource use. Such classification however should not be used for determining present pasture condition.

The trend in pasture condition is one of the most important components of the pasture resource inventory and survey. The present ecological pasture condition rating alone does not indicate whether the plant community is improving or deteriorating in relation to its potential. Thus trend is a separate determination that is necessary for assessing what is currently happening to the plant community. The present range condition is the result of a sustained trend over a period of time. In this regard, the trend is a much more sensitive indicator of changes than the pasture condition.

It is important to know the trend when planning the grazing use, management and treatment needed to maintain or improve the pasture resource. It is also important to consider the trend when making adjustments in the grazing system. Some characteristics of vegetation and soil that indicate the apparent trend in pasture condition include: species composition change, abundance of seedlings and young plants, plant residue, plant vigor and the condition of the soil surface. Five major factors are useful in determining the pasture trend: the kind of vegetation reproducing and becoming established, the vigor of desirable in contrast with undesirable plants, degree of healing of gullies or other eroded areas, accumulation of litter and lastly degree of use.

Another approach is the site potential approach for measuring pasture condition. The site potential approach is based on the fact, that each pasture site has a certain average maximum amount of forage that it can produce under practical sound management and the amount currently being produced can be expressed as a fraction of this maximum. As forage production approaches the potential for a given site the condition improves, as it drops below this potential, the condition deteriorates. In order to make a difficult job easier and to increase accuracy, five rating criteria are commonly used in the site potential approach: composition, density, plant vigor, litter and erosion.

Among all these criteria, composition of the vegetation is the most important one employed. The total plant cover within the reach of livestock is subdivided on a forage value basis into desirable, less desirable and undesirable species, according to the management objective. The second criterion is plant density usually identified as forage density, providing a valuable clue to the condition of the site. Plant density refers to the percentage proportion of ground surface covered by the current year's growth of vegetation, as seen in a vertical section. There is a general positive correlation between forage density and pasture condition. The third one is plant vigor, which is used to describe a healthy plant with an adequate root system. The vigor of key forage species is a useful indicator of pasture condition. Vigorous plants tend to indicate a pasture in good to excellent condition or an improving pasture condition. When these plants are weak, fair or in poor condition, downward trends are indicated.

Litter is of value on pasturelands as a means of reducing erosion and facilitating water infiltration. As a consequence, the amount of litter present is often useful as a criterion for pasture condition. Close grazing on northern or higher altitude ranges in particular, that permits little plant material to accumulate as litter indicates lower pasture condition. Accelerated erosion on pasture normally indicates a cover of vegetation that is not adequate to protect the soil from erosion. This inadequate cover may result from deficient precipitation, or it may indicate excessive removal of vegetation by grazing animals. Regardless of the cause, degree of erosion is a useful indicator of the condition of a pasture. The more severe the erosion, the lower will be the condition class.

The amount of people and livestock relying on this resource increases pressure on the range. Continuous overgrazing and mismanagement has resulted in the desertification of these ranges, which has negative implications on its overall production, functions and services. In addition to environmental degradation, it has also had a huge impact on the livelihoods of a large number of poor and vulnerable. The frequent and prolonged drought has also badly affected the whole ecosystem. As this range is a major resource of the area, it requires the urgent attention of policy makers and other stakeholders to save the environment and livelihood of millions of disadvantaged people. For this purpose a comprehensive Range Management policy is required. The extent and spread of resources is higher and more diversified, compared to other renewable natural resources. Some of the ranges also extend into the forest areas, which is the result of deforestation over time. These ranges are generally situated in a fragile ecosystem, where the habitat is under heavy grazing pressure and over time their productivity and bio-diversity has declined. The negative impacts of mismanagement are evident in the form of accelerated soil erosion, land degradation and an overall reduction in productivity. Most of these lands are communal, therefore management decisions rest with the whole community. In southern KPK and most of FATA desertification is a prominent phenomenon due to dry arid conditions and prolonged droughts. Other major problems in range management are: land tenure, overgrazing, non-uniform grazing, free access to the surrounding forests, accelerated erosion and spread of weeds. The major social issue is the non-equitable distribution of benefits, since there is no restriction on the number of livestock to be grazed on communal rangelands. This leads to exploitation of the resources by a few influential individuals.

The prevailing downward trend and deteriorating condition of the rangelands in KPK and FATA was identified early on. Continuous and uncontrolled free-grazing over a long period has resulted in a downward slide in the status of the pastures. There is strong evidence of retrogression, as a result of which significant changes in the composition of the species have occurred. The number of palatable forage species has reduced with a corresponding increase in the frequency of non-palatable forage species.

Soil degradation due to loss of vegetative cover through overgrazing has also resulted in accelerating soil erosion, and has thereby contributed to an unstable environment. In order to reverse the degradation process, there is an urgent need for scientific management of this resource. However, in the absence of a comprehensive Provincial Rangelands Policy, this vast resource is under threat. For policy formulation, it is important that the current status of the resource is properly assessed in terms of its geographical coverage, productivity, services and function levels and the factors contributing to deterioration and significance to the local livelihoods.

Table 32: Estimated current productivity of pastures and grazing lands of Khyber Pakhtunkhwa and FATA

Type of Rangeland	Current Productivity (Kg/ha)	Potential Productivity (Kg/ha)	Trend(Upward/ Downward)
Alpine Pastures	1240	2500	Downward
Trans-Himalayan Grazing lands	1200	2000	Downward
Himalayan Grazing lands	1800	3000	Downward
Arid/semiarid grazing lands (cover southern part of KP and whole FATA)	600	2000	Downward

In addition to the overall productivity of pastures, a region-wise and district-wise productivity of key grass species.

Based on the Table 32 above and other related surveys and studies, the following points reflect the overall situation of range and pastures in both Khyber Pakhtunkhwa and FATA:

- Estimated current productivity is less than 50 percent of its potential
- Foliar cover has decreased up to 60 percent
- Stocking rate is beyond the carrying capacity
- Weed species are spreading at a high rate covering big patches of pastures
- Ratio of palatable species has decreased to the low level of 30 percent
- Soil erosion is a prominent feature of intensively grazed steep slopes
- In the southern districts of KPK and the whole FATA area, desertification is a prominent phenomenon affecting the ecosystem and livelihood of the local people
- Due to the shortage of winter forage in the valley bottoms, there is a great tendency to graze these pastures in early spring, which hampers natural regeneration
- Livestock goes to higher altitudes and more remote places thereby greatly interfering with wildlife
- The current management system is not appropriate, as less attention has been paid to control grazing.

Major Causes of Range Deterioration

There are a number of factors responsible for the depleted condition of pastures and rangelands:

Land tenure: These pastures are mainly community owned are used by a number of villages located in the valleys. The villages located in the upper part of the valleys close to the pastures have more control on the resource. The villages in the valley bottom which have alternate sources of income utilize these pastures less frequently, but they do maintain their rights in these pastures. Within each locality, a member of the tribe can keep as much livestock as he would want and as such there is no restriction on the number of livestock to be grazed. This number is controlled by the availability of fodder for each individual herd during winter in the downstream agriculture lands. The people are generally focusing on immediate benefits, rather than on controlled use of the resource. Until all the stakeholders, especially owners and users are brought on to one platform for development of a joint scientific plan with a clear cut role for all, mismanagement will continue and the productivity of the resource will decline.

Animal numbers are beyond the carrying capacity: As already indicated, due to the communal nature of the land and the pasture users generally relying on short term gains rather than long-term benefits, they keep a higher numbers of livestock which are beyond the carrying capacity of the pasture. This results in overgrazing which leads to deterioration of the land, a proportionate decrease in palatable fodder species and a corresponding increase of non-palatable species, associated with accelerated soil erosion.

Continuous irrational use of pastures and rangelands has led to an alarming situation where the major portion of some pastures has been fully occupied by weeds and forbs and grass production has declined. As a result, erosion has started. In a number of places the topsoil has been washed away completely. Thus the overall condition of the pasture has declined and will take a long time to recover.

Table 33: Estimated annual forage production for different rangelands.

S. No.	Rangeland.	Current Production DM (tonnes / ha).	Improvement Potential. DM (tonnes / ha).
1.	Alpine pastures.	1.5	2.5
2.	Trans-Himalayan grazing lands.	0.6	2.0
3.	Himalayan forest grazing lands.	0.6	3.0
4	Desert rangelands	0.5	2.0
5.	Suleiman mountain ranges.	0.3	2.0

(Source: Mohammad 1987)

Since these range areas are producing below potential productivity, the current number of grazing animals is on the higher side.

Weeds: Due to continuous overgrazing the species composition has changed overtime and a number of invader species have occupied the pastures and rangelands. These species are generally non-palatable. In the northern and eastern aspects of the higher altitude pastures, weed (*Polygonum spp*) covers a considerable portion of the pastures and as such the pastures have shrunk, causing a substantial decline in the overall productivity. This situation has serious repercussions on the adjacent pastures. The grazing pressure is shifted to other surrounding pastures and forests which hampers natural regeneration.

Non-uniform grazing: During various surveys and studies, it has been noticed that grazing is not uniform throughout the pastures and rangelands and some pastures are overgrazed while other are underutilized. The remote areas and steep slopes of the pastures are less utilized, while grazing is concentrated on the valley bottom and more easily accessible areas. The resting places and those near water points are generally overgrazed. Therefore, these 'sacrificed' areas need special attention for proper management.

Lack of proper grazing management system: Although the grazers do understand the benefits of controlled grazing which they used to practice in the past, due to the disintegration and erosion of local social institutions, they do not observe the same. In the pastures which are privately owned, the herdsmen do observe controlled grazing to a certain level, but this is not a common practice in community land.

Rangeland Ecosystem Services

Pastures and rangelands play a very important role in ecosystems and contribute much to the national heritage (flora & fauna), vegetation types, biodiversity, agricultural productivity, industrial development and economy. A brief account is given below:

Vegetation: Pastures and range areas of KPK and FATA has developed under a specific climatic, altitudinal and edaphic set up. It carries a particular type of vegetation, i.e. trees and shrubs, grasses, and forbs. This vegetation type has its own succession trend. Biotic pressure plays an important role in the survival of existing spp. Deforestation and grazing are two important sectors which utilize and consume particular species, often existing behind ones which are not of their interest, like non-commercial trees and non-palatable grasses. Therefore, the left-over species are able to survive and spread unchecked over an entire area, disturbing the genuine eco-setup. To ensure that the natural ecosystem prospers, proper sustainable management of the resources available is required along with the application of scientific principles.

Wildlife: All wild animals stay and breed in a specific habitat, comprising of altitude, temperature range and vegetation cover. For example, Markhor (*Capra falconeri*) prefers scrub vegetation areas in the hills of Chitral and Gilgit. It cannot survive in the moist temperate zones of Kaghan and Swat. The wild animals of a specific habitat live among themselves, in a particular socially acceptable community.

Therefore, each ecological zone supports a particular set of wild animals (mammals, birds, reptiles and insects) which have a symbiotic relationship with that very particular vegetation set. The ecological zones, sub-alpine pastures and temperate zones (moist as well as dry) have specific fauna. Any change in the ecosystem of the area results in migration and extinction of these animals. A variety of pheasants are found in Kaghan, Kohistan and Kalam (Swat) forest areas. Similarly leopards, snow leopards and bears are found in the Gallies, Kaghan and Siran Forests.

The tropical belt of scrub forests is home to game birds like the black and gray partridges, chakoors and seasonal birds like cranes, while nests of waterfowls are found in water bodies in the plains. The grazing and feeding habits of wild life are of paramount importance in seed dispersal and germination. The hard coating of the seeds when passing through the alimentary canal of these birds cracks and when these seeds are discharged in the faeces, they germinate quickly under favorable soil conditions. Similarly, birds play an important role in pollen dispersal and cross-pollination, which ensures species survival.

Water: Each ecological zone has a peculiar response to the water system. Mountains (glacier zones, alpine, sub-alpine and temperate areas) receive maximum precipitation in winter in the form of snowfall. Due to the high altitude and low temperatures, this snow stays frozen for a long period – usually up to May and June and in some places up to July. It gradually starts melting with the onset of the summer season when temperatures rise. Slow or gradual melting of snow is a source of regular, sustainable supply of water into the streams of various watersheds which ultimately unite to become small and subsequently large rivers.

These rivers are the source of irrigation water for the lower districts as well as the source which feeds various dams, which store water for hydel power generation and the irrigation network. For example, the Kabul River originates in Chitral, enters into the Afghan Territory and after passing through Kabul re-enters Pakistan near Mohmand Agency, from where it passes through to Warsak Dam. Similarly Dargai

Hydel Power Station is fed by the river Swat and Tarbela by the river Indus and Siran. Kunhar River (Kaghan) joins the river system of AJK near Muzaffarabad and feeds Mangla Dam.

The irrigation system in Punjab and Sind depends mostly on the supply of water from the mountains of Northern Pakistan. Thus agriculture and hydel power production are totally dependent upon the quantum and melting rate of snow.

In the current climate change scenario, the increase in temperature has accelerated the melting of snow, resulting in the increased flow of water causing floods, soil erosion and land sliding. This phenomenon is causing damage to habitation and productive farm lands. The devastation is occurring due to climate change and the misuse and unscientific management of natural resources, which is a major threat to both upland and areas lower down. The only solution is proper land resource management using climate change as an opportunity instead of letting it become a disaster.

Tourism: Summer tourism in the country is confined to the mountainous areas because of their cool climate, scenic beauty and lush green vegetation. Alpine pastures like Seri Pai (Shogran), Bata Kundi (Naran), Kalam Valley, Marghuzar, Malam Jabba and Miandam (Swat), Kalash Valley (Chitral), Thall-Lamoti area (Upper Dir) and Gallies (Abbottabad), are famous summer tourist resorts presenting unique geological, ecological and environmental views. Pastures and plain sites are used for camping which helps tourists to enjoy the scenic beauty. Cold Water Rivers in Bamborate (Chitral), Kalam River (Swat) and Kunhar River (Kaghan and Naran) are a rich source of fish, particularly trout, which is famous for its taste and attracts anglers. This provides a source of income for poor fishermen of the area and a unique dish for affluent tourists.

Medicinal plants: Asia is rich in medicinal plant production. The Medicinal & Aromatic Plants Program in Asia (MAPPA) documented the role of the medicinal plants Industry in fostering biodiversity, conservation and rural development. The document explained the current situation, potential, bottlenecks, the role of communities & land-owners, users and the pharmaceutical industry. It also shed light on the techniques needed to solve the real issues and the role of this very important economic sector in biodiversity, conservation and livelihood improvement. Presently, these medicinal plants are collected by nomads who sell them in local shops on a nominal rate. The major beneficiaries are middlemen and industry owners. Proper awareness campaigns at the community level can help develop this sector.

Dr. M.B. Zaman, 1960 identified 100 high value medicinal plants in Pakistan and provided complete details in his book “100 Drug Plants of Pakistan.” Most of these medicinal plants are found in alpine, sub-alpine and temperate forests. The actual number of these species exceeds 200. They are used both in traditional treatment (Ayurvedic) and by the pharmaceutical Industry (Allopathic). Interest in medicinal plants has been growing rapidly in the South Asian Region due to its commercial, socio-economic and ecological value. However, Pakistan is still lagging behind. The above mentioned areas of KP lack awareness, knowledge of collection timing and techniques, proper segregation of species, and grading and linkages with main dealers. If these aspects are addressed seriously at the level of the local community, these plants have the potential to increase livelihood opportunities. The drug plants can also play an important role in bio-diversity of the area. There is a need to properly manage and carefully utilize various range ecosystem products, including mazhri leaves in FATA, wild mushrooms and other medicinal plants like *Artemisia spp a*nd Ephedra spp.

At present, major areas of the designated forests are lying empty. Leasing out these areas to pharmaceutical industries for growing species of their choice can increase the resource base, create income and employment opportunities and provide new skills to local communities.

Development of a durable and equitable relationship between the collectors, producers, consumers and processors of medicinal plants, is in the best interest of all, including the end-users. Quality raw material and medicinal plant production demands need to be channelized. Such a process may emerge by treating the collectors and producers not as mere gatherers of cheap raw material, but as an integral part of the entire 'production to consumption' system. Major problems in the development of this very important sector are:

- Insufficient primary and secondary data of potential, areas of occurrence, present extent of exploitation, demand and supply rates of procurement and sale
- Non-existence of linkages between collectors, producers and users
- Poor price control
- Destructive harvesting due to insufficient knowledge at the grass root level
- Poor standardization of raw materials and crude drugs
- Lack of knowledge regarding laws governing the medicinal plants trade
- Major share of benefit going to the middlemen and end users
- Absence of value-addition at the primary level
- Plundering of resources by end users without any investment in its development
- Minimal research and development efforts being made regarding in-situ and ex-situ conservation and cultivation of medicinal plants
- Little co-ordination between State Agencies handling the trade and development of medicinal plants

These problems have led to the exploitation of the resource, which results in the disappearance of species and a negative impact on biodiversity.

Biodiversity: The alpine, sub-alpine, moist and dry temperate, sub-tropical and tropical areas carry specific sets of flora and fauna. Unsustainable use of economic species leads to a disturbance in the level of that very species, bringing a change in the ecological balance and biodiversity of that area. As a result, some of the species disappear while others of no or low economic value populates the area. It also has a negative impact upon the fauna of the area which prefer a particular habitat for food and shelter. They migrate to other suitable areas. The presence of these birds, mammals, insects, etc plays an important role in seed dispersal and germination. Therefore it must be managed properly.

Fuel wood: Rangelands are a source of fuel wood for local communities. Being communal property, local populations lop trees; utilize foliage as fodder and the twigs and branches for firewood. Being at the lowest economic level, these communities living in far-flung areas have no employment opportunities and cannot afford to buy gas equipment and cylinders. They have to survive and meet their requirements from local resources. In the lower areas, 100 percent of local fuel wood requirement at village level is met from farm land. In the mountains, barren areas and waste land habitation 100 percent of fuel is managed from local sources, i.e. forests and rangelands.

Minor forest products: Minor forest products like mushrooms, especially Morchella, honey, tree gums and mazri are collected free of cost. It is a reasonable source of income.

Conclusions and Recommendations

Conclusions: The range and pasture management issues are linked with other components of land use i.e. coniferous forests, scrub forests and agriculture land. The development interventions should match the overall chain of grazing system and management which requires a holistic approach.

For the development of range and pasture resources, key development interventions in a planned way, on a pilot basis should be undertaken with the active involvement of the locals. These interventions should be used for demonstration purposes. They should be simple, cost-effective, and familiar for the locals, producing quick results and should be acceptable to the majority of stakeholders. Efforts should be made to base the interventions on local experience, knowledge and initiatives. The interventions should be such that they take into account vegetation, animal production and health aspects. Moreover these should involve the optimum utilization of the three production cycles i.e. water, mineral and energy, which are crucial for sustainable management.

The pilot phase activities should be started with those communities where the pasture and range condition is more degraded and there is more potential for improvement. This will help in quick recognition of problems and the locals would be more willing to adopt the suggested management practices. Before initiation of any interventions a field trip designed to create awareness would be required for the pasture in question, so that locals can observe the quantum of degradation and associated losses, while comparing good pastures with degraded ones.

The main focus of technical interventions should be on controlled grazing, supplemented by a few pasture improvement practices. The grazing management should include the demonstration of a simple type of rotational grazing system and simple and cost-effective pasture improvement techniques i.e. reseeding and planting fodder trees in the nearby forests. Before suggesting any interventions, a thorough assessment of the pasture condition would be necessary. The pasture and range trend will indicate what is currently happening to the resource and what type of management interventions are required. The sub-division of the whole pasture or range into various classes based on the level of productivity compared to its potential will help in a more focused approach.

It is always useful to know the carrying capacity of a given pasture, so that the number of animals is adjusted according to the total annual forage production. However, this approach has the inherent problem of productivity fluctuation from one year to the next, depending on certain climatic factors. Therefore, if animal numbers are kept the same, then in a year of low productivity the pastures will be overgrazed and animals will not get the required feed, while in case of high forage production the pasture will be under-utilized. To avoid overuse or underuse a residual phytomass concept/approach should be adopted. This approach is based on the criteria that there is a certain minimum level of phytomass necessary to be retained so that the erosion process does not start. In this case the stocking intensity is adjusted according to the fodder availability in that particular year.

Region and valley specific management plans have to be developed with the locals, in which key interventions, rules and regulations are identified and implemented under agreed terms and conditions, with the locals. The pasture management plan with participatory monitoring and an evaluation system, should be an integral part of the Village Conservation Plan. This is crucial for the sustainability of the development interventions.

Recommendations

The livestock sector is facing complex issues which require long term technical support. Under the existing scenario, the following recommendations are made:

1. Proper survey and GPS mapping of various categories of pastures and rangeland.
2. Documentation of existing fodder resources, issues and improvement measures required.
3. Preparation of Integrated Management Plan by involving all stakeholders, i.e. Forest, Agriculture and Livestock Departments, local range and pastures owners, nomads and herdsmen.
4. Mapping of various sites according to their suitability for watershed, water channelization, wildlife habitat, biodiversity, source of valuable medicinal plants, tourist camping site, etc.
5. Introduction of rotational grazing.
6. Introduction of high yielding fodder species.
7. Eradication of non-palatable and toxic species.
8. Keeping animals according to the grazing capacity of the rangeland.
9. Awareness at community level to understand and develop livestock rearing whether milk production, meat or wool.
10. Breed-improvement programs.
11. Educating farmers on livestock hygiene and feeding systems.
12. Linkages of farmers, nomads and herdsmen with markets to get better prices instead of benefitting the middlemen.
13. Establishment of proper routes to alpine and sub-alpine pastures to avoid damage to natural regeneration and plantation.
14. Construction of water-ponds and check dams on suitable sites.

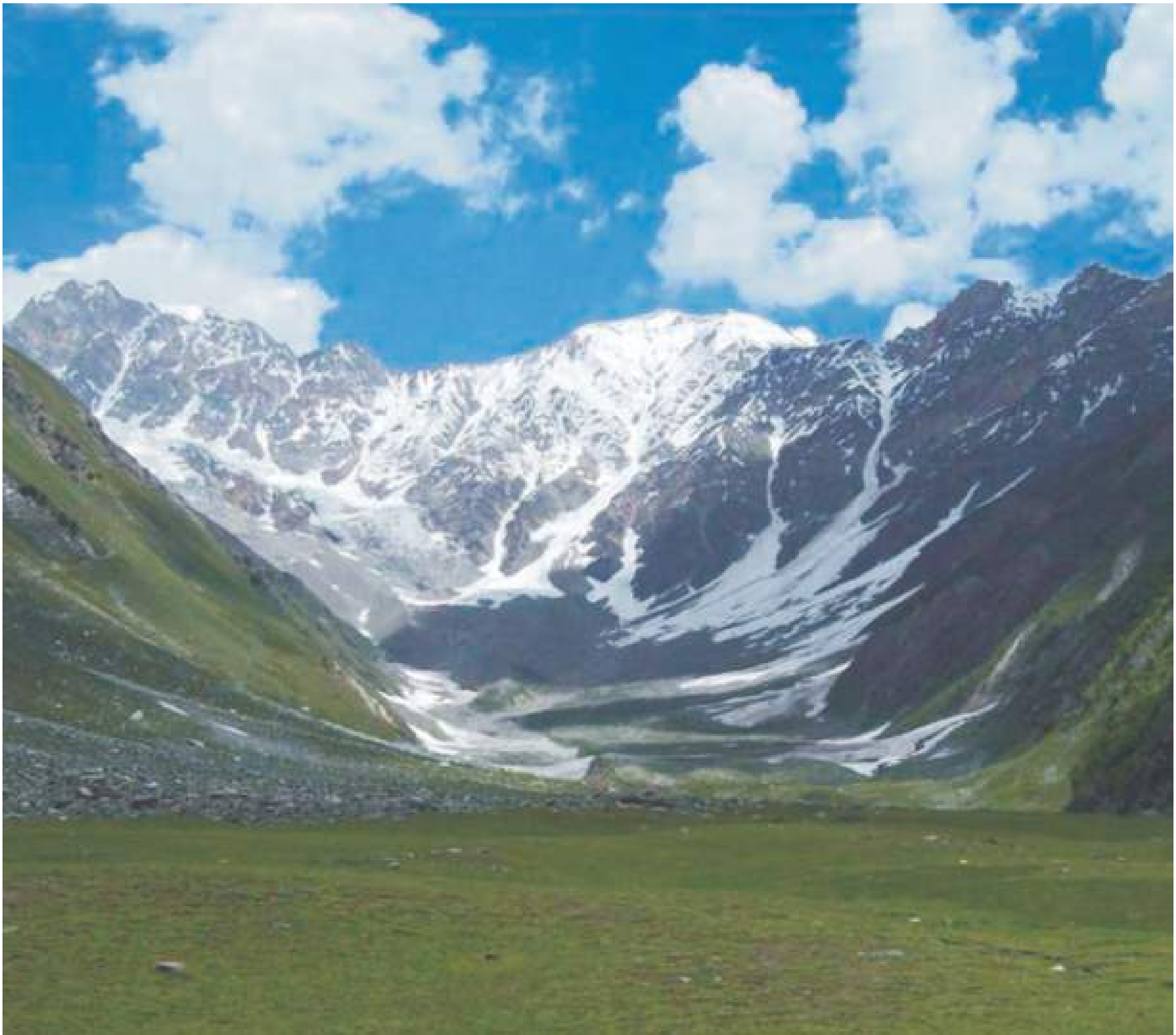
Biodiversity: The northern mountainous region of Pakistan is a living museum, blessed with a wide array of habitats that support rich biodiversity. The floral and faunal diversity has affinities largely to Palaearctic bio-geographic realm of the world and is part of the mountain ecosystem (Cox & Moore, 1993). The area falls under four biogeographic provinces of the Palaearctic Realm including Hindu Kush highlands, Himalayan highlands, Pamir-Tian-Shan highlands and Tibetan Plateau (Udvardy, 1975). So far 525 species of birds, 113 species of mammals, 50 species of reptiles, 90 species of fish and 15 species of amphibians have been recorded in the northern mountainous region, mostly rare and endangered but some being endemic to the Karakoram-Himalayas-Hindu Kush highlands.

Snow leopard, common leopard, Himalayan Ibex, Marco Polo sheep, Blue sheep, Astore makhor, Neel Gai, barking deer, musk deer, Gray goral, Tibetan wild ass, Ladakh urial, Gray wolf, Brown bear, Black bear and Himalayan lynx, are amongst the key mammalian fauna. Such a great diversity in mammalian fauna exhibits inter-penetration of the above-mentioned bio-geographic provinces, not easily seen elsewhere in Pakistan (Virk et al., 2003).

Similarly flora is also rich and varied largely because of its location and inherent climatic variability. Floristically the Eastern Irano-Turanian or Central Asiatic comprises the majority of the region's flora, including several endemic species, while Sino-Japanese cover only a part it (Ali & Qaiser, 986; Nasir & Rafiq, 1995). Astore, Leepa, Poonch, Bhimber and other parts of the region have great diversity of medicinal and aromatic plants. Approximately 342 species of plants belonging to 36 families and 142 genera have been recorded from the Deosai plateau (Woods et al., 1997), while Khunjerab National Park is known to have 152 plant species representative of 36 families (Khan, 2012). Similarly Leepa and Poonch valleys in AJK are reported to have 36 and 68 species of medicinal herbs belonging to 22 and 44 different families respectively (Khan et al., 2012; Ishtiaq et al., 2012).

Major avi-fauna species include waterfowls, birds of prey, singing birds and pheasants. High altitude lakes, marshlands, peats, streams and rivers being adjacent to Flyway IV of migratory birds (Indus Flyway) provide key habitats to a number of migratory and resident birds and are ecologically very important. The majority of the winter visitors enter the subcontinent via the Indus River valley and its northern tributaries. Qurumbar, Utter, Hundrab and Shandoor lakes harbor more than 230 species of birds – one of the most diverse populations in the mountain regions of the world (Khan et al., 2012). Western horned Tragopan, Cheer pheasant, Koklas pheasant, Monal pheasant, Indian peacock, Black partridge, Grey partridge, Himalayan griffin, golden eagle and snow cock are amongst the common birds of the region.

Forests and rangelands: Forests and rangelands constitute about 4.1 percent and 33 percent of the land area of GB and 42.6 percent and 43 percent of AJK respectively. They are rich in biodiversity and rare and endangered species, some of which are endemic to the region. Natural forests being primary watersheds of the Indus River System, regulate water for drinking, agriculture, coastal forestry, industry and hydro power generation upstream as well as downstream. High valued timber, firewood, medicinal herbs, food and fiber worth millions are amongst other tangible benefits of the forest ecosystem. Carbon sink, carbon credit, mild climate, food and shelter to wildlife and aesthetics are also some of their high value, non-tangible benefits. Forests also stabilize slopes, conserve water, control soil erosion, landslides and siltation into precious dams and water reservoirs downstream.
Similarly, rangelands including meadows, shrub meadows, shrub pastures, fir forage range, birch range and grass lands harbor highly valued medicinal and aromatic plants. They also protect water resources, recharge aquifers and provide fuel wood and grazing areas to rural communities for domestic energy



GILGIT BALTISTAN AND AZAD JAMMU & KASHMIR

PROVINCIAL REPORT

Gilgit-Baltistan, and Azad Jammu & Kashmir

Background

Gilgit-Baltistan and Azad Jammu and Kashmir share similar geography and topography. The Rangelands include alpine pastures, Himalayan grazing land and the subtropical humid temperature zone. They are used as a source of livelihood in rural areas and for domestic energy, fresh water and biodiversity.

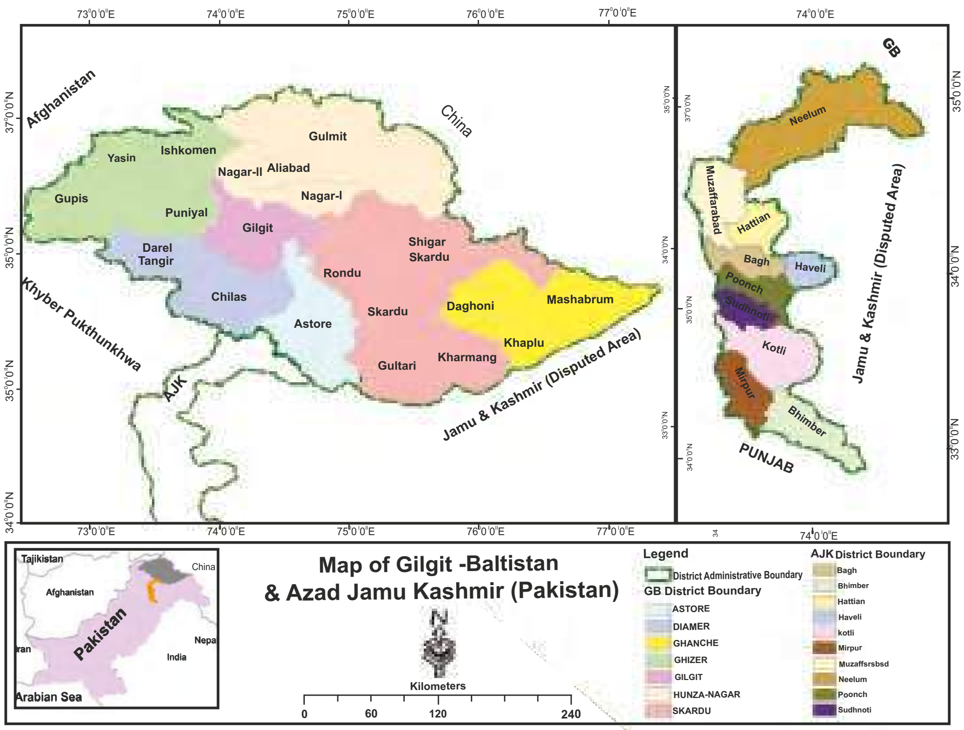
Rangelands encompass a large part of Gilgit-Baltistan and Azad Jammu and Kashmir. They are the single largest land use of the two regions. Subsistence farming and livestock herding are the two major sources of livelihood for mountain dwellers. This accounts for about 35-40 percent of local household income and 11 percent of the GDP. Apart from livestock grazing, pastures and rangelands provide substantial amounts of fuel wood to meet domestic energy needs, fodder for livestock and high-value aromatic and medicinal herbs for sale and traditional use. Rangelands are vital for sustained economic growth, water regulation and ecological flows of an agro-based national economy, fisheries and mangrove ecosystem.

The growing human population has led to a rise in the demand for food, fiber, shelter, energy and medicines, which has rapidly and significantly increased livestock numbers during the past four decades. This increase in livestock coupled with a rise in the number of wild herbivores (due to community based conservation initiatives) and the illicit removal of natural vegetation for fuel, fodder, food and medicines has resulted in the rapid conversion of rangelands into deserts, social forestry and agricultural fields. Lack of regulations and policies on the use of rangeland resources together with a lack of capacity in the custodian departments to enforce and monitor the implementation of the relevant laws, has also contributed to their degradation in these two regions.

A number of recommendations have been made for this region including: a baseline survey and an awareness program for better rangeland management, a strong monitoring and evaluation system, development of a research-based rangeland and livestock management plan and restoration of degraded rangelands. The need for a comprehensive rangeland policy for both Gilgit-Baltistan and Azad Jammu and Kashmir has also been emphasized.

The northern mountainous region of Pakistan encompassing about 13 million hectares amidst the Karakoram, Hindu Kush and western Himalayas includes Gilgit Baltistan (GB), Azad Jammu & Kashmir (AJK), Murree, Hazara, Margallah hills, Kohistan and other parts of Khyber Pakhtunkhwa (KP). Gilgit-Baltistan formerly known as the “Northern Areas of Pakistan” is a geographically defined territory of seven districts, covering 72,496 km^2 in the extreme north (longitude 75^0 - 77^0 and latitude 37^0 - 35^0). AJK is mostly hilly and mountainous with valleys and stretches of plains, encompassing an area of about 13,297 $km^{2,}$ in the lower parts of the Himalayas (longitude 73^0 - 75^0 and latitude of 33^o - 36^o). The GB and AJK region, together cover about 85,793 $Km^2$and have a common border with Afghanistan in the west, China in the north and Indian held Kashmir (IHK) in the east (Figure 26). The area is home to a human population of approximately six million (estimated 1998 census).

Figure 26: Administrative map of Gilgit-Baltistan and AJK



Source: GIS Lab, GCIC WWF-Pak (2013)

The region is gifted with immense natural beauty with having some of the highest peaks in the world, the longest glaciers, rivers, lush green pastures and thick forests harboring significant populations of globally important wildlife species, birds, fish and floral resources. Gilgit is the provincial headquarter of Gilgit- Baltistan and Muzaffarabad is the capital of Azad Jammu and Kashmir. People speak Shina, Balti, Brushaski, Wakhi and Khowar languages in GB. Pahari, Potwari, Hindko, Gojri, Punjabi and Pushto are spoken in AJK. Urdu is the language of the government of AJK and *lingua franca* in the entire region. The majority of the rural population depends on forestry, livestock, agriculture and non-formal employment for its subsistence.

Rangelands and pastures spread over 2.34 and 0.57 million hectares and are the main types of land use in GB and AJK, respectively. Over 90 percent of the rural population in the region has a direct though not complete dependence on the pastures and rangelands for daily subsistence, while almost 200 million people living downstream are benefiting from the water resources conserved and regulated by these ecosystems. Alpine and sub-alpine pastures contain highly valued floral species and offer crucial habitats for some wildlife species of global importance. They also constitute key biodiversity hotspots in the dry and moist temperate forest eco regions of Pakistan. The watershed and carbon sequestration functions of the northern rangelands have yet to be valued and utilized for economic development.

Owing to limited land resources available for cultivation, livestock herding is still an important source of livelihood for 90 percent of the people in the rural areas, where 35-40 percent of the household income is earned from this sector. Currently more than five million different types of livestock, both local and nomadic freely graze the northern alpine and sub-alpine pastures and forest grazing lands during the summer months. The herders while grazing their animals also collect firewood, fodder and other produce of the rangeland i.e. medicinal and aromatic plants and illegally hunt wild animals and birds for meat, pelts and feathers.

Recent estimates for dry matter forage productivity of pastures and rangelands are not available but the previous estimates revealed that the productivity and bio-diversity of alpine and subalpine ranges has declined tremendously. Currently forage productivity for all types of rangelands except alpine pastures is almost three times less than their potential, mainly because they were not well managed and have been over exploited for a long time. Traditionally pastures and rangelands were classified into three categories, namely spring, summer and winter pastures. There are also three principal types of livestock grazing systems, nomadic, transhumant and sedentary which still prevail in the region.

In the last three and a half decades the livestock population has increased manifold, which has increased the stocking rates on fragile ranges and pastures of the area. In 1996, there were a total of 3.583 million livestock in the region including 1.507 million in GB and about 2.076 million in AJK. This number increased to a total of 4.871 million animal heads in 2006. In Gilgit Baltistan the animal stocking rate in 1976 was 9.08 ha per animal unit, which decreased to 2.73 ha per animal unit in 2006. With a 30 percent increase in livestock population the animal stocking rate in AJK in 2006 was 0.292 ha per animal unit. This is many times more than the critical levels of 16 ha per animal unit recommended by the FAO for rangelands, with the least potential.

Uncontrolled grazing by nomadic and local herds, excessive removal of scattered and sparse natural vegetation for firewood and fodder, drought and trampling are the key issues. These are a result of extreme poverty, dependence on rangelands for grazing, energy, shelter and medicine. Weak law enforcement, lack of enabling policies, inadequate management capacities, a lack of scientific management and monitoring mechanisms, difficult terrain and resource constraints are the primary reasons for degradation of ranges in the area.

A multi-pronged integrated conservation and development strategy comprising of short, medium and long term interventions is proposed to protect, restore and eventually improve the degraded rangelands of the region.

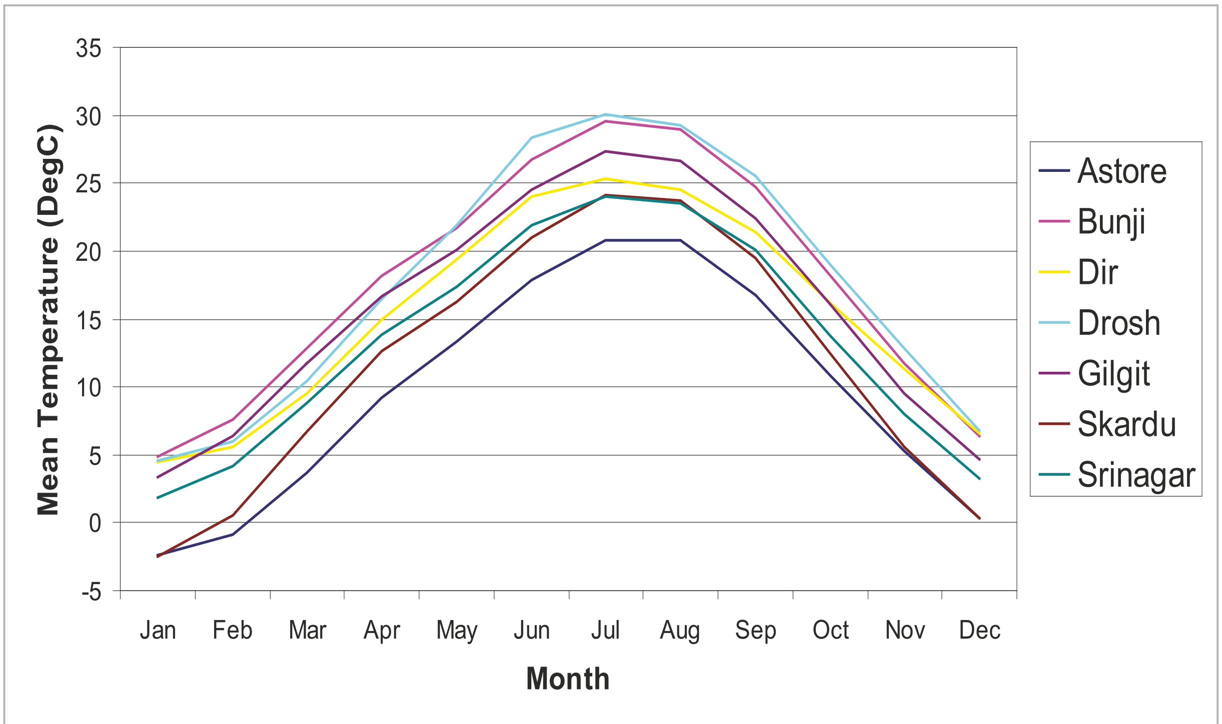
Topography: The region, with its spectacular mountains, glaciers, rivers, streams, lakes, forests and rangelands is unique in its topography. Forests and pastures are important biodiversity hotspots and storehouses of medicinal and aromatic plants. Glaciers and peaks are the only source of freshwater for almost 200 million people living in the plains of Pakistan. Nine rivers originate from the Himalayas, Karakoram and Hindu Kush Mountains, allowing the Indus to supply water for drinking, irrigation, fisheries and power generation downstream.

Physiography: Physiography is a product of the relief, slope and aspect and controls soil development, soil moisture, temperature regimes and ultimately land use. Soil provides moisture, nutrients and a foothold for roots and therefore the base for plant growth. Mountains comprising igneous, metamorphic and sedimentary rocks are rugged, with high relief amplitude and strong slopes ranging from 10 to 150 percent, with substantial accelerated soil erosion depending upon gradient, slope and vegetation. At some places very deep gorges have formed while at other locations sharp cliffs and peaks stand out. Rock debris is found at the foot of the mountains. Apart from the valley bottoms, river beds and plains, accessible slopes with thick soil cover are also terraced for arable farming with glacier melt or rain fed irrigation (Hashmi & Shafiullah, 2003).

Soils: Mountain soil in GB and AJK vary greatly in mineral composition from place to place. Soil in crests and upper parts of the mountains are very shallow (<20 cm) as compared to lower parts (20-50 cm), that are generally gravelly, coarse to moderately coarse, loamy and sandy. Some fine loamy and fine silt soils are also found but they are relatively low in organic matter, very free-draining, contain virtually no clay and have low natural fertility (usually < 1 percent OM). Soils are mostly calcareous (pH > 7) with low Cation Exchange Capacity (CEC) and a moderately high electrical conductivity (EC) and thus have poor water and nutrient holding capacity. Cultivated areas are mainly developed on alluvial fans and older river terraces, often brown to grey in color, moderately deep with better water holding capacity and comparatively fertile soil. Alluvial deposits at the base of the scree are another major cultivated land form and are used for plantation and growing forages. Soils in moraine deposits are salt affected, often low in fertility with little vegetation and high runoff. Cultivation is therefore limited to valley bottoms, river beds, alluvial fans and plains that depend largely on water from mountain streams, springs, rivers or rainfall for irrigation (Khan et al., 2004).

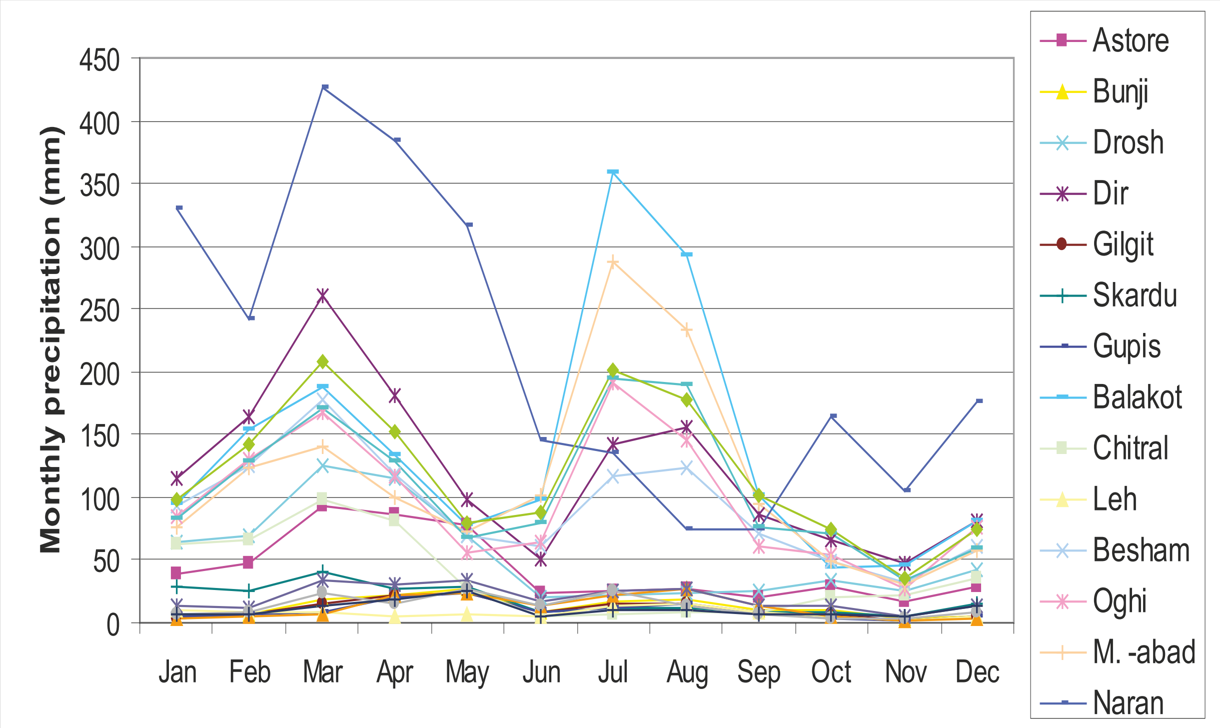
Climate: The climate is basically Himalayan, though modified by location and altitude (Figure 27). In AJK, sub tropical highland type climate prevails with 45.2^{0}C and -2.6^{0}C mean annual maximum and minimum temperatures, respectively. Rainfall varies greatly from place to place with an average of 1300mm annual (GoAK, 2011). In south western Gilgit and some parts of Astore rainfall is as high as 1000 mm year^{-1} but most of the cultivated areas receive below 500 mm and a broad tract across Ghizer, Gilgit and much of Baltistan receives >125 mm year^{-1} (Figure 28).

Figure 27: Monthly mean temperature in Northern Pakistan



Source: Fowler & Archer, 2006

Figure 28: Monthly mean precipitation in Northern Pakistan

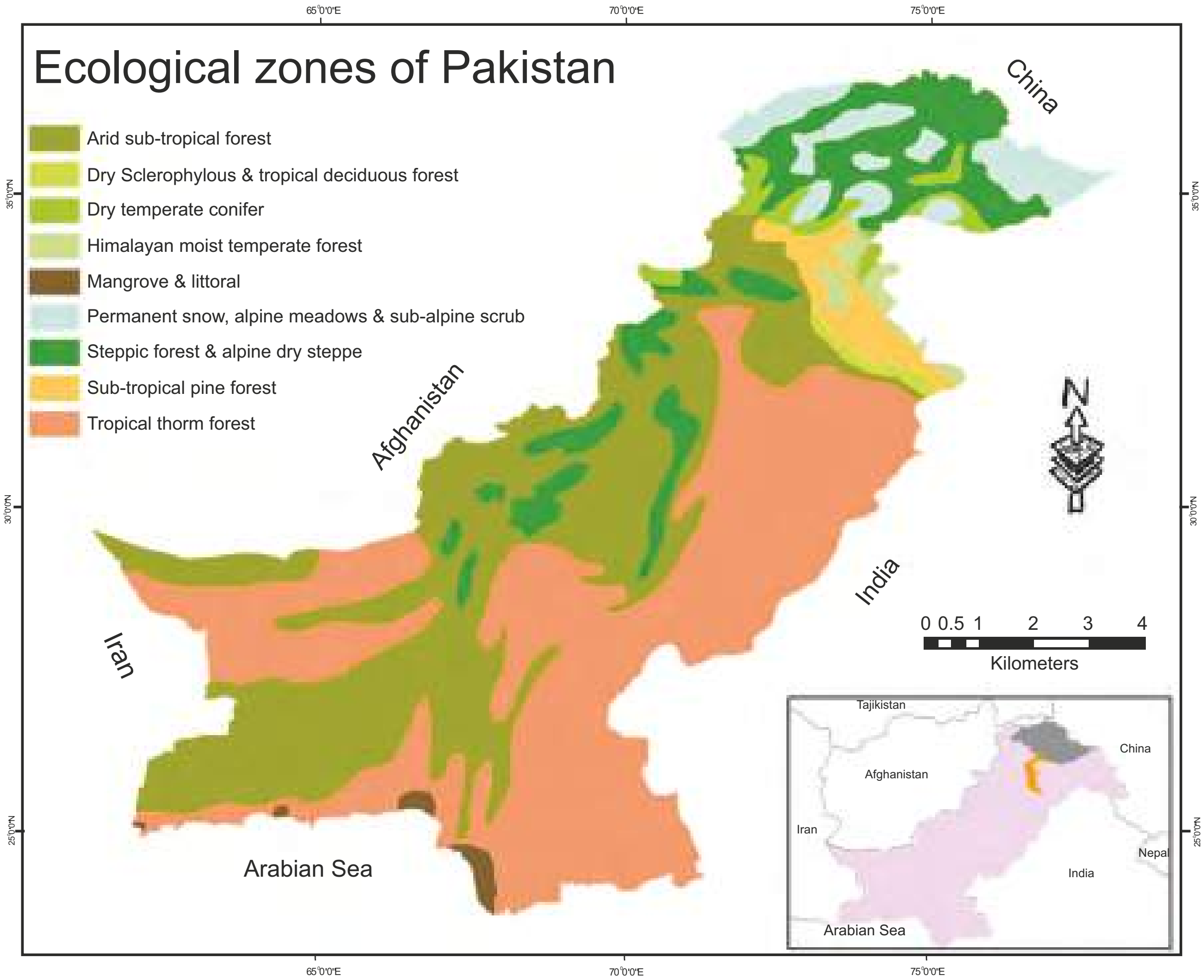


Source: Fowler & archer, 2006

The effect of altitude on climate is obvious, as it varies from 1250 m in the Indus Valley to above 8500 m at the peaks. The lower valleys are classed as arid and higher valleys as semi-arid. At higher elevations near the limit of cropping where forest and pastures occur, conditions are more semi-humid. On the mountains snowfall can be significant and annual precipitation can be in excess of 1000 mm. Altitude has an obvious influence on temperatures across the region, for example maximum temperatures in Gilgit being some 10 to 15 ^{0}C higher than those for high altitude villages in Astore, Skardu, Ganche, Ghizer and Hunza-Nagar (Hashmi & Shafiullah, 2003).

Major ecological zones: Subject to greater altitudinal variation and effects of humid westerly winds the region possesses a wide array of ecosystems and this climate variation in turn affects the type of vegetation and its associated fauna. Ecological zones are mainly based on the occurrence of plants at different elevations, aspects and prevailing climate. Anwar (2011) has identified the following eight prominent ecological zones in the northern mountains of Pakistan (Figure 29):

Figure 29: Map showing different ecological zones of Pakistan



(Source: GIS Lab, GCIC WWF-Pak 2013)

Cold desert and dry alpine zone: Most of the northern region including Chitral, Ghizer, Gilgit, Hunza, Skardu and Ganche fall into this zone. It cradles many of the world's highest peaks that are laden with snow, ice, glaciers and permanent snowfields, most of which are 5000 m above sea level (ASL). It is characterized by the most spectacular mountain scenery in the world. The valley bottoms encompass large sandy areas and sheer rocky cliffs which are apparently devoid of any soil or vegetation. However, small cold desert oases with stunt growth vegetation are found below the glaciers and permanent snow fields and on the banks of upland streams. Low xerophytic herbaceous vegetation also grows here during summer.

Himalayan moist alpine and sub alpine zone: This zone with scattered patches of Juniper and tumbled boulders is ecologically an important breeding area for many Himalayan migratory bird species. Glacier or snow melt often transforms this area into an alpine flower-studded carpet, fed by surface streams. Patches of white birch *(Betula utilis)* and thickets of wild rose (*Rosa webbiana*) and Berberis (*Berberis lycium*) are found in sheltered ledges and ravines. This zone extends throughout the higher slopes of Kaghan, Naran, AJK, GB, Swat, Dir and Indus Kohistan.

Alpine meadows: Alpine scrub and pastures are developed above the sub-alpine zone, around 4000 m in elevation. Mostly it comprises of scrub forming a dense cover of deciduous species and some ever green shrubs i.e. Juniper, Rhododendron and Ephedra etc. Sometimes it also includes a rich herbaceous growth of palatable grasses like *Acantholimon lycopodioides, Anaphalis triplinervis, Allardia stoliczkae, Anemone tatrasperma, Anemone obtusiloba, Arabidopsis himalaica, Astragalus himalayanus, Aster falconeri, Corydalis crassifolia* and *Carduus nutans.* These are common in Northern Hazara, Gilgit, Swat, Dir, Chitral and AJK where mountains often extend beyond the coniferous forest tree line.

Sub-alpine forests: This zone forms the upper most forest habitats in the Himalayas where trees are usually of moderate size but ground and field layers are well developed. It comprises a narrow range confined to small ravines on the upper slopes throughout the Himalayas, ranging between 3500 and 4000 m in elevation, in Hunza, Gilgit, Swat, Kohistan, Dir, Chitral and AJK. Major plant species include *Betula utilis*, *Sorbus aucuparia*, *Salix spp*, *Jiniperus communi*s, *Rhododendron anthopogon* and Poa spp.

Himalayan dry coniferous forests: This zone includes the northern Himalayan ranges with less influence of the monsoon and situated at an elevation between 1400 and 3350 m, extending from Gilgit, Astore and Chitral in the north down to Koh-e-Sufaid range and Takt-e-Suleiman in the south, in Balochistan. This zone can be sub divided into the following three sub-zones, depending upon the predominant tree associations there:

1. Dry temperate Evergreen Oak and Deodar forests are located in lower Indus Kohistan, Dir Kohistan, parts of Chitral and inner valleys of Hazara where Deodar and Blue Pine occur on higher elevations , while Hollyoak (Quercus baloot) and Artemisia spp can be found on the lower slopes
2. Dry temperate Blue pine and Spruce forests are found in Naltar, Astore and Gilgit
3. Dry temperate Chillgoza and Hollyoak forests occur in parts of Chilas, Darel, Tangir, Chaprote, Astore, Gilgit, Dir and higher reaches of Malakand agency.

Himalayan moist temperate forests: Being a breeding zone of Himalayan or oriental birds, this zone is an important biotope for wildlife. It is predominated by conifer forests with glades of mixed deciduous and broad leafed species common in the Murree hills range, lower Neelum and Kaghan valleys and eastern Swat bordering Indus Kohistan.

Tropical dry mixed deciduous forests: This zone represents an extension of the Siwalik zone further to the east, with a rich association of Indo-Malayan plant taxa confined to more sheltered ravines or north facing slopes. It consists of the catchments that drain into the Jhelum River, Kahuta, the lower Lehtrar valley and side ravines in the Margallah Hills National Park, Islamabad. Here spring and early summer is usually hot and dry but wet in late summer, with heavy annual rainfall (>940mm).

Sub-tropical pine forests: This is a narrow zone which ranges between 910-1820 m elevation with Chir pine (*Pinus roxburgii)* as a predominant tree species. It includes Kahuta, parts of Mangla Dam catchment area, lower parts of Kaghan and Swat valley and lower reaches of the Murree hills.

Biodiversity: The northern mountainous region of Pakistan is a living museum, blessed with a wide array of habitats that support rich biodiversity. The floral and faunal diversity has affinities largely to Palaearctic bio-geographic realm of the world and is part of the mountain ecosystem (Cox & Moore, 1993). The area falls under four biogeographic provinces of the Palaearctic Realm including Hindu Kush highlands, Himalayan highlands, Pamir-Tian-Shan highlands and Tibetan Plateau (Udvardy, 1975). So far 525 species of birds, 113 species of mammals, 50 species of reptiles, 90 species of fish and 15 species of amphibians have been recorded in the northern mountainous region, mostly rare and endangered but some being endemic to the Karakoram-Himalayas-Hindu Kush highlands.

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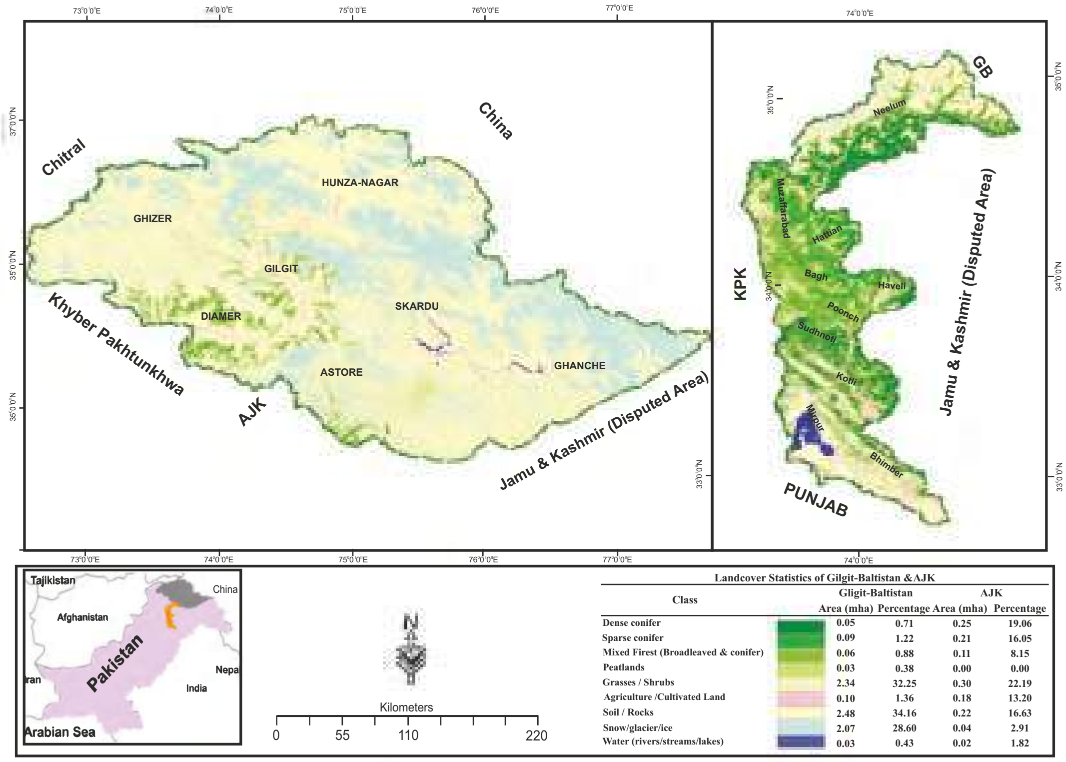
Similarly, rangelands including meadows, shrub meadows, shrub pastures, fir forage range, birch range and grass lands harbor highly valued medicinal and aromatic plants. They also protect water resources, recharge aquifers and provide fuel wood and grazing areas to rural communities for domestic energy and animal husbandry, which in turn contribute millions to the local and national economy. People living in remote valleys near forests and rangelands are often poor and depend largely on local forests and rangelands for subsistence and livelihood. The land cover details of GB & AJK are shown in Figure 30.

Figure 30: Landcover classes and statistics of GB and AJK



Class	Gligit-Baltistan Area (mha)	Gligit-Baltistan Percentage	AJK Area (mha)	AJK Percentage
Dense conifer	0.05	0.71	0.25	19.06
Sparse conifer	0.09	1.22	0.21	16.05
Mixed Firest (Broadleaved & conifer)	0.06	0.88	0.11	8.15
Peatlands	0.03	0.38	0.00	0.00
Grasses / Shrubs	2.34	32.25	0.30	22.19
Agriculture /Cultivated Land	0.10	1.36	0.18	13.20
Soil / Rocks	2.48	34.16	0.22	16.63
Snow/glacier/ice	2.07	28.60	0.04	2.91
Water (rivers/streams/lakes)	0.03	0.43	0.02	1.82

Landcover Statistics of Gilgit-Baltistan &AJK

(Source: GIS Lab, GCIC WWF-Pak 2013)

Livestock Population and Distribution: Livestock is an important sub-sector of agriculture that accounts for 37.5 percent of agricultural value-addition and about 9.4 percent of the country's GDP (Afzal & Naqvi, 2003). Keeping livestock is still a dominant mode of subsistence, as 35 - 40 percent of the household income is contributed by this sector and it is a primary source of livelihood for about 90 percent of the rural population in the region (AKRSP, 2008; GoAK, 2011). It therefore plays a key role in the local economy as well as the region's food security. In GB and AJK domestic animals are kept for many reasons including milk, meat, manure, wool/hair, prestige, movable assets and as insurance or endowment to be used in time of sorrow and joy.

In 1996 there were a total of 3.583 million livestock in the region, including 1.507 million in GB and about 2.076 million in AJK. These increased to a total of 4.871 million animal heads in 2006, including 9.87 million cattle, 16314 yaks, 6.22 m buffaloes, 7.35 m goats, 2.40 m sheep, 809 camels, 15679 horses, 6668 mules and 79372 asses, excluding rural and commercial poultry birds (Table 34).

Table 34: Livestock population in Gilgit-Baltistan and AJK (2006)

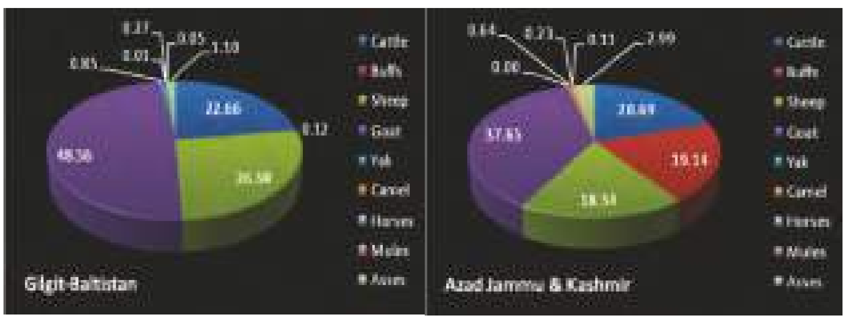
District	Cattle	Yaks	Buffs	Sheep	Goats	Camel	Horses	Mules	Asses	Poultry
Gilgit	123457	1982	304	168024	311657	89	107	24	7642	139784
Ghizer	59609	2455	95	47145	76827	33	516	38	3487	115490
Diamer	83449	1100	1705	45415	195148	30	1545	187	8151	108559
Skardu	121257	7,045	145	168433	244268	20	695	228	869	137988
Ghanche	47079	3732	14	75138	92921	14	2234	537	989	46922
Subtotal (GB)	434851	16314	2263	504155	920821	186	5097	1014	21138	548743
Muzaffarabad / Hattian	189909	0	101325	64925	291654	-	5005	2894	12694	995690
Neelum	46731	0	1215	48700	61874	-	3298	1644	1052	158285
Mirpur	32656	0	58183	5828	130911	136	881	123	10506	258957
Bhimber	68450	0	84205	5474	226650	220	318	39	10140	373820
Kotli	83934	0	169208	34332	398591	267	361	90	20290	808900
Bagh / Haveli	57758	0	73620	26283	109819	-	351	438	651	475460
Poonch	31932	0	81736	30996	137329	-	182	290	1356	662960
Sudhnoti	40412	0	51074	14354	130666	-	186	136	1545	478990
Subtotal (AJK)	551782	0	620566	230892	1487494	623	10582	5654	58234	4213062
Grand total	986633	16314	622829	735047	2408315	809	15679	6668	79372	4761805

(Source: GOP Agricultural Census Organization, livestock census 2006)

Almost 90 percent of the households in the rural areas of GB and AJK maintain a sizable number of livestock (3-8 animals) in different combinations, as part of their subsistence livelihood. Usually cattle, goats, sheep, yak and draught animals establish the household economy and the pasture grazing pattern.

Figure 31 shows the average composition of a livestock herd in GB and AJK, where people prefer keeping goats followed by cattle, sheep and buffaloes. The number of animals kept by a household is also intricately linked with availability of land, water, labor, accessibility and productivity of the grazing land (Beg, 2010).

Figure 31: Average livestock herd composition in Gilgit-Baltistan and AJK



(Source: GOP Agriculture Census Organization, livestock census 2006)

On an average, 90-98 percent of the total livestock population in GB (90 percent) and AJK, (98 percent) depend partly or completely upon pastures and rangelands, including forests for grazing from June to the end of August, while in spring and autumn these animals are grazed free, either in winter grazing lands like ranga in Baltistan or in fallow fields near villages (Baig, 2011; GoAK, 2011). The rest of the animals, (<10 percent) usually young ones below two years of age and lactating animals, are kept in villages throughout the year to meet the households' dairy requirements and provide farm yard manure for agricultural practices.

In the last decade (1996-2006) the total population of livestock in GB and AJK increased by 27 percent and 30 percent respectively. The number of buffaloes increased manifold (260 percent) in GB, followed by mules (56 percent), asses (39 percent), cattle (38 percent), goats (34 percent) and camels (32 percent), whereas, in AJK, cattle, buffaloes, goats, mules and assess increased by 45 percent, 35 percent, 31 percent, 18 percent and 20 percent, respectively (Table 35).

Table 35: Livestock population trend in Gilgit-Baltistan and AJK (1996-2006)

Species	Gilgit-Baltistan			Azad Jammu & Kashmir		
	1996	2006	± % (1996-2006)	1996	2006	% ± (1996-2006)
Cattle	0.315	0.435	38	20.424	29.559	45
Buffs	0.001	0.002	260	20.273	27.335	35
Sheep	0.458	0.506	10	23.544	26.488	13
Goat	0.698	0.932	34	41.196	53.787	31
Yak	0.015	0.016	9	0	0	0
Camel	0.000	0.000	32	0.815	0.921	13
Horses	0.004	0.005	19	0.334	0.334	0
Mules	0.001	0.001	56	0.132	0.156	18
Asses	0.015	0.021	39	3.559	4.268	20
Total	1.507	1.919	27	110.277	142.848	30

(Source: GOP, Statistics Division, Agricultural Census Organization, Livestock census 2006)

It is worth mentioning that livestock population Figures in AJK for 1996 and 2006 acquired from the AJK Economic Survey Report (2006-2007) with reference to Statistics Division, Agricultural Census Organization, Livestock Census (2006), differ greatly from actual Figures in many other references, so for optimum accuracy only percent changes have been used for population-period comparisons.

Rangeland Resources

Distribution of Rangelands: Pakistan is an agricultural country with a total area of 88 million hectares rangeland and 154.70 million head of livestock that contributes 11 percent to the GDP (Chaudhry, 2010). Almost 65-70 percent of the country's total area consists of rangelands, which provide feed for about 97 million heads of livestock (Ahmad et al., 2008). Studies reveal that animals in Pakistan are getting 38 percent of their nutritional requirements from rangelands (Hanjra et al., 1995).

About 30-35 percent of GB is covered by rangelands. AJK generally consists of moderate to steep slopes, usually broken by an intricate maze of narrow ravines, gullies, channels, sharp crests and apexes, resulting from accelerated erosion of soft geological materials. It has only 13 percent agricultural land (Butt & Ahmed, 1996) and the rest is classified as demarcated forests (42.62 percent), cultivable waste

(2.42 percent) and uncultivable waste (41.96 percent), which has been used for grazing more than four million different types of livestock (Tirmizi & Rafique 2001; Afzal et al. 2006). Grasses and shrubs cover 22.19 percent of the total area, accounting for about 0.30 million hectares, including 0.15 million ha of alpine and sub alpine pastures (Tirmizi & Rafique, 2001).

Types of rangelands: Three major types of rangelands viz. alpine pastures, trans-Himalayan grazing lands and Himalayan forest grazing lands are found in Gilgit-Baltistan and AJK. The salient features of these types are as follows:

Alpine Pastures: The alpine pastures lie above an altitude of 3500 m and below the permanent snow area, throughout the region. This includes high altitude valleys in GB (1.83 m ha) and AJK (0.08 m ha) including Astore, Kel, Ghumot, Diamer, Gilgit, Ghizer, Ganche, Hunza-Nagar, Skardu, Hatian Bala and Muzaffarabad. Alpine pastures are characterized by short, cool growing seasons and long, cold winters. Much of the landscape of the alpine pastures is rugged and broken with rocky, snowcapped peaks, spectacular cliffs and slopes. However, there are also many large areas gently rolling to almost flat topography. Slow growing perennials, herbs, shrubs and extensive growth of cryptograms i.e. mosses and lichen etc, often with no tree growth, dominate the native vegetation. Forage (dry matter) production varies from place to place depending on altitude and aspect, mainly controlled by low temperature for many months of the year.

It varied for different elevations in Khunjerab National Park (KNP) between 370 - 580 kg $ha^{-1,}$ and in Chaprote near Gilgit from 500-750 kg ha^{-1}, with average forage production recorded at 700 kg ha^{-1}(Khan, 2003). Alpine meadows containing luxuriant ground flora are often the highest value grazing lands, with an average stocking capacity of 5 ha per animal unit, if well managed (Khan, 2003) but these are often subjected to heavy grazing during summer without any planned grazing systems. Crop production, livestock herding and forestry are major land uses.

Common floral species include trees like *Juniperus communis, Rosa webbiana, Berberis spp, Cotonneeaster sp.;* grasses i.e. *Phleum alpinum, Agrostis gigantea, Trisetum spp. Poa spp. Agropyron dentatum, Agropyron caninum, Festuca ovina, Alopecurus gigantea, Dactylis glomerata, Pennisetum lanatum, p. filaccidum, Clamagrostis pseudopharag mites, Oryzopsis spp, Carex spp*; forbs like *Plantago ovata, Plantago major, P. lanceolata, Trifolium pratense, T. repens,Fragaria Wesca, Medicago spp, Potentilla spp. Rumex nepalensis, Polygonum alpinum, Anaphalis contorta, Thymus serphyllum, Astragalus spp, Taraxicum officinalis, Irishookriana, Nepata spicata, Saxifraga iacquemon tiana.* Plants of high medicinal value are *Aconitum heterophyllum, Aconitum chasmanthum, A. laeve, Saussurea lappa, Rehum emodii and Podophyllum hexandrum* (Karki and William, 1999; Rasool, 1998; Khan et al., 2011; Ishtiaq et al. 2012).

Trans-Himalayan grazing lands: Trans-Himalayan grazing lands are spread over the northern mountains in Astore, Darel, Tangir, Haramosh, Jaglote, Kargah and Naltar in GB, at elevations ranging between 1500 m to 8600 m ASL. The area has high peaks including 19 over 7000 m, such as K2 (8611 m) the world's second highest, Nanga Parbat (8125 m) and Rakaposhi (7788 m), with rugged, steep dissected slopes and narrow valleys with accelerated geological erosion. The terrain is naturally unstable, landslides and rock falls are very common. The climate of the area is that of a mountain desert with bitterly cold winters and hot dry summers.

The climatic variation in the area is greatly influenced by altitudinal differences. Low altitudes (below 2300 m) experience marked diurnal as well as seasonal temperature variations and scant precipitation. The areas between 2300 and 3300 m receive sufficient snow and enjoy a temperate climate. Areas above 3300 m are very cold with a limited growing season.

Most of the areas are beyond the reach of summer monsoon rainfall. Average rainfall in the valleys is 100-300mm, most of which occurs during winter and early spring. The major land uses in this area are mountain farming, livestock herding and forestry. Maize, wheat, potato, buckwheat and barley are the principal crops grown at lower elevations. Double cropping is practiced up to 2,300 m but single short duration crops are grown at higher elevations. Seed potato is the important cash crop of this area. Orchards of apricot, apple, pear and mulberry are important components of the farming system.

These grazing lands are usually over-grazed by livestock and natural vegetation is illicitly removed for firewood. Forage (dry matter) production varies from 500 – 1500 kg ha^{-1}. Native vegetation includes trees, shrubs, herbs and forbs. Ahmad & Qadir (1976); Alam (2010); Khan & Khatoon, 2008 reported *Juniperus macropoda, Quercus ilex, Pinus gerardiana, Cedrus deodara, Pinus wallichiana, Fraxinus xanthoxyloides, Artemisia maritima, A.sacrorum, Indigofera spp. Ephedra spp, Daphne oleoides, Sophora spp, Cotonneeaster spp. Parrotia jacquemontiana, Salix spp. Jasminum spp. Sorbaria tomentosa, Caragana spp.)* as the common trees and shrubs; *Chrysopogon spp. Cymbopogon spp, Dichanthium annulatum, Pennisetum orientale, Aristida spp, Oryzopsis sp., Dactylis glomerata, Poa spp, Bromus inermis, Agropyron dentatum, A. caninum, Agrostis spp, Rottboellia exaltata, Phacelurusspeciosus, Eragraostis spp.* as grasses; and *Iris spp*, *Tulips spp, Polygonum spp, Sambucus ebulus, Lotus comiculatus, Medicago spp, Plantago lanceolata, Lathyrus spp, Thgmus serphyllum, Nepata spicata,Viola spp, Taraxicum officinalis, Ferns* as forbs and *Ephedra nebrodensis, Artemisia maritima, Carum bulbocastanum,Thymus and Ferula, Juglans regia, Pinus gerardiana and Zizyphus sativa* as the common medicinal and aromatic plants.

Himalayan forest grazing lands: Himalayan forest grazing lands estimated around 0.27 million ha in Neelum and Jhelum valleys of AJK fall in the moist temperate and subtropical humid ecological zones, with a predominance of Blue pine, Deodar, Spruce and Silver fir forests that occur mostly above 2000 m elevation up to the timberline. Most of the areas in this zone receive more than 1000 mm annual rainfall during the monsoon, which causes accelerated soil erosion on steep slopes which have often been tilled unscientifically for growing maize, rice, wheat and potatoes. Summers are cool but winters are freezing cold. Forestry, cropping and livestock grazing are the major land uses. Blue pine and Chir pine trees cover a large forest area. Under field trials the forage production of these rangelands is estimated to be about 1000 kg per ha^{-1} which after a year's protection increased five times (Amin & Ashfaq, 1983). Similarly, Afzal and others (2006) recorded a maximum above ground dry matter production of 1410 kg ha^{-1} from 10 kg ha^{-1} of seeding in the sub-tropical zone of Muzaffarabad. Animals are grazed in forests, fallow lands and along water channels.

Important plant species (Khan et al. 2012; Ishtiaq et al. 2012) include trees (*Pinus wallichiana, Picea smithiana, Taxus wallichiana, Cedrus deodar, Quercus incana, Q. dilatata, Q. semicarpifolia, Juglans regia, Aesculus indica, Acer pictum, A. caesium, Populus alba, P. ciliata, Pyrus spp.);* shrubs (*Vibernum nervosum, Indigofera spp, Rosa webbiana, Salix spp, Cotonneeaster spp, Pistacia spp, Berberis lycium, Prunus cornata, Rhododendron arboreum, Sarcococca saligna, Rubus spp, Desmodium spp, Strobilanthus spp.);* grasses (*Dactylis glomerata, Agropyron dentatum, Phacelurus speciosus, Rottboellic exalatata, Alopecurus gigantea, Pennisetum flaccidum, Oryzopsis spp, Poa spp. Stipa sibirica, Bromus inermis,* *Bothriochloa paseudoischaemum, Chrysopogon echineulatus,Themeda anathera);* forbs (*Plantago ovata, P. major, P. lanceolata, Senecio spp, Rumex nepalensis, Astragalus spp, Trifolium repens. T. pratense, Lotus corniculantus, Fragaria vesica, Medicago spp.,Geranium collinum, G. nepalensis, Thymus serphyllum, Polygonum aviculare, P.parencoides, Phlomis bracteosa, Taraxicum officinalis)* and medicinal plants (*Zizyphus vulgaris, Punica granatum, Berberis lycium, Skimmia laureola, Viola serpens, Dioscorea spp, Valeriana wallichii, Atropa acuminata, Colchicum luteum, Asparagus racemosus, Mentha piperita).*

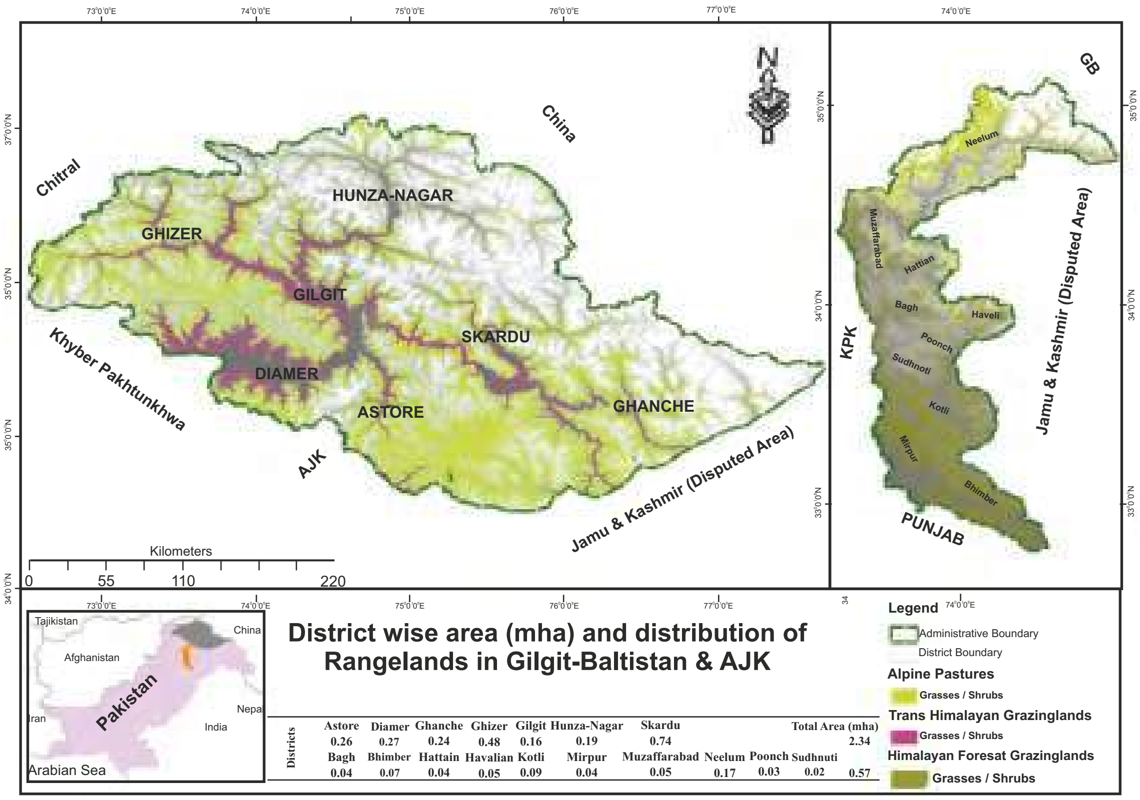
Extent and distribution: The pastures and rangelands of GB and AJK encompassing 2.34 and 0.57 million hectares constitute around 33 percent and 43 percent of the total surface area of GB and AJK, respectively. However, in previous studies 22 percent (GOP & IUCN, 2003) and 52 percent (FAO, 1992) of GB and 11.97 percent (0.159 m ha) of AJK (Tirmirzi & Rafique, 2001) has been reported as being under grasses and shrubs.Out of the total rangeland area (0.60 m ha) of AJK, almost half (0.30 m ha) comprises shrubs and grasses, whereas the remaining half (0.27 m ha) comprises Himalayan forest grazing land. The present extent and distribution of pastures and rangelands in the region is given in the table 36 and Figure 32.

Table 36: Rangeland resources of Gilgit-Baltistan & AJK

Rangelands Types	Area (m ha)	Distribution(MR)
Alpine Pastures of GB	1.83	Himalayas, Karakoram, Hindu Kush
Trans Himalayan Grazing lands of GB	0.50	Karakoram, Hindu Kush
Alpine Pastures of AJK	0.08	Western Himalayas
Sub-tropical Humid zones & Temperate humid zone (Open Grasslands)	0.22	Western Himalayas
Himalayan Forest Grazing lands	0.27	Western Himalayas

(Source: GIS Lab, GCIC WWF-Pak 2013)

Figure 32: Rangeland resources of Gilgit-Baltistan & AJK



(Source: GIS Lab, WWF-Pakistan, Gilgit 2013)

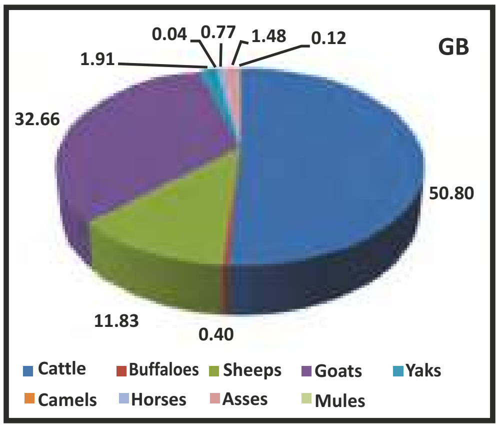
Current State of Rangelands: A large part of the region such as Gilgit-Baltistan usually remains out of the monsoon rain shadow, which makes the natural environment harsh and arid. It is often characterized by low precipitation (< 200mm rainfall), extreme temperatures and low humidity, unlike humid and sub-humid areas of AJK where dry matter forage productivity is quite high. The pastures and rangelands support more than 5 million local and nomadic livestock during the summer months, which perhaps are the major source of feed (> 80 percent) particularly for sheep and goats (Figure 33). The centuries old traditional grazing system, coupled with increasing human population and livestock numbers and the climatic challenges have decreased the productivity of rangelands. This has led to an expansion of dry land farming on marginal lands to satisfy the increasing demand for human food crops and the cutting of shrubs and trees for domestic fuel consumption (Chaudhry, 1980; FAO, 1987). As a result, more palatable grasses, shrubs and trees that once covered the rangelands have been removed or thinned out and replaced by unpalatable low quality vegetation. Therefore, each year, insufficient forage during the dry period causes heavy losses of livestock (Alvi and Sharif 1995; Grainger, 1990; PARC, 1998).

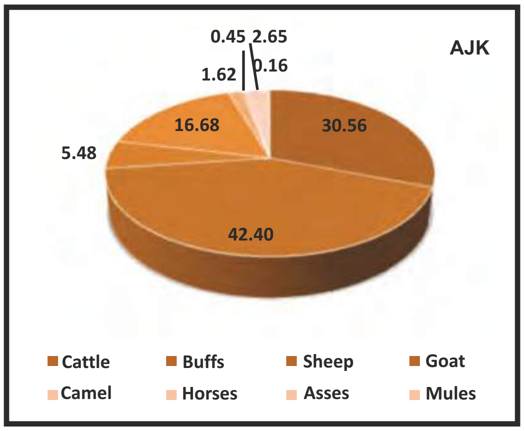
Over the past few decades, the livestock population in GB and AJK has increased tremendously. The majority of livestock mainly small ruminants are grazed in pastures and rangelands due to a shortage of fodder production particularly during summer months. The substantial increase in domestic herbivores over this period and their dependence largely on pastures has resulted in serious grazing pressure on rangelands. Generally, the animal production system in rangelands operates on a low input basis and the pressure on the land is further increased by the animals brought for grazing by nomads from different parts of the country.

The nomads come to pastures in Deosai via AJK from Punjab. Afghan nomads enter Punial, Shandoor and Ishkoman via Chitral valley. Currently, an estimated total of about 0.86 million animal units are being grazed in 2.34 m ha of rangelands in GB, at a stocking rate of 2.73 ha per animal unit and about 2.05 million animal units in 0.6 m ha of pasture and forest grazing lands of AJK, at a stocking rate of 0.292 ha per animal unit (Afzal et al., 2008; Crooks & Omastan, 1994). These numbers are substantially higher than the critical stocking rate (16 ha/animal unit) recommended by FAO 1987 for low potential rangelands.

Although the production of dry matter forage in humid and sub-humid rangelands of AJK is far better than that of the dry arid rangelands in GB, these stocking rates are many times the FAO recommended rate. Therefore it is apparent that these rangelands are burdened and over grazed which if not managed properly, may lead to severe degradation. Such overstocking of animals may affect the inherent production capacity of rangelands and a continuous decline in vegetation cover accelerating soil erosion and in the long run may cause desertification of rangelands.

Figure 33: Small and large ruminants as percent animal units in Gilgit-Baltistan & AJK





(Source: GOP Agricultural Census Organization, livestock census 2006)

Previous studies on pastures of KNP in GB and Machiara in AJK have also revealed that > 70 percent of the pastures and rangelands in these areas are depleted, mainly due to excessive grazing by livestock and removal of natural vegetation by the locals to cater to the demands for domestic energy (Khan, 1996). They are also threatened by unfavorable changes in the prevailing climatic conditions (Khan, 2009).

Range Productivity, Utilization and Strategies

Productivity: The mountainous area of GB and AJK has both dry and moist temperate coniferous forests and their associated rangeland ecosystems. A large part of GB is, however, located out of the monsoon rain shadow which makes the natural environment harsh, with alternating temperatures usually low in winter and high in summer. In AJK sub-tropical to temperate highland type climate prevails, with an average yearly rainfall of 1300 mm. Snow line ranges between 1200 and 3300 m ASL during winter and summer seasons. Both the domestic as well as wild herbivores graze the rangelands and pastures as and when the snow melts and new or old green growth appears. Studies reveal that productivity and bio-diversity of alpine and subalpine ranges has been declining in GB (Bari, 2001). Similarly, Afzal and others (2006) estimated dry matter biomass production of 1410 kg ha for the Himalayan forest grazing lands, in sub-tropical zone of Muzaffarabad, AJK. Previous records were 1000 kg ha^{-1}, which is reported to have increased almost five times, against grazing for a year (Amin & Ashfaque, 1983).

It is estimated that except in the alpine pasture (1.91 m ha) where dry matter bio mass production is above 1500 kg ha^{-1} which is within the normal range, most of the other rangelands produce significantly less, ranging between 200-500 kg ha^{-1} against their potential to produce 1500 kg ha^{-1}(Table 37).

Table 37: Estimated Forage Biomass Production from selected pastures in Gilgit-Baltistan

District	Species composition	Cover (%)			Productivity (kg/ha)		Remarks	
	No of species recorded	Foliar cover	Bare ground	Weed	Productivity at the time of survey	Estimated Potential Productivity	Pasture condition	Pasture trend
Gojal	27	73	27	2	407	1400	Poor	Down
Astore	26	72	28	27	428	1600	Poor	Down
Skardu	30	54	46	7	241	1200	Poor	Down

(Source: Bari, 2001)

The results indicate that the estimated dry matter forage productivity of rangelands is only 25 percent of its potential. Prominent factors affecting the poor condition include changes in the species composition, overall reduction in the vegetation cover, less quantity of litter and gullies and rill formation. Besides the geological and hydro-metrological factors this degradation also contributes to landslides and shifting of grazing pressure to other pastures, which can also in due course of time undergo the same process. The degraded pastures also have a negative impact on the health and productivity of wild and domestic herbivores. Uncontrolled grazing and deforestation are the key factors responsible for downward productivity of pastures and of the livestock in the region (Bari, 2001). The latest estimates of dry matter forage productivity of pastures and rangelands are not available either for GB or AJK but the previous estimates by Muhammad (1989) for the pastures and rangelands in the HKH mountain region are about three times less than their potential productivity, (Table 38) mainly because of these rangelands being over exploited and barely at all managed for a long time.

Table 38: Forage Dry Matter Production and Potential of Different Rangeland Types in GB &AJK

Rangeland	Area (moa)	Current production		Potential	
		DM	Total DM	DM	Total DM
		Tonne ha^{-1}	MT	Tonne ha^{-1}	MT
Alpine pastures	1.68	1.5	2.25	2.5	4.2
Trans-Himalayan grasslands	3.5	0.6	2.1	2	7
Himalayan forest grazing lands	0.67	0.6	0.4	3	2.01

(Source: Muhammad, 1989)

Utilization: The Himalayan-Karakoram-Hindu Kush (HKH) mountainous region of Pakistan harbors a great variety of ecosystems, especially along the vertical dimension which provides numerous goods and services to its inhabitants. Rangelands and their interfaces are dominant land-use types encompassing unique ecosystems like alpine meadows and forests, peat lands, swamps, high altitude lakes/wetlands and agro-ecosystems adjacent to high pastures and on alluvial fans. These ecosystems provide critical services to more than 2.0 million people directly dependent on natural resources for their livelihoods. These high altitude rangelands and their interfaces are also major catchments of freshwater that accumulate to flow down to the River Indus, to sustain the agro-based economy of Pakistan.

Socio-economic wellbeing: One of the major functions of rangelands in GB and AJK is the provision of agro-pastoral livelihoods, supporting about five million head of livestock in the region. About 80-90 percent of local people practice a transhumance system of animal husbandry which accounts for 30-40 percent of the total household income. Rangelands on the average contribute more than 60 percent of the livestock feed requirements in GB and AJK. Summer and winter grazing areas constitute the major part of rangelands, which include grasslands within village boundaries, winter grazing areas adjacent to the villages and summer pastures at higher elevations. The majority of the population in AJK (>80 percent) lives in rural areas and have a large dependence on forests and rangelands for their basic needs and livelihood. About 89 percent of households use wood for cooking and space heating , 94.12 percent in rural areas and 50.47 percent in urban areas whereas 98 percent of the rural population depends on forests for grazing animals partially or completely, while 87 percent depend on them completely (GoAK, 2010).

Cradle of freshwater sources: The forests and rangelands of GB and AJK are the primary watersheds of Tarbela, Mangla and the future Diamer-Basha and Bunji dams. It is not an exaggeration to state that the mountains in the areas are very fragile but are vital for their watershed services at the local and the national levels, as these grasslands enhance infiltration and help combat soil erosion. In Pakistan both the dry and moist temperate ranges in the northern areas are under heavy grazing and firewood pressures by locals as well as nomads. That affects not only the on-site forage productivity but also water quality and siltation of reservoirs because the residual phytomass significantly changes infiltration rate (Bari et al., 1993). Undoubtedly the environmental role inclusive of watershed service offered by rangelands is far greater than their grazing and firewood production roles, which has neither been evaluated nor ascertained in the past. Besides enhancing the life span of these dams, the northern rangelands can help prevent floods, maintain local water supplies and conserve soils, if maintained properly.

Biodiversity: Gilgit-Baltistan and AJK are bestowed with exceptional natural features. Together they constitute an astonishing but fragile mountain ecosystem sheltering a magnitude of rare and endangered wild species of flora and fauna, including 113 species of mammals, 525 species of birds, 23 species of reptiles, 15 species of amphibians, 90 species of both cold and warm freshwater fish and 85 species of butterflies (Anwar & Akbar, 2011). The GB region alone is reported to harbor 230 species of birds, 54 species of mammals, 23 species of reptiles, 20 species of fish and 6 species of amphibians (GOP/IUCN, 2003).The Deosai plains, adjacent to Astore, are known to have over 10,000 species of wild plants, almost 50 percent of which are endemic to the Karakoram–Himalayan mountain ranges. The types of biodiversity found in various ecological zones of GB and AJK, adapted from Roberts (1997), Mirza (1998), GOP/IUCN (2003) and Anwar & Akbar (2011) are shown in Table 39.

Table 39: Biodiversity profile of the Northern mountainous region and Gilgit-Baltistan

Taxon	Reported for Pakistan	Estimated for Northern Mountains	Estimated for Gilgit-Baltistan	Endemic to the region
Mammals	188	113	54	4%
Birds	668	525	230	8%
Reptiles	177	50	23	10%
Amphibians	22	15	6	?
Fish	525	90	20	11%
Insects	> 5000	85 (butterflies)	?	?
Plants	> 6600	?	?	5%

Source: Wildlife of Western Himalayan region of Pakistan (2011) & GOP/IUCN (2003)

Fish and Fauna: The region has many rivers, streams and alpine lakes fed by snowmelt and glacier waters. The freshwater resources contain several fish species which are an important component of the region's biodiversity. The fish are predominately Palearctic with elements of Central Asian highlands. The fish diversity in Gilgit-Baltistan is not yet described in great detail despite their biological and evolutionary significance. However, some recent studies report there are about 17 species of native and 3 of exotic fish belonging to five families. Out of these 17 native species, four are endemic to Gilgit-Baltistan, while several others have ranges confined to one or two localities. For example, *Triplophysa stoliczkai, Ptychobarbus conirostis* and *Schizopygopsis stoliczkai* are only found in eastern waters up to Kachura. During the Hunza/Gojal expedition of 2000 undertaken by the Oxford University Museum of Natural History and the Pakistan Museum of Natural History, specimens of three species of fish were collected out of which one was reported as being endemic here (Virk et al., 2003). The number of fish species found in high altitude streams and lakes of GB is quite low, mainly due to high turbidity, low water temperature, high water speed, low benthic productivity and long stretches of narrow river gorges (Rafiq, 2002). For example only three fish species were recognized from the Deosai plateau which included *Triplophysa stoliczkai, Diptyichus maculatus,* and *Ptychobarbus conirostis* (Woods et al. 1997). Among exotic species, brown trout was introduced in Gilgit agency during the early 1900s and is now well established and found in most of the rivers and lakes of Gilgit and Ghizer districts.

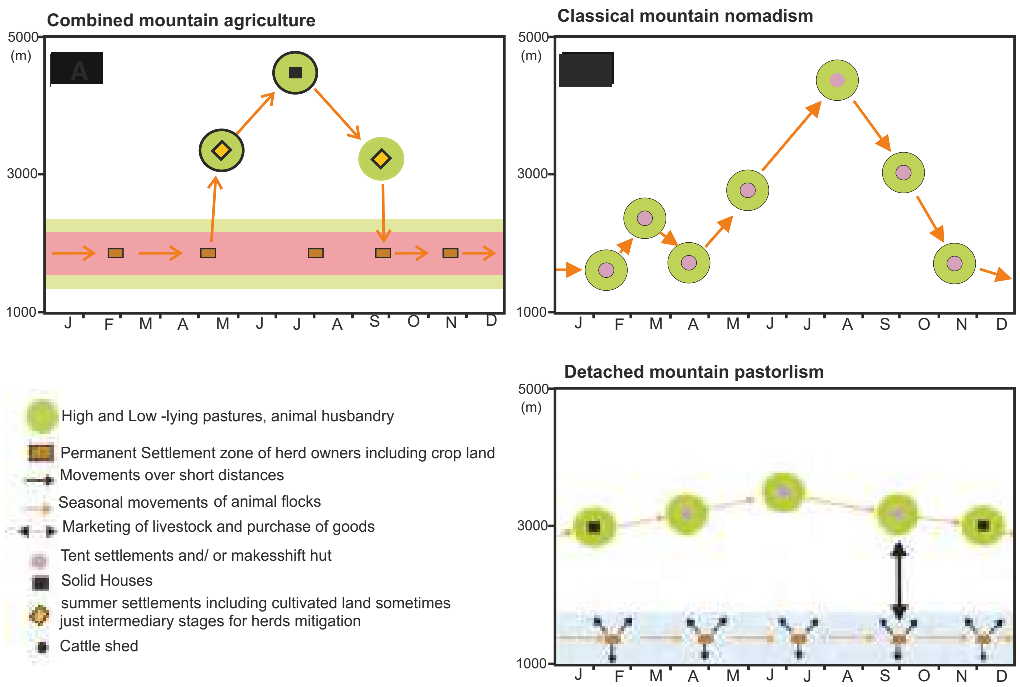
Contrary to the rivers of GB, the surface water resources in AJK consist of three main rivers including Jhelum, Neelum and Poonch which emanate from the catchments of Occupied Kashmir and drain along with their tributaries into the Mangla Reservoir. This offers an excellent habitat for about 26 different species of fresh water fish, including 8 endemic, 13 indigenous and 5 exotic species (Rafique & Khan, 2012)while Akhtar (1991) has listed 38 indigenous and 7 introduced exotic species for AJK. Important types of fish available in various rivers are Snow Trout, Gulfam, Brown Trout and Rainbow Trout in Neelum River; Mahasheer, Gulfam, and Snow Trout in Jhelum and Poonch Rivers and Mahasheer and Rohu in Mangla Lake (GoAK, 2010).

Carbon sink: The forests and rangelands of the northern mountainous region are very important sinks of atmospheric carbon. Their classified role in fixing atmospheric carbon is not yet well understood. Comprehensive scientific research is therefore needed to assess the carbon fixing capacity of different rangeland ecosystems in the region so the carbon sequestration value of rangelands could be harnessed for social, economic and ecological development in the region.

Pasture use strategies: Traditionally pastures and rangelands are classified into three categories namely spring pastures, summer pastures and winter pastures and thus three principal types of livestock grazing systems exist in GB and AJK viz. pastoral, transhumant and sedentary. However, in towns and cities animals are also kept to supply milk, meat and milk products to hotels and the urban population. The majority of the rural households keep livestock to meet their routine needs of milk, meat and other dairy products. More than 90 percent of these households in GB partly practice the transhumance system of animal husbandry during the summer months.

Similarly in AJK around 0.6 million sheep and goats, along with 0.02 million pack animals like horses, mules and asses of the nomads visit alpine pastures regularly for spring and summer grazing. This is in addition to the local 2.4 million head which start grazing as soon as growth appears until the snowfalls in autumn, leaving no time for flowering and seeding of rangeland species. This results in grazing the grasslands and commercial forest areas beyond their carrying capacity (GoAK, 2005).

Figure 34: Time-space diagram for different types of pasture use in northern mountains of GB and AJK



Pastoral System: The livestock census of 1996 showed 1-2 percent of the total population of livestock is currently under this pastoral system, which in fact is a form of *Detached Mountain Pastoralism* (Figure 34 C). It can be assumed that more or less the same fraction of small and large ruminants (<10 percent) are still being grazed on highland pastures throughout the region. Here animals are usually reared in a nomadic pattern of animal husbandry often characterized by year-round movement of animals in search of healthy grazing lands in alpine and sub alpine pastures (> 3000 m ASL). Only 4.6 percent of cattle, 0.8 percent sheep, 1.6 percent goats and 94 percent yaks of the respective total populations are thought to be under this system. Real pastoralists do not own land nor do they engage in farming activities. They in fact keep on moving their herds between the alpine and sub-alpine pastures. Usually they spend summer in alpine and sub alpine pastures and autumn through winter till spring in lower ranges. Non-local pastoralists sometime pay a nominal grazing tax to the local government or landowners for the right to graze their animals in their pastures.

Transhumant System: About 90 percent of the total livestock population in the region (144.7 million) is currently managed under the transhumant system of animal husbandry, which is either a form of the *Combined Mountain Agriculture* (Figure 34 A) or the *Classical Mountain Nomadism* (Figure 34 B) as categorized by *Kruetzmann (2004).* The majority of the ruminants such as 95 percent cattle, 98 percent sheep and 97 percent goats are maintained under this production system. Seasonal migration takes place between permanent home stays in the valley bottoms through forests up to natural high pastures in the vicinity of glaciers. During summer, animals are gradually taken upward first on lower summer pastures, then to forests and sub-alpine pastures and finally to high alpine pastures. The migration to and from the mountains typically takes place in a series of well-defined stages usually determined by tribal leadership. Their schedule reveals a time-space relationship in the utilization of local available resources. During the cold winters, animals are kept indoors and fed on maize stover, wheat straw, rice husk, and hay. In late April or early May a part of the household treks to the edge of the conifer forests where they stay for three to four weeks before moving to a third stage located within the forest itself. After a further stay of three to four weeks, both livestock and people move to the high alpine pastures where they spend the remaining summer months. They return with the first snowfall in late September or early October. In some areas animals are taken to summer pastures by paid shepherds in mixed herds of 40-60 animals, while owners stay at home. In this system of animal husbandry herders also grow vegetables like potatoes, peas and chillies and in some other places they grow cereals such as buckwheat, barley and jute for subsistence and sale.

Sedentary System: In this system, animals are kept the year round in villages and grazed either near agricultural fields or in irrigated pastures and meadows and are not taken anywhere else. In Gilgit-Baltistan barely 2-3 percent of the total number of livestock is stall fed whereas in AJK a greater proportion of lactating large ruminants are maintained under this system. Normally most productive lactating animals like cattle, buffalos, sheep and goats are grazed on gentle slopes, irrigated pastures and in fallow agricultural fields. Maize stover, hay, grasses and kitchen waste are the principal source of stall feeding. In some villages progressive farmers also arrange silage and other supplements to feed their milking animals during summer as well as winter seasons.

Major Causes of Rangeland Deterioration

The area of natural pasture land has declined drastically, while the remaining areas are degrading fast and have become dominated by rocks, scrub and inedible or poisonous plants. Diversity has also decreased (Sher et al. 2004).

As part of this study, a questionnaire-based rapid assessment was also conducted to appraise the nature and extent of existing as well as emerging threats to the rangelands in GB. For this purpose, a total of 102 respondents including both individuals and Focused Groups (FG) representing relevant government, non-government and community stakeholders, were interviewed and their responses used to determine the nature and extent of threats to rangeland resources in the region. The same questions were asked from key officials of the Forest, Wildlife and Fisheries Department of AJK. The respondents were of the view that rangelands are a fast diminishing resource for various reasons but primarily due to over grazing, removal of natural vegetation for fodder and firewood, encroachment and conversion to other land uses, drought and climate change and trampling. A brief account of these threats and issues and their causes is as follows:

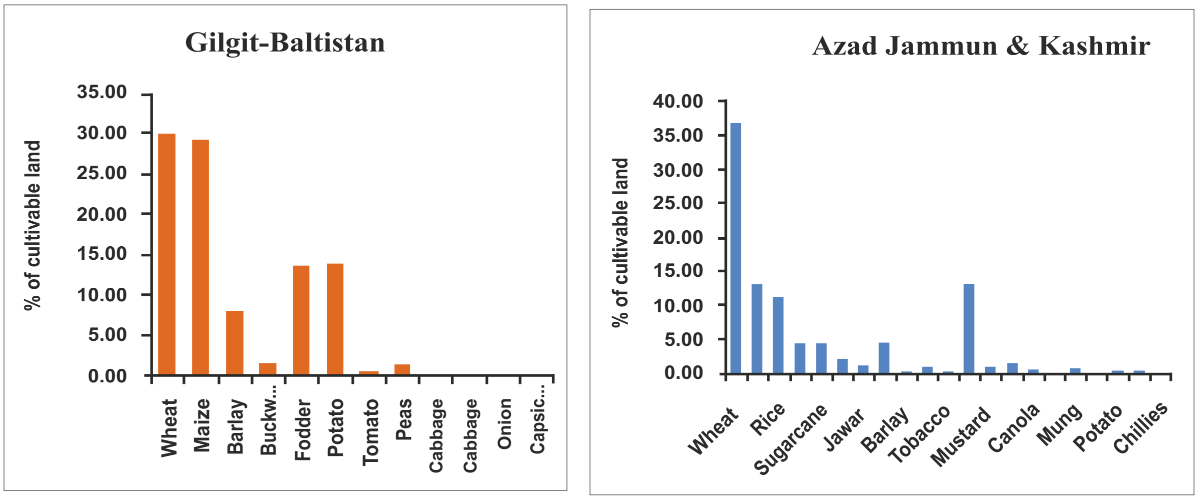
Overgrazing: The majority of the respondents (>43 percent) were of the view that overgrazing or uncontrolled grazing is the biggest threat to rangelands of GB and AJK, where an ever-increasing number of livestock both local and nomadic, has been continuously grazing the pastures and forest grazing lands beyond their productive capacities. Excessive grazing has an obvious impact on the native biodiversity of grasslands, as it causes retrogression, stimulates growth of weeds and loss of diversity (Sher et al., 2010). During the past decade livestock population in GB and AJK has increased by almost 27 percent and 30 percent, respectively (GOP, 2006).With small landholdings (>5 kanal on the average) very little land is available for cropping and folder cultivation. As a result every year more animals are taken to pastures, which directly expose pastures and rangelands already under stress, to intensive grazing for extended periods of time. It was also mentioned that the productivity as well as area of rangelands has also decreased due to floods and landslides. AJK forest officials and the field staff of Deosai National Park (DNP) consider uncontrolled grazing by huge nomadic herds as the biggest threat to alpine and sub-alpine pastures, which provide a critical habitat to the Himalayan brown bear and other associated wildlife species in the region.

Although the exact carrying capacity of different pastures and rangelands in GB and AJK is yet to be determined, this survey revealed that the majority of pastures and rangelands are currently overstocked and are therefore excessively grazed. For example in the case of Shimshal Pamir pastures, where in 2010 around 5000 yaks, 2000 goats, 1900 sheep and 500 cows were being grazed along with a few hundred wild herbivores i.e. Himalayan ibex and blue sheep in just 10,429 ha of alpine pasture, which could otherwise have hardly fed 715 yaks for a maximum period of six months (WWF, 2010). It is obvious that at higher altitudes where foliage growth is retarded by harsh climatic conditions, use beyond the carrying capacity not only deteriorates the ecological health of pastures but also leaves less or no food for wild herbivores increasing food competition and accelerated soil erosion. Although the animals may exert a beneficial or mutual influence on the vegetation, however, for their own good a large concentration of them often has harmful effects on the plants because of selectivity and over grazing. Nomadic uncontrolled grazing poses a serious threat to all grasses but in particular to the occurrence and distribution of medicinal flora in alpine and sub-alpine pastures (Sher et al., 2010).

Removal of vegetation: Provision of fuel wood for domestic energy and fodder for livestock are equally important services of pastures and rangelands in the region. About 90-94 percent of rural households use firewood for cooking, heating and warming and almost half of them collect fodder to feed livestock during winter months. A fairly large group of respondents (17 percent) were of the view that excessive removal of natural vegetation like trees, shrubs and grasses from the slopes (in AJK) and apparently arid barren plains (in GB) for firewood and fodder has not decreased the productivity of rangelands, due to less organic residual addition. This has also has exposed the shallow mountain slopes to accelerated soil erosion. Firewood and fodder collection is a public right both in GB and AJK, either granted under customary laws or under the Forest Regulation Acts of 1927 and 1930 respectively. However, the limit for collection of the above mentioned from critical rangelands is yet to be determined scientifically.

Encroachment: Comparatively a smaller group of respondents (13 percent) considered encroachment as the second biggest threat to pastures and rangelands. It generally refers to advances beyond certain limits, which may include factors like deforestation and grazing beyond the carrying capacity which usually exerts pressure on grasslands. The agricultural statistics for GB and AJK reveal that people prefer growing high cash and food value crops like cereals, cottonne, vegetables and oil seed to earn money and meet the increasing demand for human food as compared to growing fodder for livestock. In GB, 13 percent of the total cultivable land (8293 ha) is allocated for fodder cultivation, whereas in AJK apparently no land is spared for fodder crops, probably due to the small per capita land holding as well as a higher demand for human food in the local markets (Figure 35). The high cash value of seed potato coupled with the increasing demand for more cereals and oil seed crops have been converting rangelands and forest grazing lands to other land uses, mostly arable lands at an alarming pace. Moreover removal of sparse and scattered natural vegetation for firewood to meet domestic energy needs and fodder from slopes to stall feed animals during winter has also resulted into formation of rills and gullies with increased soil erosion and rangeland desertification in the region.

Figure 35: Land Utilized for cultivation of different crops in Gilgit-Baltistan &AJK



Source: GOP GB agricultural statistics (2009) Source: MINFAL, Federal Bureau of Statistics

rangelands. This is due to the impact of increasing temperature and decreasing precipitation in the region. Pastures in Misgar, Chipurson and in parts of Central Karakoram National Park (CKNP) like Bagrote Valley are reported to be the worst affected by droughts during the past decade or so (Khan, 2009; Beg, 2010). Described as mountain deserts Gilgit-Baltistan located amidst the Karakoram, Himalayas and Hindu Kush mountains, receive less precipitation particularly at lower elevations which seldom exceed 200 mm per annum but higher elevations get more snow accumulation (> 35000 m ASL) during winter (Awan, 2002) with mean temperatures ranging between -10^{0}C in winter to 35^0 C in peak summer. However, significant increases in winter mean and maximum temperatures unlike the general global pattern and consistent decrease in summer maximum temperatures have been observed in the region (Fowler and Archer, 2006). Zeidler and Steinbauer (2008) in a WWF study have reported an increase in annual mean temperatures from 1980-2006.

Such climatic variations coupled with other biotic and anthropogenic factors seem to have caused desertification of rangelands at an alarming pace, especially in the arid and semi-arid zones (GoP, 2010). In most areas of the country rainfall patterns have become very unreliable and unpredictable, making it difficult for communities to make necessary arrangements for their safety and that of crops and livestock (Salma et al., 2012). Similar evidence has been recorded in Afghanistan, Nepal, China and within Pakistan where decrease in rainfall has increased desertification of rangelands and in some places prolonged droughts have even forced people to change their migration routes or abandon pastoralism completely (Karki, 2010).

Trampling: Trampling is again, a threat to rangelands (reported by some 15 percent of the respondents) caused not only by herbivores but by people as well. The trampling by vehicles through off-road driving has been a big threat to grasslands in Deosai and Handrab-Shandoor National Parks. However, unnecessarily prolonged stay of herders with big herds in alpine oases also results in over grazing and trampling of pastures. The reason for this could be a lack of grazing and pasture management regulations. Livestock impacts biodiversity through trampling and removal of biomass, alteration of species composition due to selective consumption and changed inter-plant competition (Sher et al., 2010). Changes in grazing intensity and selectivity will inevitably change biodiversity. Under grazing and overgrazing can both have negative effects but overgrazing by livestock is more problematic because in either form of browsing or trampling it has resulted in land erosion, formation of boggy areas and reduction in plant diversity (Khan, 1994).

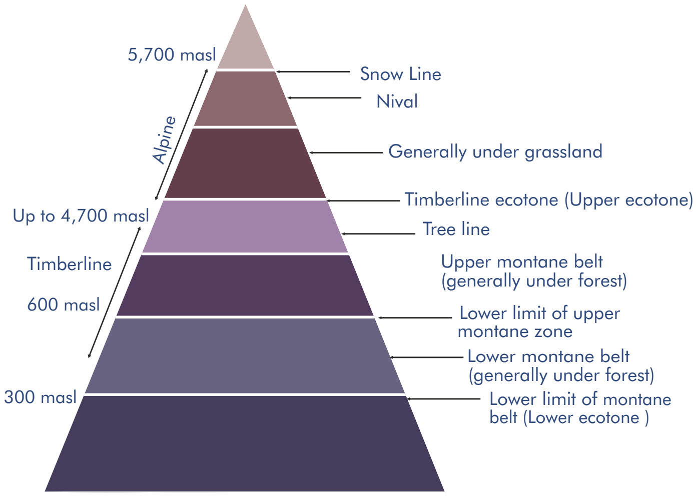
Rangeland Interfaces

Gilgit-Baltistan and AJK are situated at the confluence of the world's great mountain ranges: Himalayas, Karakoram and Hindu Kush, which often create diverse eco-tones within a short distance due to the wide variety of climatic conditions on their slopes (Figure 36). Human activities also produce different eco-tonnees, especially newly formed boundaries.

Natural interfaces: **Peat lands** are interfaces between wetlands and rangelands. A total of about 500 million ha of peat lands are found on the earth, accounting for 3 percent of the total terrestrial surface. Peat land's carbon sequestration value is highly regarded, which equals around 13 percent of the global carbon stock. In the northern mountains the peat lands are found in the Deosai plateau, Langar-Shandoor wetlands (Phunder valley), Fairy Meadows, Shimshal and Broghil valleys. An estimated 25,000 ha in GB is covered with peat lands, whereas in AJK this is yet to be estimated. Peat lands are valuable ecosystems with functions like biodiversity conservation, carbon stock, water storage and regulation, grazing grounds and domestic fuel. In Phunder and Qurumbar the peat lands are a major source of domestic fuel as these areas lack in natural vegetation for fuel wood. Major threats to peat land ecosystems include degradation and shrinkage caused by anthropogenic activities and climate change effects. Anthropogenic pressures stem from its extraction for domestic fuel, extensive grazing, drainage and diversions of water sources, mostly due to easy access and being the village commons.

Alpine timberline: Another predominant rangelands interface is the timberline existing between mountain forests and alpine meadows. The timberline interface and its geographic and ecological features vary in different ecological zones across the region. However, the elevation ranges between 3300-3800 m ASL. Himalayan dry coniferous forest species like *Abies pindrow, Picea smithiana, Pinus wallichiana* and *Quercus spp*. are found at lower elevations, while at higher elevations the plant communities are dominated by species of *Betula, Salix, Juniperus, Rhododendron* and *Poa* grasses. Anthropogenic pressures on this interface include excessive grazing, deforestation for fuel wood during the seasonal stay of herders in high pastures, trampling effects and soil erosion. Interactions of anthropogenic and climatic factors have led to the downward shift of alpine timberline on south-facing slopes in the region.

Figure 36: High altitude rangelands and their Interfaces



Source: ICIMOD, 2012

Semi-natural interfaces: The lower timberline, as is obvious from Figure 37, this ecotone generally encompasses the area between mountain forests and farming lands. Major vegetation comprises Himalayan dry coniferous forest species at lower altitudes(1400-2000 m ASL) such as *Quercus spp, Artemisia maritima, Ephedra intermedia, Monotheca buxifolia, Corylus corluna, Cotonneeaster nummularia,* and *Sophora mollis.* The lower timberline eco-tone is subject to excessive degradation and severe erosion caused by intensive farming, deforestation, infrastructure development and frequent hazards such as flash floods. Expansion of farming activities, road networks and resorts pose a threat to this important ecotone in the region.

Figure 37: Typical lower timberline ecotones at higher and lower altitudes in Gilgit-Baltistan

Source: M Zafar Khan / WWF-Pakistan

Man-made interfaces: Boundaries of protected areas are an example of man-made interfaces (Figure 38). GB and AJK have a strong network of protected areas within their territorial boundaries. In addition GB partly extends into the Pamir Ranges which are predominantly situated in Tajikistan at 3500-5000 m and also extending into Kyrgyzstan, Afghanistan and China which possess a scattered network of protected areas (Schaller, 2007). Thus the entire range has a man-made ecotone where the high altitude ecosystems and their interfaces are greatly influenced by human activities such as fencing of borders, road infrastructure, transportation, excessive hunting and armed conflicts. Schaller (2007) has revealed that Marco Polo sheep (*Ovis ammon polii*) roam back and forth across the frontiers of Pakistan, Afghanistan, China and Tajkistan in Pamir Mountains. For security reasons these countries have fenced their borders. This has restricted movement of sheep and other associated long-range species from one place to another.

According to Mr. Aziz Ali (per. com.) the wire fence on the Afghan-Tajik border in Wakhan has been a serious threat to the Marco Polo sheep as he observed fifteen carcasses of sheep within a space of six km, along the fenced border. He suspects the deaths were caused due to collision of animals with the fence trying to escape predators such as wolves or snow leopards. A similar wire fence has also been erected at the Sino-Pak border in Khunjerab. This too has had a significant impact on the free migration of Marco Polo sheep between Pakistan and China's mountainous landscapes.

Figure 38: A Typical Man-Made Interface (Carcass of Marco Polo Sheep at Tajik-Afghan Border in Pamir)

Table 40: Livestock under different production systems in Gilgit-Baltistan

Species	Stall-fed	Grazed	Both
Large ruminants	14559 (4.6)	1702 (0.5)	299703 (94.9)
Cattle	14599 (4.6)	1601 (0.5)	299175 (94.9)
Yaks	0	14004 (93.9)	910 (6.1)
Buffalos	0	101 (16.1)	528 (83.9)
Small ruminants	15144 (1.3)	14077 (1.2)	1126582 (97.5)
Sheep	3710 (0.8)	3849 (0.8)	450573 (98.4)
Goats	11434 (1.6)	10228 (1.5)	676009 (96.9)
Total	29703 (2.0)	15779 (1.1)	1426285 (96.9)

(Source: NASSD GOP/IUCN, 2003)

Rangelands: Current and Potential Formal and Informal Practices

Rangelands are a very fragile, extremely valuable and greatly under appreciated resource. Extensive pastures and rangelands are imperative to support the ever increasing population of domestic as well as wild herbivores, as the hot arid areas of Karakoram, Hindu Kush and western Himalayas have sufficient fodder only in the high mountains. In northern Pakistan pasturage is very limited by comparison. Local people and nomadic herders have grazed these ranges for centuries mainly with large herds of cattle and horses and a few sheep and goats. With the passage of time the addition of more animals especially close-cropping sheep and goats, whose agility permits them to traverse steep slopes and whose small hooves break up thin, high altitude soil have pushed pastures and mountain rangelands beyond the point of natural regeneration. Many range specialists express concern about the serious deterioration of the land and grass as a result of over grazing in the region.

Rangelands encompassing about 2.91 million hectares are perhaps the second largest land use type and an important terrestrial ecosystem in the region. Over 90 percent of the rural population in the region has a direct though not complete dependence on the pastures and rangelands for daily subsistence, while more than 200 million people benefit from the water resources conserved and regulated by these ecosystems downstream. Forests, pastures and rangelands in GB and AJK are crucial habitats for some of the globally important wildlife species and constitute a key biodiversity hotspot in the cold desert, dry and moist temperate forest eco regions of Pakistan (Khan, 2011; GoAK, 2010).

At present, the rangelands in GB and AJK are mainly used for livestock grazing, firewood collection, extraction of medicinal and aromatic herbs and for tourism related activities but often in ways not sustainable now or over the long term. Major rangeland resource use practices and the gaps therein are briefly discussed in the following sections.

Grazing: Livestock grazing is an important land use and the shortage of livestock feed resource is a major constraint resulting in excessive grazing of rangelands in GB and AJK. The alpine and sub alpine pastures lying above 3000 m ASL are used for transhumant summer grazing for a large number of migratory livestock, mostly small ruminants. Livestock population in the region has multiplied significantly during the past three and a half decades, increasing the animal stocking rates alarmingly. For instance in GB stocking rate has increased from 9.08 ha per animal unit in 1976 to 2.73 ha per animal unit in 2006. With around of 30 percent increase in livestock population the animal-stocking rate in AJK was 0.292 ha per animal unit in 2006, which shows that the rangelands resources are over-burdened and used beyond their carrying capacity. The current stocking rate is many times more than the critical levels of 16 ha per animal unit recommended by FAO for low potential rangelands, which affects the inherent productivity of rangelands. Stocking animals beyond certain limits depletes their vegetation cover, accelerates soil erosion and causes desertification in the long run.

The majority of the rangelands in GB and AJK are excessively grazed owing to traditional resource use patterns, which offer less room for regulating animal grazing based on carrying capacity. By and large, the rangelands are common tribal or communal property, unless notified as part of a designated Protected Area (PA) under the provincial Wildlife Preservation Act. In some cases grazing management even becomes a challenge for PA authorities if traditional grazing areas fall within the PA boundaries. For instance in Deosai National Park, Handrab-Shandoor National Park, Minimerg and Kel, uncontrolled nomadic grazing results in over-exploitation of grazing land apart from disturbing the wildlife. Nomadic herders neither bother improving the rangelands nor are the local authorities receiving the grazing tax

(*Kalang*) from nomads, therefore there is a need to regulate the grazing pressure. Similarly in Khunjerab National Park, local communities despite acquiring tremendous economic benefits are still reluctant to reduce the number of their livestock being grazed in the Park area. Likewise in the Central Karakoram Machiara, Ghamot and Gurez National Parks the situation is not too different with the exception of the Qurumbar National Park where the local community to some extent has adopted rotational grazing, to manage local pastures as part of their conservation program.

The ever increasing numbers of animals to meet the food requirements of the population and a shortage of livestock feed resources leaves farmers with no other options except to depend upon rangelands for grazing their livestock. However, herders mostly have no awareness of the ecological health of pastures and rangeland uses and graze animals freely and unwisely. The lack of appropriate strategies, plans and policy guidelines for sustainable management of rangelands and livestock, lack of knowledge among professionals in the custodian departments about major rangeland and livestock related issues(such as micro zonation, boundary delineation, productivity assessment, eco health monitoring, pasture management, livestock development and lack of relevant skills to manage rangelands ecosystem)are some of the reasons for depletion of low productive rangelands in the region.

Firewood: Rangelands provide plant biomass for domestic energy, as the entire rural population in GB and AJK lacks alternative sources of energy. With no other options, about 89-90 percent of population in the rural areas exposed to extreme weather conditions particularly in winters collects fire wood from local forests and rangelands to cater to their needs. Recent studies revealed that an average household of 5-8 members consumes about 5.5 tonnes of firewood during the six months of winter (AKPBSP, 2010), and about 80-90 percent of this firewood is collected from the local forests and rangelands. Firewood collection pressure is particularly high in less forested areas of Skardu, Ghanche, Ghizer and Hunza-Nagar.

All types of natural vegetation including trees and shrubs like *Juniperus macropoda, J. comunis, Rosa webbiana, Berberis lycium, Artemisia maritima, Marycaria* and *Ephedra spp.* are illicitly cut from the rangelands for use as fuel wood. However, the firewood contribution from rangelands is not as much in parts of AJK and the forest rich southern parts of Chilas, Darel, Tangir and Astore where it is collected mostly from the local forests. In some other areas like Phander, Deosai and Broghil people also extract peat lands from alpine meadows to meet their domestic energy needs (Khan, 2012). In AJK the local communities have the traditional right to cut three trees on an average by one household every year for their fuel wood requirements in the absence of alternate sources and about five trees on the average to construct a house or replace the roof after every 8-10 years. Local and nomadic herders who stay in high land settlements near pastures and in forests cut larger quantities of trees, small scrub and shrubs for their fires. Dried dung burns well but is not available in sufficient quantity. Gujers and highland villagers who descend down the valleys also cut trees to sell what they can carry back to the local markets.

Generally, pastures and rangelands in the region are more or less owned by local communities or tribes called *clans* who have traditional or concessional resource-use rights. In either case the resource-use types, schedules and limits both for grazing and fire wood collection, are usually determined by the communities or tribal groups who have ownership of the pastures as per their customary laws often non-scientific but somehow not injudicious.

In both GB and AJK, rangelands fall under the purview of the forest and wildlife authorities but unfortunately the departments have neither adequate scientific knowledge nor understanding of the complex rangeland management issues. Nor do they have appropriate strategies, ample resources or the required capacities to deal with such intricate issues.

Fodder: Livestock rearing is still a dominant occupation that contributes significantly to the household income in rural economies of GB and AJK. On the average in AJK, herds consist of 2-3 heads of small and large ruminants per household, whereas in GB herd size is slightly larger ranging between 5-8 animals per household. Some 80-90 percent of the domestic stock depends upon rangelands and pastures for grazing, partly or fully during summers and <20 percent are either grazed in fallow agricultural fields or nearby slopes and stall fed with hay, fodder and crop residues. Fodder collection from steep to moderate slopes, plains, meadows and contours of agricultural fields during autumn is a common practice to feed animals during winter. Collection of fodder is allowed either by statutory or customary laws. However, there seems to be no legislation to regulate removal of vegetation from critical habitats and steep slopes, despite the excessive removal of grasses from such areas affecting wildlife, impeding infiltration and increasing surface runoff that ultimately results into formation of rills and gullies on slopes and causes accelerated soil erosion.

Medicinal and aromatic herbs: There are approximately 300,000 species of vascular plants in the world today and almost 30 percent of them have been used for plant based remedies. Millions of people particularly in traditional cultures still use plants as medicine. It is estimated that roughly 80 percent of the world's population still relies on herbal medicine. Interestingly the trend of using traditional medicines is increasing again (Anon, 2008). Since the late 1950s almost 80 percent of Pakistan's population and people in remote areas in particular, are directly dependent on herbal medicines for all types of medical needs (Hocking, 1958). In the Karakoram-Himalayan-Hindu Kush Mountains, about 70 percent of medicinal plants and animals consist of wild species that are used by 70-80 percent of the local populace as traditional medicines for health care (Pie and Manandhar, 1987).

Like many other mountainous areas of the world Pakistan's northern region is rich in plant diversity. About 3,000 species of vascular plants have been identified in the area, out of which at least 124 have medicinal value (UNDP/IUCN, 1999). The majority of the mountain people in the remote valleys of Shimshal, Misgar, Chipurson, Qurumbar, Yasin, Gupis, Hushey, Thaley, Askoli, Minimerg, Gultari, Darel and Tangir have been using traditional medicines from herbs collected from local pastures and rangelands (Khan et al., 2011). Some 43 species belonging to 40 genera and 28 families were recorded from Dhee, Barkhun, Shimshal and Khunjerab pastures which have been used for treating twenty-nine different diseases (Khan et al., 2011).

Similarly alpine and sub alpine pastures of Deosai plateau are reported to have 342 species mostly of high medicinal value (Woods et al. 1997). Astore valley is known as a storehouse of medicinal plants where Shinwari (2003) recorded 33 medicinal herbs from Bulashbar area. Khan and Khatoon (2007) reported 48 species from Haramosh and Bagrote valleys of CKNP; Qureshi et al. (2006) recorded 27 species from Gilgit, Rasool (1998) reported 83 species; Shedayi and Gulshan (2012) recorded 35 species and Ali et al. (2012) recorded 206 plant species of high medicinal, aromatic and economic value from Gilgit Baltistan. The medicinal plant section of the Pakistan Forest Institute has listed 43 commercially important medicinal plant species for AJK. Khan et al (2012) and Ishtiaq et al (2012) have recorded 36 and 68 species of medicinal herbs belonging to 22 and 44 different families from Leepa and Poonch valleys, respectively. Important herbs and mushrooms used by the pharmaceutical industry found in the area are Kuth (*Saussurea lappa*), Kanis (*Dioscoria deltoides*), Ban Kakri (*Podophyllum emodi*), Belladona (*Atropa aumenta*), Mohri (*Aconitum chasmanthum*), and Guchi (*Morchella spp.*) (GoAK, 2010).

The natural resource base in the Hindu Kush-Himalayas is deteriorating more rapidly than many other global regions but receiving less attention than any other ecosystem (Shinwari, 2006). Medicinal plants are valued for human and animal disorders and as previously noted about 80 percent of the local population still depend on them for their health problems (Inam, 2004). Owing to an ever-increasing number of livestock on pastures and rangelands, flora of high medicinal, aromatic, and economic value is depleting fast as is the knowledge concerning their traditional use (Khan et al., 2011). Currently, the extraction of any type of herb, forbs and shrub from the wild except for a few species like Kuth, Black Zeera and Karoo, is regulated. Kuth however, is endangered and is on Appendix 1 of the CITES, and therefore its export from Pakistan has been banned since 1980.

It is important that their harvesting is regulated according to the productive capacities of their habitats. In addition their harvesting and extraction must be carried out through local communities to give them a stake in their sustainable management. Many medicinal plant species have a potential for ex-situ conservation. Techniques for raising some of these have already been developed by the Mountain Agriculture Research Centre, PARC, and others. It would be very useful for the communities to grow these on a commercial scale for earning income. This will also reduce the pressure of excessive harvesting from the wild. In addition involvement of local communities in in-situ conservation and sustainable use of medicinal plants is equally important. This approach needs to be promoted through policy formulation and legal reforms. Recently the Gilgit-Baltistan Forest, Wildlife and Parks Department with technical assistance from WWF and IUCN has developed some policy guidelines for regulation and judicious exploitation and both in-situ and ex-situ multiplication of plant resources. However at the time this study was conducted the draft was awaiting approval.

Ecotourism: Ecotourism is another valuable attribute of forests, rangelands and pastures worldwide and is perhaps the fastest growing and most advocated concept by major conservation groups worldwide as a way to promote the green economy and help conserve natural environments. Gilgit-Baltistan and Azad Kashmir are among the most fascinating areas in Pakistan, where the world's three famous mountain ranges conjoin to offer excellent tourism opportunities to adventurers, climbers, researchers and trekkers alike. Its unique cultural heritage coupled with gorgeous mountains, peaks, blue water lakes, long glaciers, vast rangelands, alpine pastures, coniferous forests and awesome wildlife attracts a number of visitors from all over the world for expeditions, explorations and recreation.

The region has tremendous ecotourism potential which has not yet been exploited. Although efforts have been made to promote summer tourism, the real beauty comes to the region during autumn and winter season and this market is yet untapped. Ecotourism with slogans like “take nothing but photographs and leave nothing but footprints” are a good option to promote environmental friendly tourism in the area. Trout and Mahasheer angling can be promoted in Ghizer, Skardu, Khanbari and Poonch valleys, Yak safari and rafting can be introduced in Shimshal and Neelum valleys and bird watching and wildlife sighting can be facilitated in Khunjerab, Deosai, Qurumbar, Central Karakorum, Machiara and Gurez National Parks. Naltar valley is ideal for skiing competitions, and Banjosa, Tolipir, Leepa and Sudan Gali have natural camping sites. Ancient culture and historical artifacts of the region can be exhibited in Shigar, Khaplo, Hunza, Darel and Yasin valleys, while trekking, climbing, hiking and camping can be organized in Baltistan and AJK.

Despite the region’s rich natural endowment, orientation of the relevant government departments and other stakeholders towards eco-friendly tourism is negligible. As a result mega development projects are often executed without prior assessment of their ecological impacts. Since nature and natural resources are the basic ingredients and products of the tourism industry, ill-planned development and unmanaged tourism activities may affect ecological processes and fragile mountain ecosystems adversely affecting their ecological functions, services, values and products. For instance holding festivities and cultural events in the ecologically sensitive areas without adequate prior care and protective measures leads to deterioration of natural ecosystems. Similarly if mountaineers, climbers and trekkers continue to dump wastes on snow-covered peaks, glaciers and grasslands a day will come when future generations will only see piles of debris instead of ice, snow and green fields. Uncontrolled hunting and excessive fishing may eliminate the wildlife, birds and fish species from their natural habitats. A failure to save these natural treasures will see these major ecological processes ceasing to function, fragile mountain ecosystems may crash, natural beauty may disappear and no visitors would want to visit these areas.

Important requirements for encouraging wilderness-related eco-tourism include: rules and ethics for visitors, designated camping sites with restrooms and cooking facilities, waste disposal and cleanliness, avoiding music and noise and eco-labeling and signage for information and awareness. Day trips and modest kiosks instead of restaurants and hotels should be preferred and a fee can be collected from visitors for entering Protected Areas or historical monuments and a part of the income can be invested back into community wellbeing and environmental conservation.

Watershed value: The rangelands, especially alpine and sub alpine pastures have vital importance for their watershed value at local and national levels as these grasslands enhance infiltration and help combat soil erosion. Their environmental role including watershed is far greater than their grazing and firewood production roles, which has neither been evaluated nor ascertained in the past. Besides enhancing the life span of these dams, northern rangelands can help prevent floods, maintain local water supplies and conserve soil if maintained properly. Comprehensive scientific studies are suggested to appraise the watershed value of the rangelands and appropriate policies formulated for sustainable management of rangeland resources in the region.

Carbon sink value: The rangelands, spreading over 2.64 million hectares in GB and AJK are sparsely vegetated yet grasslands are important sinks of carbon. Their classified role in fixing atmospheric carbon is yet to be studied and understood. Comprehensive scientific research is therefore needed to assess the carbon fixing capacity of the rangeland ecosystems so the carbon sequestration value of rangelands can be harnessed for social, economic and ecological development of people in the region.

Key Institutions

Key public and private sector institutions involved formally as well as informally in the management of the rangeland resources in GB and AJK are categorized below:

Social: The Aga Khan Rural Support Programme (AKRSP) pioneered participatory development in Gilgit-Baltistan in the early eighties. AKRSP’s aim was to tackle the appalling poverty of the region by organizing rural people into hamlet and village level community organizations (VO & WO) for collective savings. Over a period of time, these have evolved into formal community-based organizations (CBO) called Local Support Organizations (LSO).

Similarly AJK Rural Support Programme (AJKRSP), Himalayan Rural Support Programme (HRSP) and Islamic Relief (IR) have been working on participatory rural development in AJK for a long time. The provincial Forest Departments, WWF, Himalayan Wildlife Foundation (HWF), IUCN and other governmental and non-governmental conservation organizations have also formed Valley Conservation Committees (VCC), Natural Resource Management Groups (NRMG) and Rural Forest Protection Committees (RFPC) for the conservation of nature and natural resources at the grassroot level. These CBOs actively participate in extinguishing forest fires, sharing information, assisting in detection of culprits and offenders, witness in courts and in protection and conservation of forest and wildlife resources. There is somehow a network of CBOs in the entire region with a LSO, VCC or a RFPC, mandated to protect key wildlife species and their habitats / rangelands and forests in their respective areas. Both the government and non-governmental organizations prefer engaging these CBOs in identification and implementation of small and medium size conservation and development projects in the region. The CBOs however, need to grow and build their capacity in sustainable rangeland management to achieve the desired goals.

Research: The University of AJK, Agricultural University, Rawalakot (AUR) and Karakoram International Universities (KIU) are the main research institutions which have relevant expertise and research facilities in the region. The Pakistan Agriculture Research Council (PARC) also has outlets in GB and AJK. Forest and Wildlife Departments are yet to have strong research and extension wings. However, almost all of these institutions lack adequate rangeland-related expertise, latest technologies and extension services for taking innovations from laboratories into the field. The Animal husbandry department of the AUR however, has a research focus on livestock production in AJK. Similarly, the Range Management Project started in 1972 in AJK and upgraded to Rangeland Division in 1985, has a sheep farm to foster rangeland research and development but has only a few non-technical staff i.e. guards and shepherds and not even a Range Forest Officer (RFO). WWF has also been doing some research on biodiversity including species, habitats, and ecosystems, thus rangelands form part of WWF’s research-based conservation programme in GB. A well considered integrated research plan focusing on the real field issues concerning rangelands management and backed up with the required financial and technical support is needed for sustainable management of rangelands in the region. A new research facility called “Integrated Mountain Area Research Centre (IMARC)” has been established recently, in KIU by the Social, economic and environmental development (SEED) project for Central Karakoram National Park.

Management: The major public sector institutions are mandated to manage key natural resources both in GB and AJK. The Planning & Development Departments are responsible for selection, monitoring and evaluation of development projects whereas, the custodian departments like Forest, Wildlife, Fisheries and Livestock have to identify topics, write proposals and implement approved projects. Although the professional staff try writing proposals (PC-I), due to lack of capacity both human and material these proposals are either weak, vague or over ambitious and often fail to achieve the desired goals. WWF, IUCN, HWF and AKDN agencies not only provide technical assistance to line departments for writing proposals and implementation of projects but also complement their efforts through community-based conservation and development projects, at the field level. IUCN, WWF and HWF have developed the Northern Area Strategy for Sustainable Development (NASSD), Community-based Trophy Hunting Program (CTHP), and Management Plans for Khunjerab, Machiara and Deosai National Parks. At present the Forest Department in AJK and Forest, Wildlife and Parks Department in GB are responsible for rangeland resources. They have neither the knowledge, nor the capacity or the resources and technology required for managing pastures and rangelands effectively.

Monitoring and control: Rangeland management and animal husbandry need to be dealt with in an integrated manner. Currently rangeland resources come under the jurisdiction of the Forest department in AJK and the Forest, Wildlife & Environment Department in GB. Animal husbandry related matters are overseen by the Livestock and Dairy Development Departments. Similarly fish resources are owned by the Fisheries and Wildlife and Fisheries Departments in GB and AJK, respectively. Unfortunately adequate resource monitoring mechanisms do not exist. Apart from resource and capacity constraints one major reason for weak management of natural resources is perhaps the illogical distribution of roles and responsibilities among various National Resource Management related departments. Authority is often enjoyed by each department but responsibility is seldom taken by any, leading to an absence of accountability. A lack of detailed resource inventories and scientific baseline information makes projects as well as resource monitoring almost impossible in difficult mountain terrain. A clearer delegation of monitoring and control authority of all rangeland and associated functions and services to a full-fledged separate department under the overall supervision of the Chief Conservator or relevant Secretary is advisable. Detailed resource inventories, scientific baseline information and effective monitoring mechanisms are suggested for better management of rangeland resources in the region.

Law and Policy: The rangeland ecosystems and their associated biodiversity including species and habitats are generally treated as part of forests in GB and AJK. Almost all the protected forests in GB (0.9 percent of the total forests area) are regulated under The Forest Regulation Act, 1927 and Northern Areas Forest Rules, 1983. Some 3.1 percent of the total forests (4.1 perccent of GB land) located in Chilas and Darel-Tangir divisions are privately owned by local people and managed by GB Forest, Wildlife and Parks Department under the Gilgit Private Forest Regulation, 1970. Although the Cattle Trespass Act (1871) has also been extended to GB in 1976, the Act does not seem to have ever been enforced effectively in any part of it.

Similarly in AJK almost all forests inclusive of rangelands are state owned and are therefore protected forests, managed by AJK Forest Department under the Forest Regulation Act (1930). In return for the community's assistance and support for care and conservation of forests and their associated wild resources, the Act allows the local community free grazing and grass cutting from forest and rangelands, (except those areas closed for regeneration under closure rules), timber at concessional / Zamindari rate for construction of houses, mosques and schools, except *deodar*, removal of torchwood, dead, dry and fallen trees, not fit for building purposes, to be used as firewood for domestic energy, lopping of some broad-leaved species for fodder and branches for making agricultural implements and collection of wild herbs and fruits for local use. However, the Rules defining limits for extraction of these resources under the Act (1930) are yet to be drawn (GoAK, 2001).

IUCN – World Conservation Union developed the Northern Area Strategy for Sustainable Development (NASSD) in 2003.The NASSD elaborates issues related to rangelands along with many other important sectors of social, economic and environmental development in Gilgit-Baltistan. The National Rangeland Policy is yet to be extended to the region. However, HWF, IUCN and WWF have developed various management plans for selected areas in Ghumot, Gurez, Qurumbar, Bhasha, Hisper, Khyber and Khunjerab valleys, where some of these have also been implemented jointly with the respective communities.

Rangeland Issues and their Impact

Using rangelands for livestock grazing often beyond their carrying capacity, excessive removal of sparse natural vegetation (trees, shrubs and grasses) for domestic energy and fodder, converting pastures to agricultural fields for growing more potatoes, peas and barley to eat and sell, climate change causing drought and other improper land uses like trampling by visitors and nomadic herders have been the major reasons for degradation of rangelands in GB and AJK. This stems primarily due to extreme poverty and dependence on ecosystem services, global climatic phenomena, institutional weaknesses, lack of enabling policies and capacity in custodian departments. These existing as well as emerging threats to rangeland resources if not managed in a timely and efficient way may have serious social, economic and ecological implications for the region. A brief account of such impacts is as follows:

Social: The history of pastoralism in the northern mountainous region is as ancient as its unique cultural heritage. Herodotus the Greek historian (4th century B.C) writes that the first inhabitants of the present day Gilgit-Baltistan were Dards; the descendants of Achaemenian/Persian Empire and were originally nomadic pastoralists in the western Iranian plateau who subsequently had developed irrigated terraced fields and herded horses and cattle (Baig, 2012). The mountain people of Gilgit-Baltistan therefore enjoy an agro-pastoral livelihood which is also part of their culture and tradition with subsistence farming and livestock herding as the main occupations. Despite tremendous development and modernization, particularly after construction of the Karakoram Highway (1978), livestock keeping is still a dominant mode of living and a major source of income for about 37 percent of the rural households (AKRSP, 2008) in remote areas of Chilas, Darel, Tangir, Astore, Ghizer, Rundu, Haramosh, Naltar, Nagar and Hunza Valley. Similarly it accounts for >35 percent of the household income in AJK where 90 percent of the people in villages depend upon domestic animals for subsistence in terms of milk, meat and other dairy products.

Pastures and rangelands in the region are mostly owned by local communities or have at least been given resource-use concessions where grazing, firewood and fodder collection and other uses are regulated collectively by the tribes according to their customary laws. There are many families in Upper Hunza and other parts of GB that have been living in pastures for more than three generations (Khan, 2010).They have precious indigenous knowledge about pastures, their composition, changes happening over time and of course information about traditional management of grasslands and livestock.

Degradation will obviously reduce the productive and regulatory uses of the rangeland ecosystem, especially in terms of biodiversity loss, less forage productivity and low water regulation. All these will lead to accelerated soil erosion, floods and desertification. However, this will also have unforeseen socio-cultural implications, since with the loss of pastures and rangelands traditional pastoralism will also cease to exist in the region. Indigenous pasture management like the collective wisdom of setting grazing schedules, allocating separate pastures for small and large ruminants, deciding the length of their stay at each stage, defining agricultural activities and regulation of firewood collection, will gradually be extinguished. Along with this we would also lose the undocumented knowledge that pastoralists have acquired over decades during their stay in pastures concerning peculiar plants and their traditional uses for human and veterinary medicine, birds, animals and insects, their ecology and behavior, changing climate and its impacts on glaciers and pastures as a sensitive ecosystems. Though this knowledge may not be scientific, it is still very useful and relevant and not available in the hundreds of books written on these topics so far.

Since pastoralism is an integral part of local tradition therefore a complete depopulation of the grasslands may not help restore pastures. A complete removal of grazing may diminish the diversity of grasses, palatable grasses may replace unpalatable species, toxic weeds and woody shrubs may drive out medicinal herbs and make the land unusable.

Economic: Rangelands encompassing almost 33 percent and 43 percent of the land area in GB and AJK (2.64 m ha) are the major land use that feed around 4.7 million livestock and offer fodder and firewood to over 90 percent of the rural population (approx. 4.7 million) in the region. About 90 percent of the households in the rural areas have a direct dependence on rangelands for grazing their animals and collecting fodder to feed animals in winter. Villagers from Leepa, Astore, Skardu, Poonch, Naltar, Bagh, Rawalakot and other areas collect plants of high economic, medicinal and aromatic value for their domestic use as well as for sale to earn additional income for their families. However, as there is no law regulating the commercial harvest of these herbs, they are illegally collected from alpine and sub-alpine pastures and rangelands of Astore, Deosai and other parts of GB and AJK.

Similarly pastures and rangelands associated with wildlife species offer an extraordinary collection of wildlife, some being endangered and endemic to the region. Their habitats offer excellent opportunities for wildlife and bird sighting, trekking, camping, for researchers, mountaineers and anglers. This could contribute in a significant way towards both the domestic and national economies. Interestingly in the past two decades the conservation communities have earned huge sums of money through community-based trophy hunting programs in GB (GOP, 2011).The economic contribution of rangeland ecosystems, through its key productive functions has been vital for the household economy and livelihood of local people in the region.

The unabated depletion of rangeland resources due to a lack of appropriate land use plans and resource use regulations may affect the ecosystem-based livelihood of locals and nature-based tourism in the region putting the local and national economy at risk. The rangeland ecosystems provide key nature branded services and products which make them vital for local subsistence as well as tourism promotion in the region.

Ecological: The invaluable regulatory functions of the rangeland ecosystems are vital for economic development. They are less valued or ignored and the air and water related regulatory services of the high rangelands of HKH mountain region are also taken for granted. These high altitude landscapes help regulate surface and ground waters, while controlling surface runoff and soil erosion. It is roughly estimated that about 75 percent of the total flow in the Indus River is contributed by HKH based watersheds feeding through various tributaries such as Shango, Shyok, Shigar, Hunza, Ghizer, Astore, Neelum, Jhelum and Poonch rivers. In addition a number of southern forest and pasture-based watersheds of Sai Jaglote, Fairy meadows, Goharabad, Bhuto Gah, Hudur, Khanbari, Dodishal, Darel and Tangir areas also contribute downstream to freshwater supplies for drinking, irrigation, fisheries and power generation, worth billions. These watersheds are also critical in sustaining deltaic life in coastal areas of Pakistan, where the Indus enters into the Arabian Sea.

The loss of pastures and rangelands upstream, therefore may bring catastrophes to downstream farmers, industrialists, fishermen, biologists and more importantly to the economic and energy sectors of Pakistan. Denuded and barren rangelands may not regulate snow and ice melt induced runoff and thus trigger erosion and flooding downstream that may exterminate the endemic aquatic biodiversity from streams and rivers. This may also fill the dams with silt, shortening their life span which would further aggravate the energy crisis; jeopardize irrigation based agriculture; exterminate fisheries and adversely impact deltaic life. Loss of natural vegetation from upstream rangelands may cause severe flooding both upstream and downstream in the Indus River which may trigger substantial social, economic and ecological disasters for the country. A few such disasters have already been experienced in Pakistan through flooding in recent years.

Scientific research: The Mountains of GB and AJK in general, and the rangelands, pastures and their interfaces in particular, have been natural laboratories for scientific research and exploration. Diverse cultures, customs and traditional systems evolved out of challenging topography, amazing landscapes, rich biodiversity and centuries-old isolation and self-dependency. This offers outstanding research and learning opportunities for biologists, geologists, glaciologists, gemologists, anthropologists and social scientists to study glacial, morphological, biological and cultural evolutions and ethno linguistics, unique in the world. Both national and international researchers are eager to conduct research in the region. Scores of students and faculty are available in the universities of AJK and GB to write their dissertations on subjects related to bio-diversity, it's social and economic dimension and its cultural aspects and ecological development. Loss of rangelands will therefore mean the loss of research opportunities, explorations, new discoveries and their benefits for local people, the scientific community and for humanity.

Conclusions and Recommendations

Conclusions: Rangelands encompass a fairly large part of GB and AJK and constitute the single largest land use. Subsistence farming and livestock herding are the two major sources of livelihood for mountain dwellers accounting for 35-40 percent of income for local household and 11 percent of the GDP. Apart from livestock grazing, pastures and rangelands have been providing substantial amounts of firewood to meet domestic energy needs, fodder for livestock and high value aromatic and medicinal herbs for traditional use and sale. Rangelands have been vital for sustained economic growth, air and water regulation and ecological flows for the agro-based national economy, fisheries and mangrove ecosystem. However, the constant increase in the human population and the corresponding rise in the demand for food, fiber, shelter, energy, medicine and dairy products like milk, meat and pelts, has quickly multiplied livestock numbers manifold during the past four decades. Such a consistent increase in the livestock population coupled with a similar increase in the number of wild herbivores, due to community based conservation initiatives and the illicit removal of natural vegetation for fuel wood, fodder, food and medicine have resulted in the quick conversion of rangelands into other land uses. These include deserts, social forestry and agricultural fields. The lack of adequate regulations and appropriate policies regulating rangeland resource use, coupled with the sheer lack of capacity both human and material in the custodian departments, to enforce and monitor the available laws, are some of the reasons for the fast degradation of rangelands in the region.

Recommendations: A multi-faceted integrated conservation and development strategy comprising short, medium and long term interventions is required to protect, restore and eventually improve the degraded rangelands. A few suggestions in this regard are as follows:

1. Short term (planning for management and regulation of use):
    - Rangeland resources valuation and assessment
    - Mapping, zonation and resource use planning
    - Review and update existing regulations and legislation
    - Enforce updated resource use regulations

2. Medium term (monitoring of uses and restoration of rangelands):
    - Develop a rangelands monitoring framework
    - Build capacity of custodian departments
    - Monitor resource use regulations

- Restore degraded rangelands

3. Long term (improvement, research based management and awareness raising):
- Undertake detailed scientific research on priority issues
- Develop research-based rangeland and livestock management plans
- Engage local communities in implementation of management plans
- Foster rangeland conservation values through awareness and education
- Monitor and evaluate results, document lessons learnt and improve management

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Rangeland resource constitutes more than 60 percent of the land area of Pakistan, and plays a vital role in rural livelihoods, food security and nutrition. The significance of this vast resource is also high from ecological, social and economical perspectives. The function of the rangeland resources is of high significance in regulating water flow for irrigation, drinking and hydro power generation. However due to the increased demand for various products, services and functions, the resource is at decline and requires concrete actions for rehabilitation of the degraded rangelands close to their potential.

The main objective of the publication is to provide an overview of the resource encompassing the extent, geographical location, types, significance, current condition, trend and potential. The document is basically meant for policy makers, natural resource managers and range scientists to assist them in formulating appropriate rangeland policies, strategies and developmental projects and prorgammes. The publication is a comprehensive document covering all provinces and regions of the country. The association of the related government departments, ministry and experts in the publication formulation process created shared ownership, which will be helpful in the implementation of the various recommendations and follow up actions.

The publication is based on the use of secondary data, recent research findings, lessons learnt from the past rangeland management prorgamme, expert consultation and dialogue with the key stakeholders. The literature cited also provides a good data base for further review and research work.

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