ECONOMIC VALUATION OF THE BIODIVERSITY OF CENTRAL KARAKORAM NATIONAL PARK

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Contents

Table of Figures:

Research Report

Economic Valuation of the Biodiversity of Central Karakoram National Park

Chapter 1: Introduction

Planet earth has the distinctive feature of hosting all forms of life, with the most extraordinary feature being its diversity. Nine million types of animals, protists, plants and fungi inhabit the earth. (Cardinale, Duffy, Gonzalez, & Hooper, 2012). However, in the last few decades natural processes and anthropogenic pressures have dismantled the Earth's ecosystem, eliminated species and biological traits at unprecedented rates. (Koh, et al., 2004). Protected areas are amongst the most sensitive and fragile regions of the earth. They represent and protect our scarce natural resources, the diverse species and the various communities in the entire ecosystem. We can already see the drastic climate change leading to species migrations, animals and plants communities being reassembled and iconic landscapes changing or disappearing (Hannah, 2008)

Protected areas are among one of the the most significant strategies for biodiversity conservation. They play a crucial role in the adaptation and mitigation of the effects of climate change, both on the local and global scales. However, their role and its importance in responding to the changing climate is either insufficiently recognized or understated, during formulating national policies and strategies around the world, especially in countries like Pakistan. (Koh, et al., 2004)

The underlying reason behind the accelerated widespread degradation of the protected areas in Pakistan and across the world, is the undervaluation of the value of our resources and the significance of the conservation of biodiversity by the various segments in our society. To make things worse, the economic-socio-environmental activities along with the services provided by these protected areas remain undocumented, owing to the lack of scientific research and initiatives by the local authorities. Hence, the decision makers neither possesses the knowledge regarding the ongoing impacts of the changing climate on these fragile ecosystems, nor the value of ecosystem services provided by these protected areas. (Janishevski, Noonan-Mooney, Gidda, & Mulongoy, 2008)

Depicting this situation is one of the Protected areas in Pakistan known as the 'Central Karakoram National Park' (CKNP), officially designated as a national park in 1993. It is the highest national park in the world, covering an area of approximately 10,000 km^2 in the Central Karakorum mountain range of Pakistan. CKNP encompasses the greatest concentration of high mountains on earth along with some of largest glaciers outside the Polar Regions. (Mari, et al., 2014). Although blessed with abundant resources and biodiversity, the Central Karakoram National Park (CKNP) is being affected by climate change and anthropogenic activities, that is hindering the sustainable growth and conservation of its resources and biodiversity. The fluctuating precipitation rates and receding glaciers of the park are affecting the hydrological cycles, livelihoods, and food security of the region. Moreover, the wildlife including the national animal of Pakistan – Markhor, Snow leopard, Brown bear etc. remains endangered and the unsustainable agricultural practices and deforestation has resulted in increasing soil erosion, floods, landslides, and glacial lake outburst floods. (Pakistan, 2018)

Likewise, there lacks a knowledge base system that identifies both the areas within the park i.e. the ones that are rich in biodiversity and hence most economically significant, and secondly, the ones most susceptible to climate change. Similarly, the resources that have been affected due to climate change and the corresponding loss in their value, need to be studied as there exists no knowledge on these multi-dimensional relationships owing to varying climate patterns. There have been studies in the past on various ecosystems of CKNP e.g. Impact of Climate Change on Hinarchi Glacier and Bagrot River Runoff in Central Karakoram National Park of Gilgit (Hussain, Raza, & Hassan, 2016), but these were limited to specific valleys or ecosystems and none of them attempted to quantify the economic values associated with the park.

These synergistic ecological stressors pose serious impact on the value of the resources and biological diversity encompassing the park. This poses the need to assess ecosystems in the light of valuation of resources and the ecosystem they provide. It can help understand how nature and its resources contributes to the park's economy, assess the need for revisions in pricing mechanisms, and most importantly identify ecosystems with greater potential values and the one's most vulnerable to climate change. Therefore, assigning monetary values to these resources and services of the park, can ensure that the lack of existing knowledge regarding the value of services is recognized in light of the changing climatic patterns and thus, the actual values of resources and the scientific insights generated, are incorporated into the decision-making processes and management of these protected areas. (Mari, et al., 2013)

1.2 Objective:

Explore, Quantify and Value the Economic benefits generated by the Central Karakoram National Park in order to identify the most vulnerable and economically significant natural resources encompassing the National Park.

1.2.1. Research Questions:

1. What are the main ecosystem goods and services provided by CKNP?

2. What is the value of the ecosystem goods and services provided by CKNP?

3. Which valleys are the most valuable, vulnerable, and are under the most threat from climate change in CKNP?

4. Which resources are the most valuable, vulnerable, and are under the most threat from climate change in CKNP?

1.3 Methodology

Question 1 was addressed by: Literature review of the relevant ecosystem services of the park, Interviews with experts from various International organizations, and survey (Questionnaire, Interviews and FGDs) from the locals across the park to verify and consolidate the information.

Question 2 was addressed by: Identification of the most relevant provisioning services of the park through literature review, collection of raw data through questionnaires that forms the input for valuation for each resource to calculate the total economic value (TEV), in order for the data to be presented in both quantitative and qualitative terms.

Question 3 and Question 4 were addressed by: Literature review of the dynamics underlying each valley and resource, Interviews with NGOs and Local authorities, Interpreting information from the FGD's to incorporate local perceptions, Converting the raw data from questionnaires to undertake economic valuation of each resource, comparing the data from all valleys to identify the similarities and differences amongst each other, and analyzing the processed data from valuation, impacts of climate change, vulnerability parameters, and threats to determine the most vulnerable and valuable valleys.

Chapter 2: Literature review

The very definition of biodiversity includes not just “different species of plant, animal and microorganism in existence,” but also encompasses the “specific genetic variations and traits within species as well as the assemblage of these species within ecosystem.” (Secretariat of the Convention on Biological Diversity, 2010). It is, therefore, widely understood that biological diversity and a healthy ecosystem are a causal relationship. (Hanley & Spash, 1994). For a well-functioning ecosystem, biodiversity is a salient factor contributing to a wide-ranging ecosystem-driven services. (Farber, Costanza, & Wilson, 2002).

Ranging from ecological, economic, and socio-cultural goods and services, the ecosystem services provides life-sustaining means for the human species. (Diaz, Fargione, & Tilman, 2006). These ecosystem goods and services are essentially the “benefits that people obtain from nature.” (Assessment, 2005). According to the The Millennium Ecosystem Assessment-- which is one of the most exhaustive analyses of ecosystem services-- the categorization of ecosystem services are: provisioning services, which includes food, timber, water etc.; regulating services, which includes soil, air and water control and regulation; cultural services, which includes values, cultures, recreation and tourism; and, supporting services including, soil and nutrient formation and water cycling. (Sukhdev, et al., 2010).

(Assessment, 2005) concludes that of the 24 major services provided by ecosystems, almost 15 categories are in marked state of degradation, owing to a combination of human overexploitation and socio-economic triggers like, excessive nutrient loading, introduction of alien species, loss of habitats, anthropological activities, and most of all, climate change. The Assessment report also goes on to reveal that approximately 20-50% of the world’s biomes have already been transformed and changed, exacerbating the extinction process. In simple terms, the ecological biodiversity—from animal to plants to the landscape—is at threat or facing extinction. (Secretariat of the Convention on Biological Diversity, 2010).

Mountain ecosystems make up 22% of the world’s land surface, containing thick forests, glaciers, rich biological diversity, and wildlife. (Price, Gratzer, Duguma, & Kohler, 2011). It is also important to note that 915 million people worldwide live in or around the mountainous regions. (Gleeson, Dach, Flint, & Greenwood, 2016). The mountainous communities are heavily reliant on the mountain ecosystem for meeting life-sustaining needs like food, water, livelihood and continuation of posterity. (Price, Gratzer, Duguma, & Kohler, 2011). Of these various ecological systems, mountain ecosystems are particularly important as they provide resources and services to the immediate communities in the locale, but also to the communities in the periphery. (Schild, 2016). However, the ecosystem services which are especially vital to mountainous communities are becoming increasingly fragmented, erratic, and scarce. (Schild A. , 2008).

The Hindukush-Karakoram-Himalayan (HKKH) region accounts for about 18% of the total mountain surface region in the world (Sullivan, Rijal, Shrestha, Khanal, & O'Regan, 2004), providing direct services, goods and direct income to 210 million people, indirectly some 1.3 billion people living downstream. (Schild A. , 2008). While it is established that the very survival of biomes is threatened by various ecological stressors, climate and ecosystems—in particular the mountain ecosystems of HKKH—are tightly knit. (Rasul, Dahe, & Chaudhry, 2008). Climate forms the basis for the mountain ecosystem as organism, plants, animal and the terrain are adapted to the localized climate. However, dramatic changes in the climate poses to undo the very stability which is needed to ensure that ecosystem services continue to thrive. (P.Dawson, T.Jackson, House, Prentice, & Mace, 2011).

Shifts in the variables of these services will greatly affect the dependent communities, particularly the most marginalized people—either in terms of increase or decrease in benefits vis-à-vis costs. (Farber, Costanza, & Wilson, 2002). Quantification of the ecosystem benefits and costs, thus, become necessary to generate a monetary value to every goods and service provided by the ecosystem. (Bhatta, Nepal, Rai, & Kotru, 2017). According to (Secretariat of the Convention on Biological Diversity, 2010), economic valuation helps to put a tangible number on the various economic, socio-cultural and environmental aspects of the ecosystem, with a view to encourage conservation, community awareness, and environmentally friendly policies.

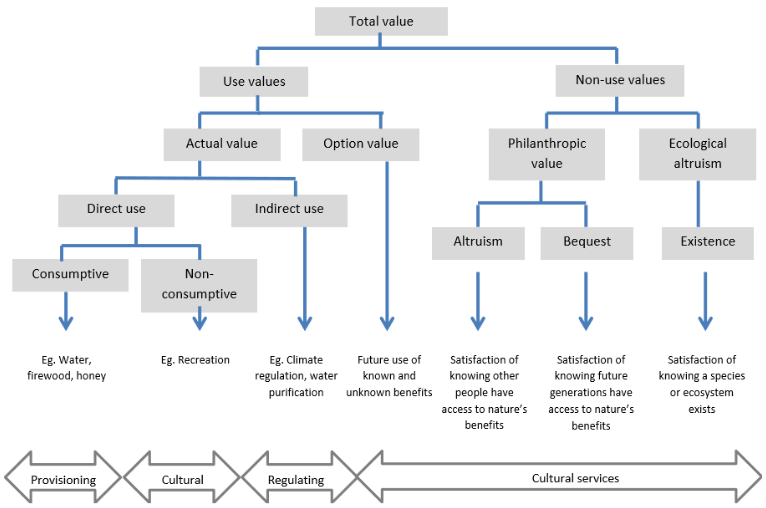
The Total Economic Value model accounts for value and non-use value. (Dalberg, 2013). Use value is qualitative and includes direct, indirect, option and bequest value. While, the non-use value is attached to goods or services a person may not use at all and includes bequest and existence values. (Farber, Costanza, & Wilson, 2002). The use value refers to the value an individual gets from the use of good or service directly. Direct use value is the benefit reaped from the actual usage. Option value is the value assigned to the potential benefit of a good or service in the future. Bequest value is the value on goods and services for posterity's use. Moreover, Existence and bequest values in the non-use value terms are values from a good or service other than through the actual use. (Losonci, 2012).

In the broader sense, ecosystem valuation can be done in specific ways: Market analysis based on the actual market prices, contingent valuation and individual choice model on the basis of simulated market prices, travel cost and hedonic price approach based on surrogate market prices, and value of changes of productivity and avoided damage costs on the basis of the production-function approach. (Farber, Costanza, & Wilson, 2002). Market based approach can be used to approximate the value of environmental goods and services sold in the market. It measures the producer and consumer surplus i.e. the maximum willingness to pay for a good or service. It presents an accurate estimation of the value of good traded in the market and due to its authenticity and real-time current relevance (Emerton, Jovetic, & Kaludjerovic, 2011), a market-based valuation approach is used in this study.

Chapter 3: Methodological Framework

In order to make sure that all the relevant provisioning services of CKNP are incorporated and evaluated, the research used the concept of Total Economic Value (TEV). TEV is an amalgamation of use and non-use values and includes direct, indirect use, existence, option and bequest values, as denoted in Figure 1:

Figure 1



Source: Adapted from TEEB Foundations Report 2010 Chapter 5 The Economics of Valuing Ecosystem Services and Biodiversity.

The Research questions were addressed through the following strategy in the same order as mentioned below:

- For literature review and secondary data purposes, project and survey reports were obtained from organizations such as WWF, Snow Leopard Foundation, ICIMOD, IUCN and Ev-k2-CNR. These included Wildlife surveys, Valley conservation and sustainable development plans, Forest – Agriculture – Glacier inventories, CKNP management plan amongst others. This was done in the first month of thesis and entailed visits to various project managers, regional managers, wildlife experts, country managers, and biodiversity specialists in their respective organizations.

- Conducted 25 Interviews with the relevant entities i.e. Ministry of climate change, forest, wildlife, livestock, and agriculture departments, along with experts from INGOs such Aga Khan Network. Moreover, tourist operators and agencies such as PTDC and Ministry of tourism, combined with lecturers from local universities i.e. Karakoram International University and University of Baltistan were consulted. These interviews were conducted in the second month of the thesis timeline. The details of Interviews are attached in Appendix A.

- Surveyed the local population through questionnaires i.e. 35 in total as they provided information regarding the dynamics of the resource i.e. local use of resources, local perceptions regarding past and future situation, impacts of climate change etc. The respondents were all male due to cultural limitations, with an average age of 33. These included people from various walks of life including teachers, farmers, shop-owners, social workers, bankers, journalist, police officials, businessmen, miners and engineers. While, the questionnaire was designed after consultations with the local leaders, university supervisor - Rolf Groeneveld, experts from organizations such as IUCN and WWF, independent researchers studying the CKNP ecosystem since the last decade, students of Karakoram International University (The biggest university in the CKNP region) and various economic-environmental specialists including lectures and researchers at various thinktanks, NGOs, governmental organizations etc. These were conducted during the fieldwork in the third and fourth month of the study. The questionnaire is attached in Appendix A.

- Alongside the questionnaires, a total of 5 Focus group discussions (FGD's) were conducted in each district, with participation of 15-20 locals to ensure the indigenous knowledge and insights of all stakeholders independent of their affiliation or field was incorporated in the study, and most importantly, the insights of the experts were corroborated by ground realities and information. These participants were recruited through the assistance of local support organizations, village conservation committees and local development organizations based in each villages, which were membership-based organizations and so they made sure the presence of their members as a result. The questions asked in the FGDs are attached in the Appendix A.

- Based on the quantitative data obtained from the questionnaires, a market-based valuation was conducted to determine the values of ecosystem services provided by each resource system under the scope of this study. The data was organized into Microsoft Excel, and the necessary steps followed including taking averages of the quantities of each resource harvested and correlating with the average market prices obtained through the survey. This was done in the last phase of the study, followed by the writing of the final report. The Excel files of questionnaire and processed valuation data is attached as separate documents alongside the final report.

The nature of the data collected for this study is both quantitative i.e. inventory based i.e. quantities and local use of the various economic goods complemented by qualitative data i.e. the use rights/customary laws data, local perceptions regarding threats and proposed solutions and the impacts of climate change on various ecosystems of the park. This data was mostly recorded through the use of voice recorders and forms, followed by transcribing/translating the Interviews/Questionnaire data onto Microsoft Excel and Word, after which it was double checked, analyzed, valuated, correlated and converted into tables/charts and processed information that is complete, concise and coherent to be shifted to the final report.

The study involved all stakeholders from the start to finish, who facilitated in data collection while simultaneously built capacity in applying the concept of provision goods and ecosystem services amongst the sample size/target audience. For the data collection, enumerators from Karakoram International University assisted along with local volunteers of the study area. The representatives of local support organizations, village conservation committees, development organizations such as Dobani development organization and Rakaposhi development organization etc., were instrumental in providing access to the locals in their homes. Local translators were provided by UNDP and WWF for assistance in translation of questionnaires and accompanying myself and the enumerators for the communication on ground.

By assigning economic values to some of the primary ecosystem services of CKNP, this research mainly draws attention to the provisioning services (economic benefits) of natural resources and biodiversity, and hence determining the direct use values i.e. the values of the **consumption goods** provided by the park. The provisioning goods that are taken into the account under the scope of this study are mentioned below. These were chosen based on various field visits and consultations with the locals, representatives and experts of CKNP, EV-k2-CNR, UNDP and IUCN as such:

- Forests
- Water
- Wildlife
- Agriculture
- Livestock
- Pastures
- Minerals

After assessing the map coverage of CKNP, analyzing the baseline study and consultations with the local representatives and technical experts of IUCN, the most economically significant and ecological hotspots were chosen for the survey which are shown in Table 1:

Table 1

District	**Valley**			
Gilgit	Haramosh		Bagrote	
Nagar	Ghulmat	Nagar	Hopar	Hispar
Skardu	Astak			
Shigar	Shigar		Upper Braldu	
Ghanche	Hushe	Thalay		

Chapter 4: Background of Central Karakoram National Park

Central Karakorum National Park (CKNP) is located in the Gilgit-Baltistan region and encompasses over 10,000 Km^2 across the Himalayan and Karakoram mountain range. The districts of Gilgit, Skardu, Shigar, Nagar and Ghanche are the most significant regions, characterized by extreme climate and altitudes, ranging from 2,000m to 8000m. It boasts of one of highest mountain ranges in the world, the Karakoram range, hosting the magnificent K2 (second highest mountain in the world). The region has carved out distinctive habitats and ecosystems , home to a large diversity of flora and fauna, from endemic herbs and perennial grasses to coniferous forests. Moreover, one of the most unique yet endangered species roam the national park, from wild animals such as Snow leopards, Brown bears and Red fox to a great avian diversity. (Invernizzi & Locatelli, 2015)

The CKNP falls in the "transitional zone" amongst the semi humid subtopics of South Asia and the arid Central Asia, with elements of a continental climate from the southern regions to the north. between the arid Central Asia and the semi humid subtropics of the northern South Asia. (Frey, et al., 2014). Its climate is influenced by global circulating patterns linked to its position in the continental mass and the ocean proximity. Moreover, higher temperatures and precipitation rates, increasing with the altitude denotes influences of westerly weather systems. (Invernizzi & Locatelli, 2015).

Being the largest protected area of Pakistan, CKNP has a high ecological and economical significance for the region. The park comprises of two zones: the buffer zone spanning 3,000 km^2, hosting low-lying areas and supplemented by settlements, and most importantly, where many commercial resource harvesting and unsustainable practices are prevalent. The buffer zone functions as a corridor to the other half of the park i.e. Core zone, which occupies about 7,600 km^2 of high mountain areas, glaciers, and a fragile ecosystem, where no commercial or unsustainable practices are permissible. (Mari, et al., 2014)

The land cover map of the park as shown in Appendix A, indicates that a major part (66.5%) is covered by snow and glaciers. Bare rocks and bare soils also represent a substantial part (15.4%) of CKNP, whereas vegetation base classes represent about more than 14.7% of the area. Vegetation classes encompassing the area include: Scattered vegetation, Sparse vegetation, Pasture and/or Meadows < 3,750 meters, Pasture and/or Meadows > 3,750 m, Open forest, Closed forest, and Cultivated areas. (Senese, et al., 2018). After assessing the resource coverage and distribution, historical trends of local use, local perceptions, and discussions with experts from WWF, EV-K2-CNR and IUCN, the most economically significant resources were chosen for analysis i.e. Forests-Pastures, Water-Glaciers, Wildlife, Agriculture, Livestock and Minerals, which are discussed below.

Chapter 5: Results of the Literature review

Forests

Different agencies have reported different estimates of forest area in Gilgit Baltistan. Forestry Sector Master Plan (1992) assessed the total forest cover of Gilgit Baltistan as 660,000 ha based on visual interpretation of satellite imageries of Landsat TM having 30 m resolution. Later, National Forest and Range Resource Assessment Study (2004) estimated the forest area of Gilgit Baltistan as 320,000 ha. (Ali & Hussain, 2017)

PFI prepared a Land cover Atlas for Pakistan which estimated the forest area of Gilgit Baltistan as 337,491 ha based on visual interpretation of spot-5 imageries having 2.5 m resolution. On the other hand, ICIMOD came up with estimates of 157,233 ha through Object Based Classification of Landsat imageries (30 m) of 2010. (Ismail, et al., 2014)

The carbon stock inventory study by the Forest, Wildlife and Environment department GB estimated the forest area of Gilgit-Baltistan as 249,205 ha which comprises of 3.57% of the total area of the region. (Ali & Hussain, 2017)

The estimates of forest area produced by different studies are given in table 2:

Table 2

S.No	Name of Study	Year	Forest Area Reported (ha)
1	Forestry Sector Master Plan	1992	660,000
2	National Forest and Range Resource Assessment Study (including FATA)	2004	320,000
4	Landcover Dynamics of Pakistan (ICIMOD)	2010	157,233
6	Landcover Atlas of Pakistan	2012	337,491
7	**Current Study**	**2017**	**249,205**

Impacts of climate change

Climate change has shown differential approaches for the propagation dependent upon the species ecology. Warmer temperatures and increased CO_2 increased the rate of photosynthesis and thus growth but has increased the pest attack is seriously stressing the forest regeneration. (Mustafa, et al., 2016)

Climate change can have both direct and indirect impacts on the growth and productivity of forests. Direct effect embraces the change in atmospheric carbon dioxide due to increased temperature and change in precipitation. The indirect effects refer to the complex interactions happening within the forest ecosystems. Climate also alters the frequency and severity of a variety of forest disturbances such as cutting and removal of fruits. (Ali & Hussain, 2017)

Table 3

Valley	Status	Altitudinal shift	30 years ago	10 years ago	Future
Haramosh	Degrading	Increased	Dense, Healthy	Started degrading	Negative
Ghulmat	Degrading	Increased	Dense, Patchy	Improving	Positive
Nagar	Degrading	Increased	Dense, Healthy	Improving	Positive
Shigar	Degrading	Increased	Dense, Patchy	Improving	Positive
Thalay	Degrading	Increased	Degrading	Degrading	Positive
Upper Braldu	Degrading	Increased	Patchy	Degrading	Positive
Astak	Degrading	Increased	Dense	Degrading	Positive

According to (Mustafa, et al., 2016) and local perceptions, the status of various forests has been summarized in table 3 above. As for the natural forest, the status can be considered degrading for all valleys mainly due to climate change and other stressors including illegal deforestation, growing population etc. For all valleys, there has been an altitudinal shift reported, most notably for non-woody vegetation.

Long term impact of the small-scale forest disturbances which cannot be observed via satellite systems must be assessed and counter measures should be adopted. With the increasing temperature and drought, it is obvious that some species will not be able to adopt and flourish in the ecosystem so there is need to assess that how long the present floral species will survive, and which species should be planted to continue the forest sustainability. (Hassan, Vuillermoz, & Listo, 2016)

Water

Water is the key ingredient and symbol of life. All the changes in climate pattern are directly and indirectly playing with water quantity. Altered precipitation patterns, warm temperatures and frequent air currents actually disturb the water quality and quantity both. Moreover, torrential rains are now more frequent which on one hand increases water quantity but also cause floods and landslides in disaster prone areas thereby creating socio-ecological stress. Water pollution is increasing due to hotels and increasing tourist pressures. Grey water from the local community is also getting mixed into fresh water and degrading its quality. (Anwar & Iqbal, 2018)

Glaciers in Gilgit Basin

According to a study by Ev-k2-CNR, the Gilgit basin hosts 36 glaciers i.e. the lowest number in the whole CKNP region. These glaciers correspond to 6% of the entire CKNP glacier census, with a glacierized area of a mere 2% of the total glaciation in the CKNP area. Hence, the Gilgit basin is the smallest relative to the other basins of Hunza-Nagar, Shigar, Shyok etc. (Bajracharya & Shrestha, 2011)

In 2010 the glacier area of the whole Gilgit basin is 83.61 km2, a value quite similar to the one found analyzing 2001 images. The area variations of the Gilgit basin during this period suggest a general glacier stability, in agreement with the other CKNP basins and in contrast to the worldwide shrinkage of glaciers outside the Polar Regions. Only 2 glaciers in the Gilgit basin changed their area: in particular, one glacier feature a slight increase (i.e. +0.01 km2) and the other one a small decrease (i.e. -0.02 km2). Both these ice bodies are debris-free and belong to the size class <0.5 km2. Due to the small size of Gilgit glaciers, only the 1% of fresh-water of the whole CKNP resource is present in this basin (for a total ice volume of 4.58 km3), of which 4.23 km3 of ice is entrapped into debris-covered glaciers and 0.35 km3 of ice into debris-free glaciers. (Smiraglia & Diolaiuti, 2016)

Glaciers in Hunza-Nagar basin

Hunza basin hosts totally 1384 glaciers, whose 123 in the CKNP area, correspond to ~20% of the total CKNP glacier census and covers a cumulative area of 766.03 km2 (21% of the total CKNP glacierized surface). (Bajracharya & Shrestha, 2011)

The Hunza glacierized area is characterized by a slight shrinkage from 2001 to 2010 (i.e. -0.76 km2), with the highest retreat for the 10-20 km2 size class and equal to -0.52 km2, as shown in the table 1 in Appendix B. Nevertheless, the area variations during this period are found to be both positive (11 glaciers, totally +0.30 km2) and negative (10 glaciers, totally -1.06 km2). For the purpose of assessing the total fresh-water resource, a total ice volume of 98.40 km3 was estimated, while 83.16 km3 of ice is entrapped into debris-covered glaciers and 15.24 km3 of ice into debris-free glaciers. (Smiraglia & Diolaiuti, 2016)

Glaciers in Shigar basin

The glacierized area in the Shigar basin is the widest in the CKNP, featuring the highest amount of glaciers i.e. 294 bodies (48% of the total CKNP census), and covering more than half of the entire glacierized surface of the national park i.e. 2308.3 Km^2. Moreover, the four biggest ice bodies in the CKNP region are hosted by this basin; Panmah Glacier (264.2 Km^2), Chogo Lungma glacier (265 Km^2), Biafo glacier (438.1 Km^2) and the mighty Baltoro glacier (604.2 Km^2). (Bajracharya & Shrestha, 2011)

In the table denoted in Appendix C, glacier area values in 2001 and 2010 are reported sorted according to 2001 size classes. Unlike Hunza basin, the Shigar glacierized area features a slight increase from 2001 to 2010 (i.e. +0.32 km2), with the highest growth for the sixth size class (i.e. 10-20 km2) and equal to +2.53 km2, and the highest retreat for the biggest size class (i.e. >50 km2) and equal to -3.62 km2. Totally, 37 glaciers (13% of all Shigar glaciers) were found to be characterized by a positive area variation (+5.90 km2) and 26 ice bodies (9% of all Shigar glaciers) by a negative one (-5.58 km2). (Smiraglia & Diolaiuti, 2016)

The largest part of glacier-derived fresh-water resource of CKNP is nested by Shigar basin (74% and equal to 392.39 km3, Fig. M), of which 187.06 km3 of ice is entrapped into debris-covered glaciers and 205.33 km3 of ice into debris-free glaciers, as shown in Appendix C. As Shigar basin hosts very wide glaciers (among which Baltoro Glacier with an estimated ice volume of 128.79 km3), the mean volume is higher whenever compared to the other basins (equal to 1.33 km3, Fig. N) (Smiraglia & Diolaiuti, 2016)

Water Use and Customary laws

The water related systems and frameworks contrast from one valley to other, but the distribution of water mainly depends upon its availability. In **Thalay** and **Astak** valleys, water distribution is dealt by customary laws which hardly had any changes since generations. In Thalay, the common distribution occurs family wise, in turns for varied time ranging from four to eight hours depending upon water availability, while other villages shares are open or based on the landholding area due to abundance of water. Other villages lying close to water channels do not practice these distribution rules due to the abundance and high availability of water for these settlements. (Hussain, et al., 2016)

In **Bagrote** valley, tap water is not allowed to use for farming. Everyone is the village must participate in the collective work of water channels repair, and if someone is absent, he must pay a fine. Moreover, the water running through a particular watershed is divided among the villages/ settlements settled in the bottom of the watershed, hence, water allocation is based on the basis of land area. Also, villagers from neighboring watersheds cannot claim for water rights in other watersheds even if the quantity of water is surplus. (Mustafa, et al., 2016)

As far as the **Hopar-Hispar** valleys are concerned, there are ten major water channels in Hoper; with five carrying water to the upper reaches of the village, while five to the settlements at valley bottom. Timing and duration of flow of water in those channels is maintained through a proper timetable, with hours being distributed amongst upper and lower channels. This system of irrigation water distribution in the valley is an old historical/traditional practice, still applicable and followed by local people and enforced by the Jirga in true spirits. (Gallo, Khan, Khan, & Khan, 2015)

In **Shigar** and **Upper Braldu** valleys, in case of water shortage, the usage rights rotate between different villages, while the usage right within the community is restricted. Households get water for a particular time span irrespective of their land holdings. Due to extreme seasons and natural disasters, upkeep of channels is needed, which includes removal of rocks, sediments, silt, anthropogenic matter and repair of side walls etc. Customary laws suggest that each household needs to assign a male worker for this task, and in any case of noncompliance, they are fined accordingly. (Pyara, Abid, & Rizvi, 2016)

In **Hushe** valley, varying rules exist for the various villages. In Hushe village, one household in a commune can avail water for irrigation purposes at an interval of 8 days on a regular basis. In Kanday village, the person first reaching the location gets water first. In the Khuwarkat area, the irrigation is sequential, which means that if the last irrigated field is located in village bottom, then irrigation of fields will take place upwards one by one in a sequence, and vice versa. (Mustafa, et al., 2016)

Impacts of climate change

In most valleys, gradual increase in temperature has been reported by local community during last 30 year with a rapid increase of temperature during last 10 years. (Mustafa, et al., 2016). According to (Zaib, et al., 2016), approximately 10% increase in temperatures relative to last 10 years were reported by the locals at 16 % in both Ghulmat and Nagar valley. In Thalay valley, a historical analysis for the period 1955 to 2010, clearly shows an increase in temperatures in the winter season, during the 55-year timespan. (Abbas, Khan, Pyara, Abid, & Rizvi, 2016).
Warming temperatures have resulted in fluctuating timings of bird migrations, increasing evaporation rates, and prolonged seasons for some wild and domestic species of Plants. (Bellard, 2012). Although, the warmer summer temperatures have resulted in longer growing seasons for

forests, it has also increased the summer drought stress and amplified the vulnerability of forests to insect pests. (P.Dawson, T.Jackson, House, Prentice, & Mace, 2011)

According to local community snow season has also showed significant delay and is getting more delayed year by year in different valleys. According to (Zaib, et al., 2016), 35% decline in amount of snow fall over last 10 years in Ghulmat valley, while a 60% decline in Nagar valley (Shimshali, Khan, & Gallo, 2016), 58% in Thalay (Abbas, Khan, Pyara, Abid, & Rizvi, 2016), 55% in Haramosh (Vuillermoz, Listo, Raza, & Pyara, 2016), and a 38% decline in Shigar valley has been observed. (Mustafa, et al., 2016). Moreover, mountainous areas may experience more intense bursts of heavy rains in the summer. (Abbas, Khan, Pyara, Abid, & Rizvi, 2016)

On the other hand, rainfall has declined up to 17% according to the perception of local community in Shigar and Nagar valleys (Shimshali, Khan, & Gallo, 2016) but have increased in Haramosh and Thalay (Abbas, Khan, Pyara, Abid, & Rizvi, 2016), with no significant changes in Ghulmat valley (Zaib, et al., 2016). The altered precipitation pattern has caused the differential availability of water during different seasons. During end summer and winter season water become scarce and leads to unsustainable water management, however during the start of summer season flood in the streams increase and irrigation channels and creates water unavailability/scarcity coupled with poor water quality. Community members have also reported reduction in the size of glaciers and increase in the frequency of Glacial Lake outburst floods (GLOF) events. (Ahmed, 2015)

Changes in the climate have had an influence on the magnitude and frequency of flooding in rivers in Gilgit-Baltistan. With respect to snow and glacier melt, the magnitude of temperature-changes during the spring and summer are enough to have caused a major change in the flood-potential of catchments. (Ali G. , 2008). Changes in winter temperatures have influenced the amount and altitudinal distribution of snow available for melt in the subsequent season and has resulted in changing flood pattern being observed over last three decades with a sharp increase in both frequency and magnitude of flood being observed in the last decade. (Adnan, et al., 2016). According to the locals, the magnitude of the flood has been increasing since the last 30 years by 25% in Ghulmat valley (Zaib, et al., 2016), 35% in Haramosh (Vuillermoz, Listo, Raza, & Pyara, 2016), 22% in Nagar (Shimshali, Khan, & Gallo, 2016), 25% in Shigar (Pyara, Abid, & Rizvi, 2016) and 45% in Thalay valley (Abbas, Khan, Pyara, Abid, & Rizvi, 2016). The frequency of floods was also reported to have increased by 20% since last 30 years in Ghulmat (Zaib, et al., 2016), 29% in Haramosh (Vuillermoz, Listo, Raza, & Pyara, 2016), 21% in Nagar (Shimshali, Khan, & Gallo, 2016) and Shigar, and 54% in Thalay valley. (Mustafa, et al., 2016)

Wildlife

Important Wildlife of the Central Karakoram National Park

Central Karakoram National Park is home to the most unique yet endangered wildlife on the earth. The Wildlife distribution map is shown in Appendix C. The most notable species residing in the park are; **Snow leopard** which resides in the rocky and mountainous meadows from 2700-6000m. Most of its population in the CKNP region is in the Hushey, Basha, Upper Braldu valleys and the glaciers of Biafo and the might Baltoro glacier. (Abbas Y. , 2018) **Lynx** is found at the highest of alpine slopes at 4200-4500m, and usually seen in the Basha and Braldu valleys of the national park. (Invernizzi & Locatelli, 2015). **Brown bears** are in the alpine and sub-alpine areas in Gilgit-Baltistan at an altitude of 2600 to 5000m. Having made the Deosai national park its habitat, the brown bear also reportedly exists in the Shigar, Braldu and Biafo (Hispar) regions of the CKNP. (Invernizzi & Locatelli, 2015). The **Himalayan Ibex** is usually found in high pastures from 3500 to 5200m across the Gilgit-Baltistan region. Most of its population in the CKNP area is in the Hushe, Basha, Braldu, Hushe and Thalay valleys. The population distribution areas of the Himalayan Ibex are shown in Appendix C. The Astor **Markhor** is mostly found across sparsely wooded mountains of the western Himalayas at elevations ranging from 1500 to 3600m. Like the ibex, the Markhor has a high economic value, as its trophy can be hunted for up to 1,500,000 USD. (Invernizzi & Locatelli, 2015). The population distribution areas of the Astor Markhor are shown in Appendix C. The **Red Fox** can reside at an elevation up to 4500M and is commonly found in all regions of Gilgit-Baltistan and CKNP. It is also prone to being killed for pelt and is considered a threat for the poultry and small domesticated animals residing in the villages. (Invernizzi & Locatelli, 2015). **Ladakh Urial** are found at relatively lower altitudes of about 3500m across CKNP area, usually found in Jaglot, Shigar, Upper Braldu, Astak, Turmik and Arondu valleys. (Invernizzi & Locatelli, 2015). The **Musk deer** inhabits dense forests at an altitude of 2000 to 3000m. In CKNP, it is usually seen in Haramosh, Turmik, Basha and Shigar valleys. Similar to Ibex and Markhor, the musk deer has a great economic value as it can be sold for up to Rs. 45000 per gram. (Invernizzi & Locatelli, 2015).

As for the avian diversity, according to (Abbas, et al., 2014), 108 bird species belonging to 16 orders, 38 families and 75 general were recognized in the area of study. 48% of these species were residents, whereas 23% were winter visitors and 24% the visitors of the summer. In the CKNP area, **Hoper** valley possesses the largest diversity i.e. 95 plus species, followed by 80 species residing in **Shigar** valley, **Nagar** valley with 70 species, and **Hisper** valley hosting a great variety of 70 species. Most of the species are usually observed near agricultural fields, vegetative areas and settlements, while the rare and threatened species like snowcocks, vultures, lesser kestrels and snow partridges were identified at a greater distance, at higher altitudes away from the human settlements. (Abbas, et al., 2014)

Impacts of climate change

Institutional structures to manage wildlife and protected areas experience lot of issues due to increasing urbanization, degrading forest and natural areas. The biodiversity of CKNP and its buffer zones has the species, which are of international and national importance. Wildlife plays an important role in both ecosystem sustainability and community economics. Although trophy hunting is a controversial subject, yet it enabled the community to earn millions of dollars since its start and contributed to conservation as well. (Mustafa, et al., 2016)

The many components of the changing climate are predicted to impact all the segments of the biodiversity. Whether it's an effect on an organism or a biome, climate change has been projected to be a progressively greater threat in times to come. The increasing temperatures, along with varying precipitation rates and high frequency of extreme weather events, can be expected to have far more greater impacts on the health of biodiversity across the world, and specifically CKNP in this context.

Agriculture

Impact of Climate change

Climate parameters such as CO^2 concentrations, temperatures, precipitation rates, availability of water have direct impacts on the wellbeing of crops and fruit trees. With increased temperature and CO2, crops such as wheat, maize, barley, buckwheat, fodder etc. and fruit trees are likely to grow more rapidly due to increased photosynthesis. Moreover, it provides grounds for insects, diseases and weeds to grow, which further hinders agricultural production. Aided to these additional stresses is the variations in precipitation and irrigation water patterns. Early and rapid snow melting accompanied by irregular rainfall followed by drought declines the productivity.

Disease pressure on crops is continuously increasing, with earlier and prolonged summers and warmer winters, which allows proliferation and higher survival rates of pathogens and parasites. (Hussain, Mudasser, Sheikh, & Manzoor, 2005). In the future, it is predicted by the locals that weeds will become more common and irregular patterns of precipitation will lead to lower productivities for the agro-economy of the region. (Hussain & Mudasser, 2007). As per ICIMOD, "52.4% of the GB population is food insecure and lack adequate access to food due to numerous challenges that are aggravating at express pace". (Hussain & Mudasser, 2007)

Livestock

Livestock is an integral part of agro-pastoral economy of Gilgit-Baltistan. In 1996, the total population of livestock was estimated to exceed two million animals, including 404,306 cattle, 1,047,285 goats, 518,052 sheep, 21,483 donkeys, 7,903 horses, 955 mules, 15098 yaks (Invernizzi & Locatelli, 2015), but the numbers have significantly gone down in the last few decades. According to a study by WWF-Pakistan in 2010, the estimated population of livestock in 23 valleys of CKNP was just a mere 421,839 animals (as denoted in a table in Appendix E).

Pastures

In Gilgit-Baltistan, alpine and sub-alpine pastures are the two major categories of land use. The extent and the spread of this resource is much more relative to other resources in the region. These pastures are not only located in alpine and sub-alpine zones, but also spread in the scattered stands of natural forest. In general, these intermediate pastures are the result of deforestation over the past. The alpine pastures are covered with snow from early winter to late spring. The animals graze these lands as and when the snow melts, in this way, the grazing pressure is gradually shifted to higher altitude pastures. (Ullah Baig, 2011).

The land tenure system is designed in such a way that the users are primarily focused on the short-term immediate gains, rather than the sustainable long-term benefits. (Invernizzi & Locatelli, 2015). Usually, the grazing rights and utlizaition of forests and pastures are mostly defined and delimited by natural boundaries i.e. ridges or rivers. Generally, these areas are situated in close proximitiy of the respective villages, or in nearby valley sections, or on the adjoining slopes. Villages with a limited amount of forest resources in their pastures are sometimes granted additional access to areas beyond their grazing rights, but only in some exceptional cases. (Mari, et al., 2013). Moreover, based on the availability of fodder, water, amount of snow etc. villagers make appropriate decisions regarding use of pastures and grazing systems annually before taking livestock to the pastures. In terms of local level management of pastures, the village heads make deliberations regarding utilization of different pasture units by different livestock types as well as the timing for animals' movement from one pasture unit to the other. (Zaib, et al., 2016). Under the customary laws, there exists a strict ban on free grazing during the summer period.

Impact of climate change

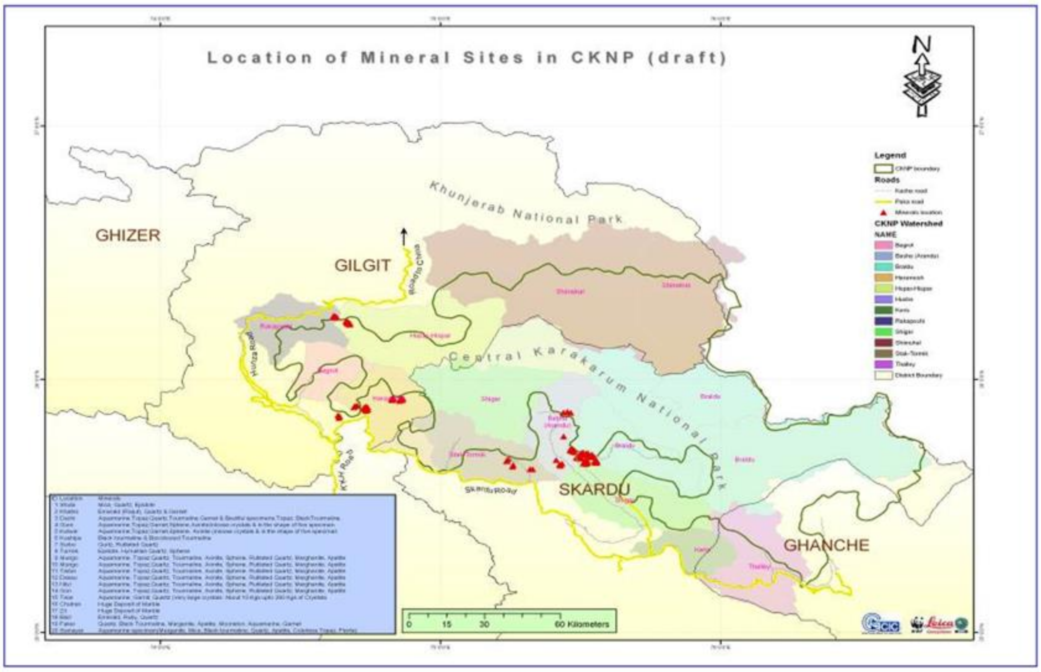
Regional climate scenarios indicate prolonged seasons of growth and fluctuations in the temperature and precipitation patterns in and around the CKNP area. However, despite the better and prolonged growth seasons range lands that serve as pastures and grazing lands are degrading annually. In the alpine and sub alpine areas, between 10% and 40% degradation has been observed across the CKNP valleys. However mid and low land grazing areas have declined between 15% and 50% which is more than alpine regions because of high livestock pressure. It can be assumed that many plant species are migrating vertically for lower temperature, thus increasing the plant diversity at higher alpine regions and growing competition by highly productive species at lowlands. (Bellard, 2012)

Higher temperatures and rising microbial activity is likely to contribute in carbon loss from these alpine pastures of the region. According to studies by WWF and Ev-k2-CNR, we now know that higher amounts of carbon are stored in soils, relative to the aboveground biomass above the tree line. Hence, it can be concluded that alpine ecosystems in the longer run, maybe serve as carbon sources instead of carbon sinks. (Ismail, et al., 2014).

According to (Vuillermoz, Listo, Raza, & Pyara, 2016), the alpine and sub alpine areas of **Haramosh** valley is degraded by 40%, while the Mid and low land grazing areas have declined by 50%. Due to unavailability of alternative grazing areas, the community can't restrict the use of degrading pastures and hence, no adaptation measures are undertaken by the community. In **Ghulmat,** 24% degradation in the alpine and sub alpine areas and 31 % in Mid and low land grazing areas, (Zaib, et al., 2016), 13% degradation in the alpine and sub alpine areas and 16 % in Mid and low land grazing areas in **Nagar** valley, 24% degradation in the alpine and sub alpine areas and 31 % in Mid and low land grazing areas. (Shimshali, Khan, & Gallo, 2016), 21% degradation in the alpine and sub alpine areas and 32 % in Mid and low land grazing areas in **Shigar** valley (Pyara, Abid, & Rizvi, 2016), 10% degradation in the alpine and sub alpine areas and 15 % in Mid and low land grazing areas in **Thalay** valley(Abbas, Khan, Pyara, Abid, & Rizvi, 2016), 29% degradation in the alpine and sub alpine areas and 33 % in Mid and low land grazing areas in **Upper Braldu** (Hassan, Vuillermoz, & Listo, 2016) and 21% degradation in the alpine and sub alpine areas and 28 % in Mid and low land grazing areas in **Astak** valley have been observed. (Hussain, et al., 2016).

Minerals

Figure 2



At present about **32** varieties of the gemstones are being mined in the Gilgit-Baltistan region including Ruby, Aquamarine, Topaz, Fluorite, Marganite, Tourmaline, Quartz and Epidote etc. In order of priority the most important gemstone producing areas of the region include **Haramosh** valley in Gilgit District, **Shigar** valley in Shigar District and **Nagar**, Hunza and **Hisper** valley in Gilgit District. (Invernizzi & Locatelli, 2015)

"About 30,000 people associated with the mining sector are carrying out activities inside the Central Karakoram National park territory, adding that the act may result in the loss of habitat for various species". In **Bagrote** valley, mining activities in Bulchi village have been carried out between 1990s to 2010 on a small scale by 3-5 mining groups, consisting of 3-4 miners and mostly mining marble and quartz. For the last few years, there hasn't been any activity due to the location of minerals in glaciated areas, the prevailing heavy snowfall and less melting of snow. (Khan, 2015)

Haramosh valley being one of the most significant gemstone producing areas in CKNP, is rich in deposits of precious stones such as Ruby, Black Tourmaline, Topaz, Aquamarine, Fluorite, Morganite and Quartz. Since the 1930s, groups are mining through hit and trial methods, and hence not being able to obtain the true value of their discovery. (Vuillermoz, Listo, Raza, & Pyara, 2016). The Chumarbakor mine in **Nagar** valley is the most promising gemsone area in the valley hosting precious gemstones like Aquamarine, Tourmaline, Apatite, Beryl, Fluorite, Quartz, Calcite, Topaz, Albite and Microcline. Though communities of all villages are not engaged in mining but on average 25 groups from three villages are reported being engaged in mining activities earning on average PKR 250,000/- annually. (Shimshali, Khan, & Gallo, 2016)

Dassu and Hyderabad mines in **Shigar** valley are considered to be the most productive areas famous for production of gemstones like Aquamarine, Ruby, Zoisite, Microcline, Albite, Garnet, Quartz, Topaz, Tourmaline, Bi-Color Tourmaline, Green color tourmaline, Calcite, Marganite, Apatite, Fluorite, Folsite, Diopside, Kunzite, Emerald, Sapphire, Pargasite, and Axinite etc. In **Hushe, Hopar-Hispar** and **Thalay**, the mining sector hasn't been explored yet, although there are signs of mineral deposits in the area. The Tookla mines in **Astak** valley, is one of the famous sites for gems production in CKNP, at an elevation of 10,000 feet ASL, where gemstones like Tourmaline (Green), Tourmaline (Black), Tourmaline Bi-Color (Green-Red), Marganite, Fluorite, Tanzanite, Quartz, and Aquamarine etc are found. However, the mine have collapsed and has been considered potentially dangerous for future exploration work. (Hussain, et al., 2016)

Chapter 6: Results of Focus Group Discussions

The FGDs were attended by approximately 100 participants in total during the course of 5 Focus groups being conducted. This meant that the presence of at least 15-20 locals was ensured during each FGD. The attendees were mostly village locals that comprised of members of various local/development organizations and village conservation committees. The presence of farmers, wildlife watchers, miners, pastorals and shop-owners were ensured to incorporate local perceptions and establish correlations amongst each stakeholder perceptions/objectives. The participants were all male due to cultural barriers, and the average age would be approximately 35. The mediator of these FGDs along with myself was usually the local development organization president or one of the elderly figures of the village. The education levels of them varied from having little or no education such as Farmers to having more knowledge and skillsets like a medical specialist, teachers, businessmen who had at least a bachelor's degree in their respective fields. Based on the information provided by them through the Focus groups, the qualitative analysis of the ecosystem goods and services has been conducted as discussed below.

Forests

Most of the local communities are still highly dependent on plant biomass from natural forests. However, the inhabitants of CKNP fulfill their timber and firewood requirements from the plant biomass too, that is procured from agro-forestry interventions practiced on lands less suitable for agricultural practices.

Poplar varieties are common plantations aided significantly to alleviate stress on natural forests. They are preferred due to high annual biomass, higher pest resistance, site adaptability, and easy vegetative propagation. As for Artemisia, apart from being component of the fuel sources, it is also used by livestock during winter. Juniper is relatively inaccessible due it being located on steep mountain slopes. Junipers are preferred species for fuel because of its dryness and aroma. Moreover, Walnut (Juglans regia) is also cultivated on the private lands for valuable timber and fruits. Old apricot trees either having low productivity due to age or disease are also harvested for same purpose.

As a consequence of increasing population, expansion of villages is a common phenomenon in most valleys of CKNP and thus construction of settlements/houses is also on rise. The timber for construction purposes is either purchased from Proper Nagar, Hunza, Gilgit or Skardu timber markets or from natural/artificial plantations. Timber harvesting is usually regulated for its harvest in many valleys, regardless of the abundance of forest cover or not. However, these regulations are mostly on paper and hardly implemented in practice, with the locals usually deciding within themselves where, when and in what quantities to harvest. In some valleys, the major sources are animal dung and fruit trees, and hence, the dependency on forests can be very low due to strict and effective implementation by the community and regulating authorities such as CKNP directorate, Forest department, WWF etc.

Among the alternative fuel wood resources electricity, gas cylinders and kerosene oil are usually employed. Kerosene and LPG are being used in winters (December – February) while electricity is mostly being used in spring and summer from April to September as an alternative source of domestic energy, mostly for cooking. Plantations by local community on private lands have help alleviate strains on natural flora considerably. Judging by the yearly firewood consumption in the region, it is apparent that even dense forests may be vulnerable to severe burden and rates of chronic disturbances, hence, pushing these rich forest regions towards fragmentation.

According to my study, an average amount of fuelwood harvested varies around 3404 kg/hh/yr. As for timber, a tree is divided into logs and carried to the surrounding cities of Skardu and Gilgit and is normally sold for 100,000 rupees (Picea) and 125,000 (Pinus), depending on the quality and the type of wood. Hence, timber is a significant source in the share of household revenues in the region.

Customary laws are being followed mostly in all valleys of CKNP including Ghulmat, Nagar, Shigar, Hopar-Hispar, Upper Braldu, Thalay and Astak. Community is allowed to collect only dead and fallen trees for fuel wood and timber up to need basis, based on the customary rules and CKNP directorate guidelines. However, these laws have many loopholes in the system, for e.g. Illegal trade to markets of Gilgit and Skardu is still taking place, it does not address the maximum amount of harvest allowed in the buffer zone, and most importantly, customary laws have no guidelines regarding the types of floral species that can be harvested and hence, species such as Juniper is harvested extensively by local community from both the buffer and core zone, without taking into consideration its deliberate growth. (Mari, et al., 2014). However, the Local support organizations (LSO) and Village conservation committees (VCC), are striving to ensure the effective implementations of these rules, in order to reduce the burden and ensure the sustainable management of these natural forests.

According to the FGDs conducted with the local community, the following impacts of climate change on the forest were observed:

- Rising temperatures have impacted the local forest ecosystems of CKNP by providing prolonged growth season which seems to enhance its productivity apparently. But this rising temperature can lead to phenological shifts of the alpine species and they will become locally or regionally extinct since they are unable to shift to higher altitudes.

- The nullahs branching out from glaciers and springs are the major irrigating channels for the agriculture crops and the forest species. With increasing temperatures these channels dry out and cause water stress augmenting the forest degradation in the valleys.

- Along with this, warmer springs has the potential to increase the range and lifespan of a variety of pests, that put a constant stress on the trees and crops. Moreover, warmer springs decreases the quantity of available water for use throughout the year.

According to the locals, 30 years ago the forest patches in almost all valleys were dense and healthy, while it started degrading 10 years ago, except in Thalay, where the forests were degrading 30 years ago too, due to heavy reliance on natural forests since the beginning. Also in Ghulmat and Nagar valleys, the condition of the forests have been reportedly improving since the last 10 years, mainly due to more awareness, conservation and regulations. However, more degradation is expected if a sustainable use of these tree species isn't practiced.

For the fruit trees, the status has been considered degrading by the locals as well. It has been reported that 30 years ago, pests and crop infections were not frequent and thus, artificial fertilizers were not required. However, since the last 10 years, new pest varieties have been reported by the locals. In the future, it has been predicted by the locals that weeds will become more common and most importantly, irregularity of water availability due to increase in floods, diseases, large adoptability of traditional farming methods, and fluctuating precipitation rates, will lead to a decline in productivity with the same varieties of seeds.

After various consultations with foresters, locals and field workers, the management issues and problems associated with forests include depletion of plant biomass due to growing population and the consequent timber and firewood extraction, debarking and trampling of newly planted and fruit trees by livestock, lack of alternatives of domestic energy, and insect pests defoliating the trees leading to wilting and stunted growth.

After discussions with the locals and experts, the proposed interventions include various mechanisms such as regulating use of firewood by updating customary laws for e.g. cutting or uprooting an entire tree should be strictly banned and ensuring cutting of single basal shoots from plants. For regulation of Timber, management based on proper planning of harvesting in time and space, target diameter, and specie-specific treatments for plants, that are targeted based on the varying ecological needs of a certain species is required. Secondly, firewood plantations on individual farmlands instead of block plantations on communal lands is proposed, along with plantations of sea buck thorn, that serves as a hedge after 3-5 years. Thirdly, investment in energy efficient technologies such as Hydro-powered electric plants, fuel-efficient cooking stoves, bio-brackets, hatched window and use of biogas is recommended. Moreover, effective implementation of statutory laws and revision of customary laws is needed, as they don't address the current threats of climate change and conservation needs. Out-of-forest firewood Plantation diffusion through effective short rotation coppice systems can also be considered. Also, training of farmers to maintain small-scale farm forests will reduce the dependency on natural forests. Lastly, considering the climatic changes, the upcoming forestry projects must come up with the forward crediting instead of required crediting, referring to restoration of forests alongside conservation of natural forests.

Water

Inhabitants of various valleys in CKNP have established complex irrigation mechanism or water system frameworks and agricultural fields in a long process of water channel development, land leveling and improvement. In most valleys, the glacial melt water is extracted from nearby stream or Nullah following gravitational force and brought to agriculture fields through open water channels. The water related systems and frameworks contrast from one valley to other, but water distribution mainly depends upon its availability. Most importantly, there is no price of water-use across the whole region.

The FGDs informed that the drinking water supply to the villages in most valleys including Bagrote, Hopar-Hispar and Hushe, is from natural springs brought down to village by pipes, while irrigation water is mostly from glacier streams flowing down from the mountain tops. The spring water has generally been claimed to be clean in most areas, while glacier water containing debris is not considered suitable for drinking. The location, source, use and condition of water in Bagrote valley is shown in Appendix C.

Valleys such as Haramosh, Ghulmat, Shigar and Astak have adequate water supply from the mainstream at the middle and small water streams from both sides of mountainous terrain. The overall water availability is sufficient to cater required need of the valleys; but during the peak season, flood and landslides damage the irrigation channels, leading to a water shortage.

According to FGDs, the valleys of **Haramosh**, **Ghulmat** and **Nagar** are rich in freshwater resources and mostly villages divide these channels according to the customary rights. In Nagar, area wise distribution takes places, allowing a specific area to use water on a weekly basis. However, there have been objections from the locals regarding the unfair distribution of water in these areas, as new settlements claim to have less water available, relative to the old villages. The loopholes in the customary laws are further fueled up in winters when the water shortage prevails in the region.

Shift in season along with increased extreme events have also been reported by local community during FGDs. The most visible evidence of temperature increase is the earlier melt out of snow cover and glaciers across the region which has become more rapid over last one decade. This increasing temperature is responsible for disastrous activities and glacier recession which is getting frequent day by day according to the local community. According to the locals, increasing temperature is the reason for increasing length of the summer season. Local community assess these changes through daily and seasonal activities e.g. ripping of crops, melting snow/glacier, human diseases etc. Regarding decrease in winter season, the community members responded that temperature in winter has increased with occasional snowfall. During FGD in Shigar valley, the community reported that 20 years ago, once the minimum temperature fell to -36C and now the minimum temperature is -13.

Changes in climate such as reduced snowfall and increased rainfall, are reported across the area by local communities, but solid evidence of the impact is difficult to ascertain. Amongst the changes observed include changes in water quality, varying precipitation rates, stream flows, snowmelt, flood hazards and the size of storms affecting the moisture available for plants. Rainfall variability and periodicity has changed since last 30 years with most profound effect since last ten years. High speed and late rains have been observed by the local community which accelerates the crop

diseases and infections. It shows that pests are getting adaptable to seasonal shift and variability more than other organisms and contribute to increased economic loss of crops and fruit trees.
The elders in the FGDs reported that in the past they used to receive heavy snowfalls in winter and doors of their houses used to remain shut for several days but now they usually experience just rainfall in winters and seldom get light snow. Moreover, mountainous areas may experience more intense bursts of heavy rains in the summer.
After discussions with locals, the management issues associated with Water include problems with construction, repair and maintenance of irrigation channels owing to limited resources, difficult terrain and disaster-prone topographic conditions and the threat of glacial lake outburst floods. For Pakistan 0.6°C rise in temperature was projected during 2001-2010 but it ended up with 0.93°C and the Gilgit-Baltistan region heated up to the level of 1.3°C. Such signatures leave alarming signals of glacial lakes formation, their expansion and outburst flooding. (Rasul, Chaudhry, & Mahmood, 2011). Moreover, locals reported lower quality owing to weathering and improper waste-disposal and no possessing no knowledge related to early warning systems and the adaptive/mitigation strategies regarding disaster management, leaves them vulnerable to huge economic depressions in all sectors ranging from transport to land farms.

After various consultations with locals and experts, the proposed interventions include improvement of water courses, small or medium-sized reservoirs in the plains and foothills, communal water storage tanks, training for locals especially hotel-restaurants owners on waste-disposal for ensuring water quality, assessments of glacier extraction, along with early warning systems to give timely alerts on floods and landslides, to locals for their crops and livestock protection.

Wildlife

Both in the core and buffer zone of CKNP, hunting or killing/poaching of wild animals is completely banned, while allowing for 'Trophy hunting' only in the Community managed conservation areas (CMCA). However, community take advantage of inaccurate population counts of wildlife and hunt wildlife at events such as family gatherings, holy occasions and so on. In **Bagrote** valley, if someone is guilty of illegal hunting or poaching, a fine up to Rs. 5000 is imposed or an in-kind contribution needs to be made, usually in the form of an adult cattle, preferably a bull. Moreover, the gun is confiscated, and the case is referred to Wildlife Department. In Hushe valley, if someone hunts for e.g. an ibex illegally, a fine is imposed equivalent to the amount of ibex national trophy hunting permit. Most importantly, there are no existing customary rights for their conservation, and hence, poaching and illegal hunting is controlled primarily through regulations and trophy hunting. Considering the birds like wild pigeon, sparrow, Monal pheasant, crows, vultures, eagle and falcon and butterflies have been reported by the local communities across CKNP, as being species that were common a long time ago, but now several of them are not common and experiencing decline. The community also reported that the arrival of migratory birds decreased and even their arrival time has been changed. The apparent reasons are the absence of favourable climate for prey species, decline in seed crops, removal of forests and floral species. Hence, owing to changing trends of species and how they adapt to climatic changes, it is a challenge to prioritize these species for conservation actions and to monitor the effect of climate change on the biodiversity.

After several consultations with forest guards, wildlife experts and locals, the management issues and problems associated with wildlife include, Illegal hunting and poaching, retaliatory killing of mammalian predators, diseases transmission amongst wildlife and livestock owing to lack of proper disposal, mortality of overwintering most noticeably amongst Ibex kids, Red tapes in the initiation of trophy hunting in some valleys such Hopar-Hispar and Bagrote, Weak enforcement of both statutory and customary laws, Non-existence of population assessments and trends, trapping and excessive shooting of game birds, and most importantly habitat degradation pushing the species to isolated and low-quality habitats, leading to additive stress on wildlife's genetic health and reproduction potential. (Abbas, et al., 2014)

Owing to discussions with various locals and experts, proposed management interventions include population assessments, community-based watch and ward, strengthening livestock insurance schemes, species recovery plans owing to habitat fragmentation, Identification of genetic reserves, notification of potential valleys as Community managed conservation areas (CMCA), and declaration of wetlands and dense forest patches for key bird areas, as no-hunting zones across the national park.

Agriculture

The valleys of **Bagrote, Ghulmat, Shigar, Hopar-Hispar, Hushe and Upper Braldu**, falls under the single cropping zone due to harsh climate which does not allow another cropping cycle. The most important crops in the CKNP are Wheat, Maize, Barley, Buckwheat, Millet as major cereal crops, while Potatoes and fruits such as Apricot, Cherry are the major cash crop. Agriculture in most valleys is both irrigated and rain fed. The valleys of **Nagar, Thalay and Astak** falls in the double cropping zone, where Wheat, Potatoes and Barley are the main subsistence crops, while Maize, Fodder is cultivated as the secondary crop. Similar to the single cropping zone areas, these valleys cultivate potatoes and fruits such as Cherries and Apricots as the main cash crops.

In many valleys of CKNP including **Haramosh** and **Ghulmat**, local farmers have developed terraced patches of agriculture fields through land reclamation at different altitudes around their settlements which is forest rich landscapes. These terraces offer new niches of plantations having favorable conditions for growth of valuable trees and specialty crops. Moreover, it protects and improves the prevailing cropping system. For example, a farmer would plant fruit/nut trees next to the edge of terrace rises, and hence, successfully allowing the establishment of tree crops in the management of scarce plain areas.

In valleys such as **Hushe,** dates are fixed for cultivation and grass cutting (fodder for animals). If someone goes to cut grass earlier the specified period (After mid-August each year), the quantity of grass he cuts is confiscated by the village conservation committee (VCC) or Stranso. In Marzigond village, Ban has been imposed in Astanyoq area to sale out a piece of land to a person outside the Marzigond village. A fine of Rs. 100,000 has been fixed if someone violates the rule.

The yield of many cash crops e.g., potatoes, walnut, apricot, mulberry, almonds etc. has declined in most valleys of CKNP and become more sensitive to climate change, relative to agriculture crops.

Local farmers observed the productivity and economic decline which shows that they are aware of climate change impacts but at the same time these people have no idea about the climate resistant seed varieties. Some farmers reported that despite of using high yielding seed varieties and inorganic fertilizers, the average crop productivity is less as compared to past years. 30 years ago, pests and crop infections were not frequent at all and artificial fertilizers weren't required. Moreover, there have been new varieties of pests being reported since the last decade. The status of agriculture crops is perceived to be degrading by the local communities since the last decade mainly due to adoptability of traditional farming methods, irregular water availability, diseases, floods etc.

The fluctuating climatic conditions, the increasing glacial lakes, land reductions and heavy rainfall induced calamities have disturbed the natural ecosystem balance and their farm productivity rates as a result. The farmers lacking the desired knowledge, are vulnerable to extreme weather patterns, and are hence, moving to cash crops such as potatoes, instead of subsistence crops like wheat and maize.

After several consultations with the farmers and experts, the management issues associated with agriculture include traditional low yielding practices, shrinking land due to encroachment of human settlements and commercial activities, confusion amongst landowners related to water sharing due to no documentation of customary rights and low productivities due to increasing pest prevalence, erratic precipitation rates, low fertility partially due to inorganic fertilizers, water unavailability, soil erosion and disasters such as landslides and floods. Moreover, due to non-availability of market value chains, the high-value crops such as potatoes and buckwheat, doesn't generate enough income for the farmers.

After discussions with locals and experts, the proposed management interventions for sustainable mountain agriculture include value chain development of high-valued crops, new settlements to be built on barren or abandoned lands, crop insurance schemes, introduction of certified seed varieties resistant to climate related and pesticide issues, trainings of climate friendly agricultural practices and formation of a soil testing facility addressing farmers queries regarding suitable seed varieties, microbiota of soil and its capacity of crop growth.

Livestock

Animal rearing serves as a "living bank" in terms of food and cash. Majority of the local people rear livestock, varying in numbers and types depending upon the owner's land holding status, availability of fodder and water, size of pasturelands and household labour to rear livestock. Livestock mobility, dispersion, shifting of households and utilization of pastures are the adaptation strategies the pastorals usually practice for livestock herding. Among the dominant livestock types; goats, sheep and cows form the grazing pattern of the pastures and the household economy.

However, livestock rearing trend decreased considerably during last ten years owing to less economic returns and various other factors. Due to increased school enrolment especially of boys, access to off-farm employment opportunities particularly the tourism industry in Baltistan, has changed the livestock herding practices throughout the region. Similarly, modernisation and the growing trend of nucleated families is another factor that has driven local population towards off-farm employment opportunities. Further, transformation of agricultural land into constructions and other economic purposes and fragmentation of cultivable land by the division of families are other factors contributing to decreasing numbers of livestock.

Livestock in most of the villages in the valley are taken to high land grazing lands and pastures mostly during late spring and summer (April- September) with maximum number of days at pastures in June and July. While in winters (October – March) the livestock are either grazed in winter grazing areas (areas adjacent to the permanent settlements in the village) or stall fed on stored hey collected from their own fields or from the nearby pastures.

After multiple consultations, the management issues and problems associated with livestock include livestock mortality owing to predator depredation, diseases and avalanches/floods, owing to growing alternative livelihood options, unattended animals grazing in pastures as being more susceptible to predator attacks, lack of veterinary facilities and vaccination programmes, traditional cattlesheds with poor sanitary measues affecting their productivity and being susceptible to predatory attacks, scarcity of fodder owing to prolonged winters, and owing to traditional customary pactices and information gaps on climate change mitigation strategies, the pastorals not being able to address any climate-related or anthropogenic threats.

After consultations with field workers, locals and experts, the proposed management interventions for livestock include Improvement of veterinary services in the valley through for e.g. establishing a vet facility, livestock vaccination programmes, Improvement of cattle sheds for improved sanitation and predator avoidance, livestock breed improvement and livestock product development for e.g. developing the cottage industry.

Pastures

The majority of these pastures are communal and hence, management of this ecosystem lies within the realm of the whole community. The patterns of grazing are **transhumance**, which refers to the seasonal movement of herders and shepherd families, along with their livestock to higher pastures in the summer and lower ones during the winters typically.

Local trends of utilising natural resources throughout the region is identical in general, however, the extent of exploitation and management patterns vary from valley to valley. In **Haramosh** valley, pasture sharing occurs within two or more villages, guided by customary laws, and hence ensuring the common access rights. Herd grazing is only allowed in the buffer zone and tourism focused zones of the park. Moreover, grazing of traditional free roaming yaks and yak-cow breeds in buffer and core zone is acceptable. If livestock of one village moves to pasture of neighboring village intentionally, then penalty has been fixed by village community according to the loss. (Vuillermoz, Listo, Raza, & Pyara, 2016). Similarly, in **Ghulmat** valley, indigenous system of grazing can be considered sustainable. A few decades ago, herders ensured to take livestock into the pastures when the vegetation became knee-length. As of now, the herders have completely abondoned this practice and instead take their livestock to pastures even before the sprouting takes place. (Zaib, et al., 2016). In **Hopar-Hispar** valleys, the rights of use of pastures in Hoper is specified by tribes/settlement. The division of pastures among the various tribes have been made centuries ago, when the Mirs of Nagar ruled the area. In **Hispar**, the use of various pastures is specified by Jirga. Although, there is a restriction in movement of livestock from pasture to pasture, with dates being fixed according to seasons, all pastures in the valley are jointly and equally used by the villagers. (Gallo, Khan, Khan, & Khan, 2015). In **Hushe** valley, a fee of Rs.1200 per cattle is charged on livestock, when the animals from outside the village are brought to Hushe for grazing purposes.

Majority of the pastures of CKNP are declining at rapid rates. The pasture sustainability is also facing lot of pressures from livestock more than thier carrying capacity, medicinal plants extraction, landslides and floods. (Invernizzi & Locatelli, 2015). After consultations with the locals, experts and field workers, the management issues and problems associated with pastures include, over dependence of livestock on pastures leading to pastures degredation, gaps in customary practices regarding for e.g. the maximum number of livestock heads allowed, weed invasion, impatient pastorals grazing their livestock before a pasture matures, lack of zonation, the locals not possessing any knowledge regarding the extraction and uses of medicinal plants, disputes amongst villages over use rights and non-uniform grazing which leads to overutilzіaiton for many patches of these high pasture lands.

After discussions with the locals and experts, the proposed interventions regarding grazing management include various mechanisms such as effective utilization of rest rotation and deferred rotation systems, development of water points in selected pastures through construction of ponds, and in order to remove the stress of early grazing, utilization of valley slopes and regionally adapted and high nutrition value fodder crops can be cultivated for fodder instead of traditional species. Moreover, it has been proposed that local flora should be cultivated on the barren patches within the pastures. With regards to medicinal plants, training on its cultivation and utilization, along with appropriate site assessment can be promoted to provide an alternative source of livelihood income. Lastly, development of consumer linked ethno-botanical databases for each village, can not only enhance the market for the local farmer but also foster the direct link to the consumer.

Minerals

The management issues and problems associated with minerals include primitive techniques, lack of modern tools and training of farmers resulting in damage and lower quality of rock, owing to improper cutting and polishing, the miners losing the opportunity of value addition to earn increased revenues, and most importantly, lack of planning leading to mining sites not being properly identified and approved as safe mining zones.

After consultations with the locals, field workers and experts, the proposed management interventions include notification of resource use zones where mining can be allowed after detailed assessments on scientific lines, remediation and reclamation of mine back to its vegetated state, and implementation of safe mining techniques entailing trouble Shooting Guides, Blasting Techniques and Fuse Recommendation, Sanitation, Hand Tools, Personal Protection Equipment (PPE), Rocks Splitting Methods, Blacksmithing, Man-powered Ventilation System, and Alluvial Processing Equipment etc.

Chapter 7: Results of Questionnaire

The Questionnaire was conducted amongst 35 locals from the 10 valleys, all male participants and having an average age of 33. The education levels of them varied from having little or no education such as Farmers to having more knowledge and skillsets like a medical specialist, teachers, businessmen who had at least a bachelor's degree in their respective fields. Based on the information provided by them through the questionnaire, the valuation of the ecosystem goods and services has been conducted as discussed below.

1.1. The Value of Forests in valleys of CKNP

The provisioning services provided by the forests of CKNP is an amalgamation of timber and fuelwood sources for construction and energy purposes respectively. The value of forests in each of the 10 valleys under the scope of this study are estimated below:

As for **Bagrote** valley, based on the population index sourced WWF and Ev-k2-CNR, and verified by the ministry of planning department, the population of Bagrote is around **9588** people, encompassing the villages of Sinaker, Datuchi, Hopay, Masingot, Bulchi and Taisot. (Mustafa, et al., 2016). For Timber, we can use the information on the 'Timber consumed for construction purposes', as an indication of the demand and consumption of timber in a specific valley.

Table 4

Village	Timber consumed on construction of houses in the last five years	
	Number of logs	Volume (CFT)
Sinaker	83	290.5
Datuchi	294	1029
Hopey	259	906.5
Bulchi	1785	6247.5
Taisot	159	556.5
Masingot	46	161

From the information verified by WWF and given in table 4, we can determine that **2626** logs were consumed in a span of 5 years in Bagrote valley. This means that **525** logs were being consumed annually in the years 2010-2014. As a large tree can provide up to 50 logs, while a smaller one can give up to 20 logs, we can take an average of **35 logs** per tree being harvested. So we can determine that **15** (525/35) trees were being harvested annually in Bagrote valley for construction purposes.

As we know after consultations with locals and regulatory authorities such as the Forest department officials, that a large tree after being harvested, divided into logs and carried to the surrounding cities of Skardu and Gilgit, is normally sold for 100,000 rupees (Picea) and 125,000 (Pinus), dependent on the quality and the type of wood. Average amount of trees adds up to **112,500** rupees. Based on this information, we can determine that the economic value of trees used for timber purposes in Bagrote valley by exercising the market-based valuation using the equation:

$$Vt_a = T_a \times Pt_a$$

Where Vt_a denotes the value of timber, T_a denotes the number of trees harvested and Pt_a denotes the price of timber in year a.

Hence, the value of forests can be determined at Rs. **1,687,500** (112,500 x 15) rupees on an annual basis.

As for the fuelwood, the average quantity of fuelwood consumption in Bagrote valley is **7.3** kg/HH/year with highest in Hopay (9.1kg/HH/year and lowest in Sinaker (4.5kg/HH/year). Based on my research, the average quantity of fuelwood harvest is 92 maund which amounts to **3404** kg/HH/year across the CKNP. The average prices of fuelwood are, 1108 rupees (min) and 3103 rupees (max), with an average of 2105 rupees. As this price is of maund, and maund = 37 Kgs, we can determine that a kg of fuelwood (various shrubs, trees) is of **57** rupees/kg (2105/37). For the Bagrote population i.e. approximately 9588 people in 960 households, we can determine the value of fuelwood using the following equation:

$$Vt_a = H_a \times F_a \times Pt_a$$

Where Vt_a denotes the value of fuelwood, H_a denotes the no of households, F_a denotes the average quantity of fuelwood harvested and Pt_a denotes the price of fuelwood in year a.

This means that the value of fuelwood harvested can be estimated at **186,266,880** Rupees (960 x 3404 x 57).

Hence, the economic value of forests in Bagrote based on timber and fuelwood consumption patterns, are Rs. 1,687,500 (timber) and Rs. 186,266,880 (fuelwood), which amounts to Rs. **187,954,380/yr.** However, this estimation is clearly understated as, the value is based solely on the amount that is harvested and not the actual volume of timber and fuelwood present in the forest.

As for **Haramosh** valley, we can recognize that 28 trees were used in the years 2010-2015 for the purpose of construction (denoted in the table in Appendix A), which means that approximately 6 trees were used annually. (Vuillermoz, Listo, Raza, & Pyara, 2016). As the price of trees in the nearby markets is on average 112,500 rupees, the value of these trees used for construction in Haramosh are **630,000** (112,500 x 6) rupees annually.

As for fuelwood, based on the consumption of the four most notable villages of Sassi/Shahtot, Dasso, Hanuchal, Jutial, the average consumption of fuelwood per household is **3363** Kg/HH/yr. as denoted in the Table 5 below.

Table 5

Village	HH	Consumption per HH			Consumption per Village		
		W	S	Total	W	S	Total
Sassi /Shatot	230	1200	450	1650	276000	103500	379500
Dasso / Iskere	340	2800	1400	4200	952000	476000	1428000
Hanuchal	270	4000	1200	5200	1080000	324000	1404000
Jutial	60	1600	800	2400	96000	48000	144000

According to my research the average price of fuelwood is **57** rupees/kg, the value of fuelwood in Haramosh can be determined at an approximate value of **191,691** rupees/HH/yr. Since Haramosh valley has approximately 1041 Households in total, the value of fuelwood across the valley can be estimated at **199,550,331 rupees/yr.**

Hence, the economic value of forests in **Haramosh** based on timber and fuelwood consumption patterns, are Rs. 630,000 (timber) and Rs. 199,550,331 (fuelwood), which amounts to Rs. **200,180,331/yr.**

As for the rest of the valleys, the same steps are followed to determine the values of forests in each respective valley, as shown Table 6 below:

Table 6

Valley	No of HH	Trees harvested/yr.	Fuelwood harvest/kg/HH/yr.	Timber value Rs./yr.	Fuelwood value Rs./yr.	Value of forests/Rs./yr.
Bagrote	960	15	3404	1,687,500	186,266,880	187,954,380
Haramosh	1041	6	3363	630,000	199,550,331	200,180,331
Ghulmat	1875	6	3197	675,000	341,679,375	342,354,375
Nagar	3432	229	2051	25,762,500	401,224,824	426,987,324
Hopar-Hispar	940	30	386/24	17,100,000	5,412,720	22,512,720
Shigar	2433	184	4338	20,700,000	601,598,178	622,298,178
Hushe	629	20	1500	2,250,000	53,779,500	56,029,500
Thalay	955	117	3326	13,162,500	181,050,810	194,213,310
Upper Braldu	428	742	5798	83,475,000	141,448,008	224,923,008
Astak	922	42	4496	4,725,000	236,282,784	241,007,784
Average	**1362**	**139**	**2898**	**17,016,750**	**234,829,341**	**251,846,091**

Thus, the total value of forests of the Central Karakoram National Park, based on the timber and fuelwood harvest rates is, Rs. **2,518,460,910.**

1.2. The value of Wildlife

The valley wise results of the Winter wildlife survey of Central Karakoram National Park conducted by the CKNP directorate and Wildlife department in December 2018, is considered the most accurate representation of ungulates population in the region. The number of Ungulates sighted during the survey are 2197, with the Himalayan Ibex having a population of 2086 and the Markhor at 111 individuals. (Abbas Y. , 2018). The survey is attached in Appendix C and will be used in this research for valuation purposes.

Table 7

Valley	Ibex Population	Ibex Value Rs/yr.	Markhor Population	Markhor value Rs/yr.
Bagrote	**43**	**10,750,000**		
Haramosh	**43**	**10,750,000**	**38**	**535,298,400**
Ghulmat			**23**	**323,996,400**
Hopar	**99**	**24,750,000**		
Hispar	**135**	**33,750,000**		
Hushe	**383**	**95,750,000**		
Thalay	**125**	**31,250,000**		
Upper Braldu	**526**	**131,500,000**		
Astak	**16**	**4,000,000.**		
Total	**1370**	**34,250,000**	**61**	**859,294,800**

Thus, the total value of Wildlife i.e. Markhor and Ibex in this case, is estimated to be Rs. **893,544,800.**

IBEX

The population of Ibex vary with respect to different landscapes and terrains across the CKNP. After consulting with the CKNP directorate and the Wildlife departments, the prices of their trophy hunting permit have been shared and are listed below:

Ibex trophy hunting price for Locals – Rs. 105,000

Ibex trophy hunting price for Nationals – Rs. 160,000

Ibex trophy hunting price for Foreigners – Rs. 4,85,000

In order to determine the value of Ibex in CKNP, an average of the three prices will be taken i.e. Rs. **250,000** per animal. According to the survey conducted by CKNP directorate and Wildlife Dept in Winters 2018, the population of Ibex in **Bagrote** valley is **43.** This means the value of Ibex in Bagrote valley can be estimated using the equation:

$$Vt_a = I_a \times Pt_a$$

Where Vt_a denotes the value of Ibex, I_a denotes the population of Ibex and Pt_a denotes the price of trophy in year a.

Hence, the value of Ibex in Bagrote valley can be estimated at Rs. **10,750,000.** However, the population of Ibex is estimated to be **88** in 2011 according to estimates of CKNP/WWF Wildlife Survey report 2011, which indicates the population of Ibex has considerably gone down in the last 7-8 years.

According to the survey, **Haramosh** has an Ibex population of **43**, which means the value of Ibex in Haramosh is estimated to be around Rs. **10,750,000** using the same equation i.e. market based valuation**.** For Ghulmat, the ibex population stands at 85 in number, leading to a value of approximately Rs. **21,250,000.**

For **Hopar**, the ibex numbers are observed to be **99**, which means the value of Ibex in Hopar stands at Rs. **24.750,000**. It has to be noted that the population was between 250-300 in 2013, so there is a considerable loss in the numbers, which indicate the illegal hunting of the specie or movement of the animal to other areas.

For **Hispar,** the ibex population is estimated to be around **135** in number, meaning that the value of Ibex in Hispar approximates to around Rs. **33,750,000**. Its of great significance to point out that the population was greater than 500 in the year 2015, and thus a great decline in its population has been observed over the last 5-6 years.

In **Hushe,** the population of Ibex has been observed at **383**, which means a high value of **Rs. 95,750,000** of the ibex in the valley. However, the population in 2014 has been observed to be around 600, which shows a high decrease in the population of Ibex in the valley.

The Ibex population in **Thalay** has been observed to be around 125, meaning a value of Rs. **31,250,000**, while the population in **Upper Braldu** is around 526 having a value of approximately Rs. **131,500,000**. As for the population of Ibex in **Astak** according to the winter wildlife survey, it has been observed at around 16 heads, having a value of Rs. **4,000,000.**

MARKHOR

The population of Markhor vary with respect to different landscapes and terrains across the CKNP. After consulting with the CKNP directorate and the Wildlife departments, the prices of their trophy hunting permit have been shared and are listed below:

Markhor trophy hunting price for Foreigners – USD 75,000 to 105,000 as per bid

In our research, we will use the average of USD 75,000 and 105,000 i.e. **USD 90,000**. Since USD 90,000 is equal to Rs. 14,086,800**,** we will use these figures for further valuations.

In **Haramosh** valley, the population of Markhor has been observed to be around **38** in number, according to a winter wildlife survey conducted by the CKNP/WWF Wildlife Department. This means that the value of Markhor in Haramosh can be estimated using the equation:

$$Vt_a = M_a \times Pt_a$$

Where Vt_a denotes the value of Markhor, M_a denotes the population of Markhor and Pt_a denotes the price of trophy in year a.

Hence, the value of Markhor in Haramosh valley can be estimated at Rs**. 535,298,400.** In **Ghulmat** valley, the population of Markhor is observed be around 23 in number, which means that the value of Markhor in Ghulmat is around Rs. **323,996,400**, after using the same equation.

1.3. The value of agriculture

According to my research, in **Bagrote** valley the average yield of **Wheat** per HH is approximately **586 Kg/year,** while if we analyze the data collected by the Agriculture department and WWF (denoted in the table in Appendix D) for the 6 villages of Bagrote valley, we can calculate the average at **848 Kg/year**. The varying estimates are due to the varying sample sizes and hence, we take an average of 586 kg and 848 kg for a relatively accurate estimate of average production of wheat per household i.e. **717 Kg/year**. As we can determine from our research that the average market price of wheat is Rs**. 1396/kg** and with **960** Households consisting in the valley, we can roughly estimate the value using the market-based equation:

$Vt_a = H_a \times W_a \times Pt_a$

Where ***Vt_a*** denotes the value of wheat, ***H_a*** denotes the population in Bagrote, ***W_a*** denotes the average yield and ***Pt_a*** denotes the market price of wheat in year a.

Hence, the value of wheat in Bagrote valley can be estimated at **Rs. 960,894,720/yr. (717 x 1396 x 960).**

The same steps can be repeated for determining the value of **Maize** in Bagrote valley. According to my research the average maize production per household is approximately 329 Kg/yr., while for the Agricultural dept and WWF, the estimates can be analyzed and determined at 599 kg/yr. We take average of the two figures to come up with a relatively accurate estimate i.e. **464 kg/yr.** My research indicates that the average market price of maize is roughly Rs. **1166/kg** and with **960** households consisting in the valley, we can estimate the value of maize in Bagrote valley at **Rs. 519,383,040/yr.**

For **Potatoes**, my research informs that 4200 kg/yr. is produced by a household, while after analyzing estimates of other studies, the figure is 3335 kg/yr. In order to arrive at more accurate estimates, we take an average of both estimates and arrive at **3767 kg/yr.** According to my study, the average market price of a bag of potatoes is Rs. 2426/bag (A bag contains 120 kg). This means that 1 kg of potatoes is Rs. **20**. (2426/120). As there are 960 households in Bagrote, the value of potatoes in Bagrote can be estimated at **Rs. 72,326,400/yr.** (3767 x 20 x 960)

Altogether, the value of these 3 crops i.e. Wheat, Maize and Potatoes, sum up to have a value of **Rs. 1,552,604,160/yr.**

For **Haramosh** valley, studies have been conducted in the past by Ev-k2-Cnr, and they have estimated the economic benefits of various crops for the households in Haramosh valley. As the village Sassi/Shahtot has 230 households and an average value of crops per household are Rs. 50,000/yr., (as denoted in table 8), we can estimate the value of crops being produced in Sassi/Shahtot at Rs. **11,500,000/yr.** (50,000 x 230) Doing the same exercise for the rest of villages, we come up with estimates of Rs. **20,400,000/yr.** for Dasso/Ishkere, Rs. **13,500,000/yr.** for Hanuchal, Rs. **3,300,000/yr.** for Jutial, Rs**. 3,660,000/yr.** for Shuta and Rs. **12,000,000/yr.** for Barchi village.

Altogether, the values of crops for all villages in **Haramosh** valley, sums up to have an estimate of **Rs. 64,360,000/yr.**

Table 8

Village	Crops	Consumption /year (%)	Sale/year (%)	Av. Income/HH/year	Av. Value/HH/year
Sassi/Shatot	Wheat	100	0	26,534	50,000
	Maize	10	90		
	Potatoes	30	70		
	Fruits	70	30		
	Vegetables	100	0		
Dasso/ Iskere	Wheat	100	0	29,421	60,000
	Maize	100	0		
	Potatoes	20	80		
	Fruits	30	70		

As for the rest of the valleys under the scope of this study, the same methods are applied to estimate the total values of the major crops as denoted in table 9:

Table 9

Valley	Value of major crops/yr.
Bagrote	**1,552,604,160**
Haramosh	**64,360,000**
Ghulmat	**2,415,131,250**
Nagar	**328,150,000**
Hopar-Hispar	**95,301,600**
Shigar	**3,655,542,660**
Hushe	**413,922,256**
Thalay	**131,600,000**
Upper Braldu	**429,483,000**
Astak	**52,015,000**

Thus, the total value of agriculture, mostly based on the values of major crops i.e. Wheat, Maize and Potatoes in all valleys under the scope of this study, is estimated at Rs. **9,138,109,926.**

1.4. The value of livestock in CKNP

According to the survey by Ev-k2-CNR in 2014, the livestock population in Bagrote is estimated to be around **16,418** in number, as denoted in table 10:

Table 10

Villages	Sheep	Goats	Cattle (cow, bull)	Cross breed of yak and cow	Yak	Equines (donkeys and horses)	Total	Milking cattle
Sinaker	315	1710	390	0	0	9	2424	255
Datuchi	560	1220	700	0	100	0	2580	380
Hopey	636	1896	468	12	12	3.6	3028	192
Bulchi	1470	2220	1080	9	24	126	4929	420
Taisot	270	810	525	3	0	6	1614	285
Masingot	330	1120	390	0	0	3	1843	170
Total	**3581**	**8976**	**3553**	**24**	**136**	**148**	**16418**	**1702**

According to the data collected in my research, the average minimum price of **Sheep** is calculated at Rs**. 9600** per sheep. On the other hand, the average maximum price of Sheep is determined at Rs. **12,700.** Consequently, the average of the min and max price of Sheep can be estimated at Rs. **11,150.** As there are about 3581 sheep in Bagrote valley, the total value of sheep can be estimated using the market-based equation:

$$Vt_a = S_a \times Pt_a$$

Where Vt_a denotes the value of Sheep, S_a denotes the population of Sheep and Pt_a denotes the market price of Sheep in year a.

Hence, the value of sheep in Bagrote valley can be estimated at Rs. **39,928,150.** The same steps will be followed to determine the values for other species of livestock.

According to the data collected in my research, the average minimum price of **Goat** is calculated at Rs**. 12,500** per goat. On the other hand, the average maximum price of Goat is determined at Rs **16,267.** Consequently, the average of the min and max price of Goat can be estimated at **Rs. 14,384** per goat. As there are approximately 8976 goats in the valley, the total value of goat in Bagrote can be estimated at **Rs. 129,110,784.**

According to the data collected in my research, the average minimum price of **Cattle** is calculated at Rs. **58,148** per cattle. On the other hand, the average maximum price of Cattle is determined at Rs**. 79,800**. Consequently, the average of the min and max price of Cattle can be estimated at Rs. **68,974 .** As there are about 3553 Cattle in Bagrote valley, the total value of Cattle can be estimated at **Rs. 245,064,622.**

According to the data collected in my research, the average minimum price of **Yak** is calculated at Rs. **120,000** per head. On the other hand, the average maximum price of Yak is determined at Rs**. 130,000** Consequently, the average of the min and max price of Yak can be estimated at Rs. **125,000.** As there are about 136 Yak in Bagrote valley, the total value of Yak can be estimated at **Rs. 17,000,000.**

According to the data collected in my research, the average minimum price of **Zo** (cross breed of cow and yak) is calculated at Rs. **65,000** per head. On the other hand, the average maximum price of Zo is determined at Rs**. 100,000** Consequently, the average of the min and max price of Zo can be estimated at Rs. **82,500 .** As there are about 24 Zo in Bagrote valley, the total value of Zo can be estimated at **Rs. 1,980,000.**

According to the data collected in my research, the average minimum price of **Equine** is calculated at Rs. **100,000** per head. On the other hand, the average maximum price of Donkey is determined at Rs**. 120,000**. Consequently, the average of the min and max price of Donkey can be estimated at Rs. **110,000.** As there are about 148 Donkeys in Bagrote valley, the total value of Donkeys can be estimated at **Rs.16,280,000.**

Therefore, the total value of all livestock in **Bagrote** valley can be estimated as a sum of all animals i.e. **Rs. 449,363,556.**

As for the rest of the valleys, the same steps are used to determine the economic values of livestock under the scope of this study, as shown in table 11:

Table 11

Valley	Value sheep Rs/yr.	Value goat Rs/yr.	Value Cattle Rs/yr.	Value Yak Rs/yr.	Value Zo Rs/yr.	Value Equine Rs/yr.	Total value Rs/yr.
Bagrote	39,928,150	129,110,784	245,064,622	17,000,000	1,980,000	16,280,000	**449,363,556**

Haramosh	850,745,000	333,708,800	1,291,193,280	63,750,000			**2,539,397,080**
Ghulmat	69,453,350	98,746,160	120,014,760	31,625,000			**319,839,270**
Nagar	113,730,000	184,259,040	240,374,390	67,750,000			**606,113,430**
Hopar-Hispar	72,653,400	64,454,704	193,403,096	79,625,000	10,725,000	17,820,000	**438,681,200**
Shigar	151,472,750	235,178,400	449,710,480	29,750,000		285,450,000	**1,151,561,630**
Hushe	35,546,200	58,025,056	83,665,462	33,000,000	106,012,500	5,060,000	**321,309,218**
Thalay	109,270,000	83,427,200	73,802,180	159,375,000		124,300,000	**550,174,380**
Upper Braldu	123,207,500	161,100,800	171,055,520	269,375,000		151,800,000	**876,538,820**
Astak	106,371,000	127,729,920	331,075,200	5,875,000		169,510,000	**740,561,120**

Thus, the total value of livestock of the 10 valleys can be estimated at Rs. **7,993,539,704.**

1.5. The value of pastures of CKNP

The pastures of the Central Karakoram National Park are abundant in various kinds of medicinal and economic plants each having multiple uses and significance. There are believed to be more than 150 types of medicinal plants in the region. The most common types include Tamuro, Phelel (wild mint), Ishkin, Pong, Salajeet, Kashkash, Mushrooms, Chotal, Black cumin, amongst many others.

There haven't been any studies in the past that depicts the inventory stats of these plants which can inform us about the abundance of their existence. As per my research, their use was identified. Some of the people claimed that they only used them rarely or as per need, while one of the respondents also claimed to harvest approximately 750 Kg of various plants yearly. However, after taking the average of yearly consumption per household, a figure of 11 Kg can be estimated without the outlier i.e. 750 Kg and 47 Kg, with the outlier. For accuracy purposes, we will be using the figure without the outlier i.e. **11 Kg/yr.**

As for the prices quoted by the locals, the min average price of these plants is Rs. 833, while the max average price is Rs. Rs. 13408. By taking the average (median) of the max and min, we estimate the average price of medicinal plants at **Rs.7121/kg.**

As **Bagrote** valley comprises of **960** Households, the value of medicinal plants can be estimated using the equation:

$$Vt_a = H_a \times M_a \times Pt_a$$

Where ***Vt_a*** denotes the value of medicinal plants, ***H_a*** denotes the no of households, ***M_a*** denotes the average consumption of household in year a and ***Pt_a*** denotes the average price of medicinal plants in year a.

Hence, the value of medicinal plants in Bagrote valley can be estimated at **Rs**. **75,197,760/yr.** (960 x 11 x 7121). As for the rest of the valleys, the same steps are taken to determine the values of medicinal plants for each respective valley as shown in table 12:

Table 12

Valley	**Value of Medicinal Plants Rs/yr.**
Bagrote	**75,197,760**
Haramosh	**81,542,571**
Ghulmat	**146,870,625**
Nagar	**268,831,992**
Hopar-Hispar	**73,631,140**
Shigar	**222,303,378**
Hushe	**49,270,199**
Thalay	**82,639,205**
Upper Braldu	**33,525,668**
Astak	**65,171,392**

Thus, the total value of pastures, based on the value of medicinal plants in the 10 valleys, is estimated to be Rs**. 1,098,983,930.**

1.6. The value of Minerals of CKNP

According to my previous knowledge and consequently verified during the fieldwork, there exists around 61 mining groups in **Haramosh** valley, who are mostly involved in the mining of semi-precious stones such as Aquamarine, Topaz, Ruby, Fluorite etc. In Sassi village, 20 mining groups exist, receiving an average revenue of Rs. 1,250,000 annually (denoted by the table 13), meaning the value of minerals being mined in Sassi is approximately **Rs. 25,000,000 (1,250,000 x 20).** Doing the same exercise for rest of the villages, we find that Dasso village has a value of **Rs. 5,000,000,** while Hanuchal and Jutial both have a value of Rs. **300,000.** Moreover, Barchi village has an estimated value of Rs. **800,004.** Altogether, the value of minerals that are mined in the valley can be estimated at **Rs. 31,400,004/yr.,** after summing the values of minerals in all villages of the valley.

Table 13

Village	Since	No. of Mining groups	Mining Products	Revenue/Year /Village (Rs.)	Revenue/Year /Group (Rs.)
Sassi/Shatot	1952	20	Aquamarine, Topaz, Black Tourmaline, Ruby	25,000,000	1,250,000
Dasso/Iskere	1930	25	Aquamarine, Topaz, Tourmaline	5,000,000	200,000
Hanuchal	1940	5	Fluorite	300,000	60,000
Jutial	1930	5	Fluorite	300,000	60,000
Shuta	--	--	--	--	--
Barchi	1930	6	Beroj, Topaz, Quartz, Morganite, Tourmaline	800,000	133,334
Total	**--**	**61**	**--**	**31,400,000**	**--**

In **Nagar** valley, it has been reported during the FGDs that 25 mining groups exist in the area. As the villages of Sumayar, Phekar and Proper Nagar all have varying revenues (denoted by the table in Appendix G), an average will be taken which sums up to Rs. **9,416,667**, meaning a group earns this much on average in a given year. Since there are 25 groups operating, the value of minerals mined can be estimated at Rs. **235,416,667/yr.**

Deposits of Aquamarine, quartz, Salajeet (Benione) and Phulride have been identifed by some locals in **Hopar** valley but mining is not very popular in the valley. It has been reported in the FGD that in 2014, a group extracted approximately 1000 Kgs of Salajeet in the valley, having an approximate value of **Rs. 1,500,000/yr.**

In **Bagrote** valley, mining is not that prominent nowadays due to heavy snowfalls and the mines being located in the glaciated areas. However, it was prominent a few years according to locals, as much as 3-5 mining groups are existing in the areas and focusing mainly on marble and quartz mines located in the area. As per one of the FGDs, each year almost 1200-1600 kg of quartz was mined in the previous years, that gives an indication of the potential in the area. However, due to incomplete information, estimates of the value of minerals in Bagrote is difficult to ascertain at this point.

In **Shigar** valley, 30 mining groups exist (denoted by the table in Appendix G) which are mostly involved in the mining of semi-precious stones like Quartz, topaz, Aquamaine, Beroj, Tourmaline, Morganite and Fluorite. The average revenue of a mining group can be estimated at Rs. **1,115,000/yr.** As there are 30 groups operating earning approximately Rs. 1,115,000 annually, the value of minerals mined can be estimated at **Rs. 33,450,000/yr.**

In **Astak** valley, 88 mining group exist (denoted by table in Annex G), receiving an average revenue of Rs. **454,762** annually. Thus, the value of the minerals mined here can be estimated at **Rs. 40,019,056/yr.**

Table 14

Valley	Value of Minerals Rs/yr.
Haramosh	**31,400,004**
Nagar	**235,416,667**
Hopar	**1,500,000**

Shigar	**33,450,000**
Astak	**40,019,056**

Hence, the total value of minerals in the mentioned valleys above, can be estimated at Rs. **341,785,727.**

Chapter 8: Analysis – Discussion

(Bhutiyani, Kale, & Pawar, 2007) and (ShaukatAli, DanLi, FuCongbin, & FirdosKhan, 2015)both conclude that the temperature increase rate in the North Western part of the Himalayan region reported in the last century has been greater than the global increment rate. One of the reasons for higher temperature is owing to an overall increase in the absolute minimum and maximum temperature values. As a result, there has been Diurnal Temperature Range (DTR) as the maximum has increased at a greater rate (Kazmi, et al., 2015)**.** The situation for the life and biodiversity in the Himalayas-Hindukush-Karakoram region is highly vulnerable with predictions of global temperatures rising from 1°C to 3°C by 2050s and 2°C to 5°C towards the end of the 21st century. (ShaukatAli, DanLi, FuCongbin, & FirdosKhan, 2015)

The situation in Central Karakoram National Park faces the same set of vulnerabilities and risks, as various studies conducting future projections based on the IPCC scenarios, have projected the temperatures in Pakistan's Northern region to rise at a rate faster to the rest of the country. Initially assessing the next decade, a study by (Kazmi, et al., 2015), projected that between 2021-2030 the minimum temperature under both the A2 and B2 scenarios have an increase of 0.50–1.00 °C across the country. Most importantly, under scenario A the maximum temperatures are projected to be higher than the previous decades, with a rise of **1-2**°C, while the B2 scenario depicting relatively milder conditions. This scenario is further endorsed by (Pilz, Amjad, & Wiberg, 2015)**—** by 2020s, it is expected that the maximum temperature will increase 1.68°C. The maximum temperature continues to show an overall increase by 2.64°C in the 2050s. At the same time, in the A2 scenario, it is projected that the minimum temperature and the precipitation will increase by 3.22°C and 48.62% respectively. Whereas, under scenario B, it has been projected that the maximum temperature, minimum temperature and precipitation will increase by 1.62°C, 1.63°C, and 5.39% respectively.

As for the RCP scenarios, during 2006-2035 in RCP4.5, there has been a projection of 0.5°C increase in the mountains of Upper Indus Basin (for climatic and hydrological changes), 1.5°C from 2041–2070, and 2.0°C for 2071–2100 has been projected in RCP4.5. For scenario RCP8.5, from 2006-2035 there is a projected temperature increase of 2.2°C, 4.2°C for 2041-2070, and 5.8°C for 2071-2100. (ShaukatAli, DanLi, FuCongbin, & FirdosKhan, 2015)

Similarly, while determining the climate change impact across the glaciers of KKH region (Chaturvedi, Kulkarni, Karyakarte, Joshi, & Bala, 2014)**,** it has been estimated that average temperature will rise between the range of 2.36 °C (RCP2.6) to 5.51 °C (RCP8.5) by 2080s in comparison to the pre-industrial era (1861-1900). Moreover, various studies have confirmed that Pakistan will also experience an increase in nighttime temperatures in the coming years. If the UIB nighttime temperatures continue to increase, then snow accumulation will decrease which may prove disastrous since this area feeds the national lifeline of the country i.e. Indus River. (Cheema, Rasul, & Kazmi, 2011)

Forests

Rural communities are particularly reliant on forests for not only sustenance, but also for income generation. Forests provide a range of tradable commodities like, food, fuelwood, timber, and several other regulatory ecosystem services. In Pakistan, the forest area covers about 4-5% of the total land area, estimated at around 4.19Mha.

Climate change manifestations like: the variability in temperatures, precipitation, sea levels, and increasing incidences of extreme events, will all negatively impact the forest ecosystems, the delicate balance of biodiversity and the quality of soil. However, a research on the impact of climate change on the forest ecosystems in the north of Pakistan revealed an increase in the net primary productivity of all biomes by using the BIOME3 model. (Chaudhry, 2017)

The threats facing the CKNP forests include timber and firewood harvest pressure, free grazing, lack of alternatives of domestic energy, mortality, and insect pests among others. These human-environmental-climate trifecta of threats are causing forest ecosystem destruction. In tandem, the biodiversity balance will be destroyed, rendering a loss in the ability of the ecosystem to deliver major provisional, regulatory and supporting services, essential to the sustenance of mountainous communities. Moreover, the degradation and destruction of the forest ecosystems in the Himalayan region will have a ripple effect, posing serious threats to the economic services and the environment of the adjoining Indus basin. Disruption of the hydrological cycle will trigger a whole host of issues like, soil erosion, floods, desertification, and siltation. This effect is already coming to the fore as it has been observed that the severity and frequency of floods in the Indus river system continue to increase since the past 25 out of the 65-year-old observations. (Qamer, et al., 2016)

The climate change projected by various studies will have a significant bearing e on the health, productivity and ecosystem services of the forests of CKNP. The analysis of **forests** is done based on the economic valuation, the threats facing forests, the various IPCC projections, and the impacts of climate change on the ecosystem across the 10 valleys of the park.

Table 15

Valley	**No of HH**	**Trees harvested/yr.**	**Fuelwood harvest/kg/HH/yr.**	**Timber value Rs./yr.**	**Fuelwood value Rs./yr.**	**Value of forests/Rs./yr.**
Bagrote	960	15	3404	1,687,500	186,266,880	187,954,380
Haramosh	1041	6	3363	630,000	199,550,331	200,180,331
Ghulmat	1875	6	3197	675,000	341,679,375	342,354,375
Nagar	3432	229	2051	25,762,500	401,224,824	426,987,324
Hopar-Hispar	940	30	386/24	17,100,000	5,412,720	22,512,720
Shigar	2433	184	4338	20,700,000	601,598,178	622,298,178
Hushe	629	20	1500	2,250,000	53,779,500	56,029,500
Thalay	955	117	3326	13,162,500	181,050,810	194,213,310
Upper Braldu	428	742	5798	83,475,000	141,448,008	224,923,008
Astak	922	42	4496	4,725,000	236,282,784	241,007,784
Average	**1362**	**139**	**2898**	**17,016,750**	**234,829,341**	**251,846,091**

Thus, the total value of forests of the Central Karakoram National Park, based on the timber and fuelwood harvest rates is, Rs. **2,518,460,910.**

Bagrote valley has an abundant vegetative cover of approximately 432 Km^2, comprising of 47 Km^2 of closed forests, that makes up of about 10% of the total surface area of Bagrote valley. The open forests in the valley have a spread of 33 Km^2, while the sparse vegetation at 77 Km^2, having a surface area of 7.6% and 18% respectively. (Khan, Conservation and Sustainable Development Plan for Bagrote Valley of CKNP, 2015). Bagrote has a comparatively low number of HH in the scope of this research i.e. **960** HH, and hence the pressure on timber is low as 15 trees being harvested on average annually for construction purposes. The introduction of customary laws have partially controlled the unsustainable harvesting, however, it has been reported by the locals that the customary laws are biased, as the extraction rate of firewood in the notable villages of Bulchi and Hopay is greater than 1900 kg/hh/yr., while for other villages, it is as low as less than 100kg/hh/yr. However, owing to the abundant vegetative cover of approximately **432** Km^2, along with regenerating forests on valley slopes of Kail, Pine and Spruce, and the effective adoption of energy efficient technologies such as bio-brackets, hatched windows, house insulation etc., **Bagrote** valley can be considered as relatively less vulnerable. Moreover, due to having close proximity to the biggest market in the CKNP region i.e. Gilgit, Bagrote has relatively better accessibility in terms of the value chain of consumption goods and hence, people can buy and transport easily, putting less burden on the forests.

Haramosh valley which lies at humid south west side of CKNP has comparatively rich forest with approximately 128.5 km2 vegetation cover and its average ABG is 1,005,445 Mg or 7827.5 MgKm-2 and CAI of 6064.7Mg/year (Ferrari, 2014). The vegetation cover has been estimated at 52%, comprising of 6.8% open forests, 13% closed forests, 19% grasslands and 6.7% of sparse and scattered vegetation. (Vuillermoz, Listo, Raza, & Pyara, 2016). Due to customary laws being undocumented, having loopholes and little practical implications, species such as Juniper is being harvested at an alarming rate, and hence, the future implications for this high valued specie is alarming. Although, the valley hosts forest rich villages comprising of high valued timber of Pine and Spruce species, which denotes a significant share in the livelihood incomes of communities across the valley, with the status being considered degrading by the locals and an altitudinal shift observed for non-woody vegetation, the natural forests of Haramosh are relatively vulnerable under the scope of this study.

Ghulmat valley has comparatively fragmented and spares forest with approximately 34.1km2 vegetation cover and its average ABG is 3029.7MgKm-2 and CAI of 1577.6 Mg/year (Ferrari, 2014). Vegetation cover of Ghulmat valley comprised of 10.6% grasslands, 5% close forest, 5.7% open forests and 20 % for both scattered and sparse vegetation. (Zaib, et al., 2016). The status of forests is overall degrading with an increasing altitudinal shift, and the community have reported a decrease in vegetation on mountain slopes. However, major dependency is on animal dung and fruit trees and hence, the stress on natural forests for fuelwood is relatively low in Ghulmat valley because of strict regulations by community itself. This is the reason a trend of increasing forest cover has been observed in Ghulmat since the last few years. Despite having a large population of 1875 HH, only 6 trees were harvested annually for construction purposes since the last few years. The average consumption of fuelwood per HH in Ghulmat is also less then Bagrote and Haramosh valley due to community participation and ownership in the conservation of forests. Owing to the reasons mentioned above, the status of Haramosh can be considered as relatively less vulnerable.

Nagar valley has comparatively fragmented and spares forest with approximately 34.1km2 vegetation cover and its average ABG is 3029.7MgKm-2 and CAI of 1577.6 Mg/year (Ferrari, 2014). Vegetation cover of Nagar valley comprised of 10.6% grasslands, 5% close forest, 5.7% open forests and 20 % for both scattered and sparse vegetation. High density of timber trees is found in south-western valleys of CKNP than North eastern valleys. (Shimshali, Khan, & Gallo, 2016). The natural forests in **Nagar** valley are degrading with an increasing altitudinal shift of species. However, in the last few years the situation is getting better, as the focus is shifting from primary sources i.e. timber and fuelwood, to natural gas and electric heaters. Also, community is practicing social forestry and purchasing timber/fuelwood from markets in Hunza and Gilgit, and hence, the stress on natural forests has reduced compared to last decade. Although, the average household consumption of firewood (2051 kg/hh/yr.) is comparatively low compared to other valleys, the households are the highest in number out of the 10 valleys under the scope of this study i.e. 3432 Households. This means the demand and burden on natural forests will always remain high as the population further rises. This is proved by the fact that in the last decade, 229 trees were harvested annually for construction purposes, compared to 6 trees each in Ghulmat and Haramosh. More importantly, the value of forests is estimated at Rs. **426,987,324/yr.,** which is higher than the average and hence, more is at stake if the forests are lost due to climate change and more human-induced pressures in the future. Thus, Nagar valley is considered relatively vulnerable under the scope of this study.

Hoper-Hisper valley like other areas of District Hunza-Nagar dominated by rugged and barren lands, dominated by Artemisia slopes and devoid of natural forests, except few patches of juniper in Hoper. Vegetation cover in Hisper area is 1305 km^2, with an open forest spread of 18.31 Km^2, 1.047 Km^2 closed forests and a sparse vegetation of about 108.89 Km^2. Similarly Hoper valley comprises of a vegetation cover of 426 Km^2, with 17.17 Km^2 of open forests, 9.49 km^2 of closed forests, and sparse vegetation on 53.16 km^2. In Hoper-Hisper valleys, natural forests comprise of broad leaved mainly comprising of Birch (Betula utilis), Juniper (Juniperus sp.) and or willows (Salix sp.), scattered at 3300-3800 m on north exposed valley sides. (Gallo, Khan, Khan, & Khan, 2015). In **Hopar** valley, the natural forests are situated at remote locations which aren't easily accessible, and hence timber isn't harvested on a regular basis. In Hopar, there exists ban on cutting of Juniper and green wood generally, but in Hispar, there is no specified law for timber or fuelwood conservation. These inconsistencies in the customary laws is the reason why the average consumption of fuelwood is 30 kg/hh/yr. in Hopar, compared to 380 kg/hh/yr. in Hispar. According to experts from WWF and Ev-k2-CNR, these forest patches rely heavily on snow accumulation for water availability and consequent growth of forests. However, the locals have reported that there has been a considerable decrease in the snowfall in the last few years, and hence, the forests are vulnerable to snowfall conditions in the future. Moreover, the snout and lower reaches of Miar glacier, which was once highly vegetated, is subject to desertification and has turned into barren, degraded slopes, mainly due to absence of seasonal glacial-melt water. On the other hand, it has to be noted that, Hopar-Hispar valleys have the lowest average consumption of firewood i.e. 24 kg/hh/yr. in Hopar and 386 kg/hh/yr. in Hispar, which is considerably less than the average of 10 valleys i.e. 2898 kg/hh/yr. under the scope of this study. More importantly, the value of forests of Hopar-Hispar has been estimated at Rs. 22,512,720, which is the lowest amongst the 10 valleys in this research, and substantially less than the average value of **251,846,091** of these 10 valleys. According to Ev-k2-CNR, In Hoper about 47.32 % and in Hispar 40% of respondents use alternatives fuel sources such as LPG, Kerosene oil etc., while the rest of the respondents are dependent entirely on plant biomass. In Hopar, 75% and in Hispar 95% of the respondents use electricity from Micro-hydel power plant, which is an indication of less dependency on natural forests for firewood. Owing to the lowest average consumption of firewood, the lowest value of forests, an increasing trend towards renewable and other alternatives, the Hopar-Hispar valleys would be considered relatively less vulnerable.

Shigar valley which lies at dry north eastern side of CKNP has comparatively fragmented and spares forest with approximately 34.1km2 vegetation cover and its average ABG is 1755.5 MgKm-2 and CAI of 435.6 Mg/year (Ferrari, 2014). Vegetation cover is 46.9% (23% grasslands, 1.4% close forest, 2.3%

open forests, 20.2 % for both scattered and sparse vegetation). High density of timber trees is found in south-western valleys of CKNP than North eastern valleys. (Pyara, Abid, & Rizvi, 2016). The dynamics of **Shigar** valley are the same as rest with degrading fauna and rise in altitudinal shift of species, along with less vegetation on slopes now. However, the most important aspect is that the value of Shigar forests is estimated to be the highest amongst the 10 valleys i.e. Rs. **622,298,178,** which is also considerably higher than the average of **Rs. 251,846,091.** This refers to the fact that the stakes and vulnerability is the highest in Shigar valley, if and when the forests are to be lost either due to climate change or anthropogenic effects. Moreover, the average consumption per household of fuelwood is **4338kg/hh/yr.**, which is considerably higher than the average of 10 valleys i.e. **2898 kg/hh/yr**. Also, the amount of timber used for construction purposes is 184 trees annually since the last decade, which is very high relative to other valleys such as Hushe (20 trees), Bagrote (15 trees), and the average of 10 valleys i.e. 139. This refers to the extent of demand of 2433 Households in the valley, which is again a high number of HH, relative to other valleys across the national park. Thus, Shigar valley would be considered relatively highly vulnerable under the scope of this study.

Hushe valley like other areas of District Ghanche, is dominated by rugged and barren lands, Artemisia slopes and devoid of natural forests. Vegetation cover in Hushe area is 1039 km^2, comprising of 30.37 Km^2 of open forests, 2.33 Km^2 of closed forests, and a sparse vegetation of about 151.95 Km^2. (Khan, Khan, & Khan, 2015). In **Hushe** valley, it is imperative to note that the number of households in the valley i.e. 629 HH, the average consumption of fuelwood i.e. 1500 kg/hh/yr., and the value of forests estimated i.e. Rs. **56,029,500/yr.,** all three factors are the second lowest amongst the 10 valleys under the scope of this study. Moreover, in Marzigond and Tallis villages, there are no customary laws regarding harvesting as timber is not readily available, except for Juniper and Birch species, which aren't easily accessible either due to being situated at higher altitudes. However, there have been reports of heavy infestation of caterpillars on newly planted poplar and willow species, that is hindering the growth and quality of the trees planted in the valley. Also, it has been reported by locals, that most people in the valley do not use alternative sources of fuel such as LPG, Electricity, Kerosene, and unless the trend changes, burden on the natural forests can be increased in the future. However, Hushe is the gateway for the climbers to the Karakoram range including the famous K2 – the second highest mountain in the world, and with an abundant population of Ibex in the area, the prospects of tourism and trophy hunting respectively seems highly positive in the future. Hence, based on the second lowest average consumption of fuelwood, the second lowest value of forests, timber accessibility issues due to difficult terrain and the future prospects for tourism and trophy hunting, Hushe valley can be considered relatively less vulnerable under the scope of this study.

Thalay valley which lies at humid north east side of CKNP has comparatively rich forest with approximately 44.9 km2 vegetation cover and its average ABG is 682.9MgKm-2 and CAI of 246.8Mg/year. Vegetation cover is only 26.6% (2.6% grasslands, 0.5% close forest, 4.6% open forests, 18.9% for both scattered and sparse vegetation. (Invernizzi & Locatelli, 2015). Since the communities in **Thalay** valley have always remained highly dependent on natural forests, the ecosystem has been degrading since the last few decades, coupled with increasing altitudinal shift of species, as seen in most of the other valleys too. One of the primary reasons for this is the fact that high valued species such as Willow and Poplar are grown in close proximity of the settlements and hence, easy accessibility for the locals. Moreover, with increasing livelihood needs, locals are altering landuses and working on land reclamation by clearing natural forests for agricultural practices. On the other hand, it has been reported by govt representatives and WWF personnel, that the Local support organization (LSO) of Thalay, is one of the only LSO's in the region which is striving for the practical implementation of conservational strategies in conjunction with the village conservation committees. Despite the LSO being highly active, the valley of Thalay would be considered relatively vulnerable as compared to other valleys in the park.

Upper Braldu valley which lies at dry north eastern side of CKNP has comparatively fragmented and spares forest with approximately 160.9 km2 vegetation cover and its average ABG is 1428.6 MgKm-2 and CAI of 1616.5 Mg/year. Vegetation cover is 9.01 % (16.8% grasslands, 3.5% close forest, 1.5% open forests, 24.8 % for both scattered and sparse vegetation). (Hassan, Vuillermoz, & Listo, 2016). The dynamics in **Upper Braldu** are very interesting as it is the valley with the lowest number of households i.e. 428 HH, amongst the other 9 valleys in this study, but is having the highest average consumption of fuelwood i.e. 5798 kg/hh/yr. and also, the highest number of trees used for construction purposes i.e. 742 trees – considerably greater than the average of 139 trees. The reason could be the remoteness of the region, with no alternatives available and extreme temperatures, with considerably cold winters relative to other valleys in the park. Moreover, in a valley which already has scarce forest reserves i.e. 160.9 Km of vegetative cover, timber and fuelwood harvest is usually unchecked and unmonitored. Customary laws although allow the use up to need basis and don't allow sale of wood extracted from natural forests but this is hardly practiced, and locals decide by themselves where and how much to cut. Therefore, owing to the considerably high consumption patterns of timber, fuelwood and the non-implementation of customary laws in the valley, Upper Braldu would be considered highly vulnerable, relative to the other valleys in the national park.

Astak valley which lies at humid south west side of CKNP has comparatively rich forest with approximately 37.5% km2 vegetation cover and its average ABG is 3924.8 MgKm-2 and CAI of 971.2 Mg/year. The vegetation cover in Astak is 52%, with 5.7% open forests, 4.5% closed forests, 14.5% grasslands, and 9.2% of sparse and scattered vegetation. (Hussain, et al., 2016). In **Astak** valley, it has been reported by (Hussain, et al., 2016) that 43% of the village, partially use electricity to fulfill their energy needs and as a result, saves up to 432 kg of firewood every year. However, the dependence on fuelwood is still high, as the average consumption of fuelwood in the valley is 4496 kg/hh/yr., which is considerably higher than the average of 10 valleys i.e. 2898 kg/hh/yr. Therefore, Astak would be considered relatively vulnerable under the scope of this study.

Thus, based on the discussion above, it is clear that the most vulnerable valleys are Upper Braldu and Shigar, and with Shigar having the highest value of forests of **Rs. 622,298,178,** it is also considered the most valuable valley in terms of forest cover and its use.

Water-Glaciers

The analysis of **Water** is done based on the impacts of climate change, the dynamics of glaciers, the IPCC projections, and the threats facing the ecosystem, across the 10 valleys of the park.

According to (UNEP, 2012), Baltoro, Hispar-Biafo and Siachen glaciers within the park boundaries are significant for rendering 'the largest fresh water source in Pakistan' as major river systems including the mighty Indus river basin is fed by them. However, for next half century the glaciers retreat is expected to increase the water flow in the Indus but as soon as the continuous retreat would make the glacier disappear, the water flow may decline by around 40 percent. (Rasul, Dahe, & Chaudhry, Global Warming and Melting glaciers along southern slopes of HKH ranges, 2008) pointed out the upward shift of snow line of about 1km by studying the variation in 30°C during a period of 25 years (1981-2008) with 1.3°C rise in the mean temperature in the Gilgit-Baltistan region. Snowline shift is one of the contributing factors for biodiversity migration and shift in the type of precipitation (rainfall instead of snowfall). This upward tick in the thermal temperatures has already resulted in a rapid rate of snowmelt in the low-lying glaciers across the region. Consequently, expansion of existing lakes and lakes formed by glacier water pooling have caused an increase in outburst floods. (Rasul, Chaudhry, & Mahmood, Glaciers and Glacial Lakes under Changing Climate in Pakistan , 2011)

Central Karakoram National Park, being at the heart of the Himalayas, Karakoram and the Gilgit-Baltistan region, is highly vulnerable to the projected impacts of climate change. The valleys of **Bagrote** and **Haramosh**, are part of the Gilgit-Basin, that hosts **36** glaciers i.e. the lowest number in the Central Karakoram National Park. These glaciers correspond to 6% of the entire CKNP glacier census, with a glacierized area of a mere 2% of the total glaciation in the CKNP area. (Smiraglia & Diolaiuti, 2016). Hence, the Gilgit basin is the smallest relative to the other basins of Hunza-Nagar, Shigar, Shyok etc. According to (Senese, et al., 2018)**,** the area variations of the basin between 2001-2010 period, suggest a general glacier stability, in line with the other CKNP basins and in contrast to the worldwide shrinkage of glaciated areas. This is further endorsed by (Mayer, et al., 2010)**,** which indicates that, just like the rest of the Upper Indus basin, the glaciers in Bagrote valley have shown stable conditions. However, during the FGDs, the locals reported that three decades ago, the glaciers were in close proximity to the villages and the locals had to walk past them to reach the waterways and pastures, but now they have shrunk both in length and width, with significant changes in the last decade. Nevertheless, due to the small size of Gilgit glaciers, only **1%** of the fresh water of the whole CKNP resource is present in this basin (for a total ice volume of **4.58 km^3**), meaning a considerably lower quantity of water available for the valleys lying in the basin. Moreover, extraction of glacier ice from glaciers such as the Hinarchi glacier in Bagrote valley has been an important source of livelihood for the locals. Large slabs of glaciers are cut from the terminus of Hinarchi glacier and transported to Bulchi village (1-2 km) on the back of donkeys and horses, from where the same are transported to Gilgit on jeeps. This glacier is used as ice in domestic use and in making ice creams in markets nearby. Scope of this business has been exponentially increasing for the last 5-8 years due to lack of electricity and affordability to run and purchase refrigerators. An increase of 1°C in the temperature of UIB would result an increase of 16–17% in summer runoff. (ShaukatAli, DanLi, FuCongbin, & FirdosKhan, 2015). However, as the practice of glacier ice extraction persists in the Bagrote valley, the volume of glaciers will considerably decline, and hence, lower glacial runoff and water tables in the long run for the community to utilize.

The valleys of **Ghulmat**, **Nagar** and **Hopar-Hispar** are part of the Hunza Basin that hosts 1384 glaciers with **123** of them lying in the CKNP area and corresponding to 20% of the total CKNP glacier census. (Bajracharya & Shrestha, 2011)**.** According to (Senese, et al., 2018), the Hunza glacierized area is characterized by a slight shrinkage from 2001 to 2010 (i.e. -0.76 km2), with the highest retreat for the 10-20 km2 size class. (Anwar & Iqbal, 2018)**,** identifies that 3.53% of glacier area of Batura, Passu, Ghulkin and Gulmit glacier, all in the Hunza-Nagar basin, have decreased since 1994 to 2017. Moreover, in and around the northern flank of Rakaposhi, the glaciers provide even stronger meltdown indications, including shorter glacier tongues. (Mayer, et al., 2010)

For the purpose of assessing the total fresh-water resource, a total ice volume of **98.40 km^3** is present in the basin. Moreover, the condition of water resource in **Nagar** valley has been considered to be better relative to other valleys in the basin, that could also be due to a 16% increase in the temperatures as reported by the locals and the consequent snow melt as a result. Although, the locals have reported that the rainfall has declined by upto 17% in the last few years, except the last two years, where unprecendented amounts of rainfall was experienced across the CKNP area. (Ali, et al., 2018) using HBV hydrological model concludes that across Hunza River Basin streamflow will show an increase right up till the end of the 21st century in comparison with the current times but will show a slight decrease relative to the midcentury.

The valleys of **Shigar** and **Upper Braldu** lie in the **Shigar** basin, which has the widest glacierized area in the CKNP, hosting the highest amount of glaciers i.e. **294** bodies (**48%** of the total CKNP census), and covering more than half of the entire glacierized surface of the national park i.e. **2308.3 Km^2.** (Smiraglia & Diolaiuti, 2016)**.** Unlike the other basins, the Shigar glacierized area has experienced a slight increase between the 2001-2010 time period. Regarding the Liligo glacier in the Upper Braldu valley, (BELO, MAYER, SMIRAGLIA, & TAMBURINI, 2008)**,** confirms the Liligo glacier has shown increase since the 1970s, along with increased thickness of the glacier and heavy crevassing. Moreover, the largest part of glacier-derived fresh-water resource of CKNP i.e. **74%** , is hosted by the Shigar basin, which is equal to **392.39 km^3**, of which 187.06 km3 of ice is entrapped into debris-covered glaciers, while 205.33 km3 is a part of debris-free glaciers. (Smiraglia & Diolaiuti, 2016).Moreover, the mean ice volume in the basin is relatively higher compared to other basins i.e. 1.33 Km^3. (Senese, et al., 2018). On the other hand, in the FGDs, the communities have reported of increase in winter temperatures in Shigar i.e. from -36C two decades ago to -13C now, but it can be assumed that this variation didn't have much influence on the glaciated area of the basin. Moreover, the practice of disposing waste material containing explosive residues from the mines into rivers and adjacent streams, pollutes the freshwater ecosystem of the Shigar and Hunza rivers, thus affecting the quality of drinking water and aquatic life downstream. (Pyara, Abid, & Rizvi, 2016)**.** Regardless of the threats, Shigar basin can be considered the most significant and valuable in the entire CKNP, in fact in the entire Gilgit-Baltistan, as the highest contribution of water availability in the Indus river basin comes from glaciers located into the Shigar basin. (Senese, et al., 2018)

The valleys of **Hushe** and **Thalay** are part of the **Shyok** Basin, which hosts 3357 glaciers, of which 94 lie in the CKNP, and correspond to 15% of the total CKNP glacier census, covering a cumulative area of 334.87 km^2 (9% of the total CKNP glacierized surface). (Senese, et al., 2018).The glaciers of the basin are found to feature a general increase (with a general value of +0.25 km2) except for the largest class (i.e. >50 km2) which accounts for a total shrinkage of -0.45 km2. (Smiraglia & Diolaiuti, 2016). Shyok basin has the highest number of debris-covered glaciers i.e. 62 ice bodies, while only 27% of ice is nested into debris-free glaciers. (Senese, et al., 2018). Assessing the total freshwater resource, only a total ice volume of **26.88** Km^3 is present in the basin, which is a considerably low number relative to the other three basins mentioned above. (Smiraglia & Diolaiuti, 2016).The Mean volume of a glacier is equal to 0.29 Km^3, which is again relatively lower than the Hunza and Shigar basins. On the other hand, the communities have reported an increase in precipitation rates particularly in Thalay valley, since the last decade, which ensures the partial availability of water in the basin.

Since, **Shyok** basin hosts the highest number of debris-covered glaciers i.e. 62 ice bodies, it will be less relatively less vulnerable in the future, since recession rates are usually lower in debris covered glaciers. (Ashraf & Batool, 2019)**.** This is further endorsed by (Nicholson & Benn, 2013)**,** which indicates that the abundant presence of supraglacial debris reduces the melting processes affecting the underlying ice (Nicholson & Benn, 2012), allowing glaciers to survive at these lower elevations.

Valleys such as **Haramosh, Ghulmat, Shigar and Astak** have adequate water supply from the mainstream at the middle and small water streams from both sides of mountainous terrain. The overall water availability is sufficient to cater required need of the valleys; but during the peak season, flood and landslides damage the irrigation channels, leading to a water shortage. However, water availability will not be a concern in the short-term future at least, as (Sullivan, Rijal, Shrestha, Khanal, & O'Regan, 2004) projects increases of between 14% and 90% in mean flows in the first few decades, followed by decreasing levels of -30% to -90% by end century. (Briscoe & Qamar, 2008) emphasizes the projection, by predicting western Himalayan glaciers to experience shrinkage and hence, increased flows in the Indus basin for the next 50 years, followed by a decline of water flow by 40% over the next half of this century.

In order to assess and compare the various basins and glaciers encompassing the national park, (Ashraf & Batool, 2019), denotes the Hunza, Gilgit an Indus sub-basin to be dominant in terms of number of ice bodies, while Shigar, Hunza and Shyok basins to be dominant in terms of ice **volume.** Moreover, we can recognize that the widest basin (for number of ice bodies, glacier extent and ice volume) is the Shigar basin, where the largest glaciers are present (including the iconic Baltoro Glacier), and the smallest one being the Gilgit basin, while the highest number of debris-covered glaciers is found in the Shyok basin (62 glaciers). (Smiraglia & Diolaiuti, 2016)

Hence, after analyzing all factors, with the highest number of ice bodies, glacier extent, ice volume and the largest part of glacier-derived fresh-water resource of CKNP i.e. 74%, **Shigar** basin/valley can be considered the most valuable relative to other basins and valleys encompassing the national park. The sustainability of Shigar basin is endorsed by (Ashraf & Batool, 2019)**,** which explains the dominance of Shigar basin owing to the slight increases in the glacier numbers as well as the volume between the time-span of 2001-2013, along with possessing unique hydroclimatic conditions, favorable for the Kuhl irrigation system in the basin.

As for the vulnerability, we can assess that the Hunza-Nagar basin can be considered the most vulnerable as, comparing glaciers between 2001 and 2010, according to (Smiraglia & Diolaiuti, 2016), the Hunza glacierized area is characterized by the maximum shrinkage albeit not particularly intense (i.e. -0.76 km^2)**.** (Ashraf & Batool, 2019) emphasizes the notion as it describes a variable decrease in glacier number and volume in the Hunza river basins during the 2001-2013 time period.

As for the snowfall rates, According to (Mustafa, et al., 2016), the communities have reported a 35% decline in amount of snow fall over the last 10 years, except the last two years, in Ghulmat valley, 60% in Nagar valley, 58% in Thalay, 55% in Haramosh, and a 38% decline in Shigar valley. In contrast, (Minora, et al., 2016) observed a slight increase in late summer average snow covered area during 2001–2010 observed from MODIS snow data. Also, observations entailing increased snowfall and declining mean summer air temperature since 1980, meant a relatively higher snow cover during melt seasons. (WWF, 2007) estimates that changes in the precipitation especially in summers are responsible for the sudden glacial surges as increase in the precipitation is directly proportional to the number of surges. However, (Frey, et al., 2014) has a contrasting view, which states that since there is a delay in response times of glaciers responding to changes in climate (several decades for large glaciers), the correlations made amongst climate parameters and glacier changes are unreliable.

(Ikram, Afzaal, Bukhari, & Ahmed, 2016) emphasizes that several decades are required for glaciers to adjust to changes in climate. As the time required for the adjustment increases with the size of the glacier, large glaciers are expected to continue shrinking over the next few decades, even though the temperatures trends toward stabilization.

Therefore, the analysis of area changes during 2001–2010 across the CKNP region, reveals a general stability, evidence of the anomalous behaviour of glaciers in the Karakorum, in contrast to the worldwide shrinkage of glaciers. (Smiraglia & Diolaiuti, 2016). However, Studies on the elevation-dependent warming of the glaciated regions of the world in IPCC AR5 show these regions have become most vulnerable to climate change. (Ikram, Afzaal, Bukhari, & Ahmed, 2016)

All the scientists agree upon low elevation glaciers up to 4500 meters have been losing their ice mass at a much faster rate relative to high elevation glaciers. (Rasul, Chaudhry, & Mahmood, 2011)**.** Moreover, Smaller glaciers will also continue to shrink, but they will adjust their extent much quickly. (Ikram, Afzaal, Bukhari, & Ahmed, 2016)**.** The most prominent valley glaciers like Siachen, Hispar, Batura and Passu exhibited a retreating behavior in the recent decades (Ashraf & Batool, 2019), and if the IPCC projections of the Hindukush-Himalayan-Karakoram region are realized, great vulnerabilities lie ahead for the human populations and biodiversity of the Central Karakoram National park and beyond.

Wildlife

It is commonly known that many physiological aspects and behaviors of animal species, their size, shape and colour, their feeding and sexual behaviours, are constantly adapting to the conditions and climate they reside in. Hence, changing climates can have serious impacts on the population size, which consequently have effects on the distribution and abundance of species, and ultimately ecosystem structures and functioning. (Green, Harley, Spalding, & Zockler, 2001). Climate change could lead to extinction of 6300 species including pollinators and parasites. (Koh, et al., 2004). Changing and fluctuating climate patterns will lead to a decline in genetic diversity owing to rapid migrations of species, which would further impact the resilience of the system and ecosystem functioning. (Botkin, et al., 2007)

Wildlife in Central Karakoram national park is the most unique, diverse yet vulnerable due to population growth and climate change impacts. The analysis of **Wildlife** is done based on the economic valuation, the threats facing wildlife, and the impacts of climate change on the ecosystem across the 10 valleys of the park, under the scope of this study.

Bagrote valley hosts 43 Ibex, possessing a value of Rs. **10,750,000**, according to estimates of the winter wildlife survey of 2018. However, the population size was observed at 88 in 2011 by WWF, which clearly indicates a decrease in the population size since the last decade. There haven't been any recorded incidents of illegal poaching/hunting in **Bagrote**, but this doesn't rule out the possibility of hunting of Himalayan Ibex and game bird shooting, as hinted by some locals and wildlife experts. As for the retaliatory killings, there have been reports of snow leopards being killed in order to protect livestock, iron traps being installed, and carcasses being poisoned against a threat from predators such as wolves and foxes. Moreover, skin diseases such as Coryza, have been affecting the populations of Ibex, Ramchakor and Fox in the past.

Haramosh valley hosts 43 ibex having a value of Rs. **10,750,000, while,** the population of Markhor in Haramosh has been observed to be around **38** having a value of Rs. **535,298,400**. In Haramosh, the faunal diversity is on the decline, as species such as Ibex, birds and butterflies are continuously degraded. (Vuillermoz, Listo, Raza, & Pyara, 2016). It indicates that either climate is posing pressure on the survival of species or species may have the difficulty in adapting to the changing climate. However, the Markhor population has improved due to trophy hunting and conservation efforts.

Similarly, **Ghulmat** valley has 85 Ibex of a value of **Rs. 21,250,000** while, the population of Markhor has been estimated at 23, having a value of Rs. **323,996,400.**. In Ghulmat, according to (Zaib, et al., 2016) the Ibex population has seen a 36% increase in the last few decades but the species such as

Markhor and Butterflies have almost disappeared. For **Birds**, the habitat is observed to be decreasing currently, while the population and diversity was good since the last 30 years.

For **Hopar** valley, the ibex numbers are observed to be **99**, which means the value of Ibex in Hopar stands at Rs. **24.750,000**. It has to be noted that the population was between 250-300 in 2013, so there is a considerable loss in the numbers, which indicate the illegal hunting of the specie or movement of the animal to other areas. As for the Avian population, **Hoper** valley possesses the largest diversity i.e. 95 plus species, followed by 80 species residing in Shigar valley, and around 70 species in the valleys of Nagar and Hisper. In **Hoper** the illegal hunting and poaching activities have been controlled to a greater extent but in **Hisper** some illegal hunting activities have been reported. In Hopar, Ibexes have been dying due to avalanches, while Hispar has experienced a decline in the red fox population due to skin diseases.

For **Hispar,** the ibex population is estimated to be around **135** in number, meaning that the value of Ibex in Hispar approximates to around Rs. **33,750,000**. It's of great significance to point out that the population was greater than 500 in the year 2015, and thus a great decline in its population has been observed over the last 5-6 years. In **Hushe,** the population of Ibex has been observed at 383, which means a high value of **Rs. 95,750,000** of the ibex in the valley. However, the population in 2014 has been observed to be around 600, which shows a considerably high decline in the Ibex population in Hushe. One of the reasons identified is the mass mortality of overwintering Ibex kids. There haven't been any incidences of Illegal hunting in the valley, primarily due to the success of Trophy hunting Programme in the region. However, Ladakh Urial sheep (Ovis vignei vignei) is said to be locally extinct from valleys such as **Hispar** and Kanday village in **Hushe**, due to persecution, challenges of an isolated population, excessive hunting and most importantly, because of an unknown disease, spread in the valleys a few decades ago. In **Hushe** valley, there exists an interesting relationship between the attitudes of the locals towards the Snow leopards and Wolves. The FGDs reported that locals possessing a large livestock holding was more in favor of elimination of the big cat, while people prone to more livestock depredation cases, were relatively less tolerant towards wolves. This mindset doesn't help the conservation of the two species in the future, as the locals continue to practice trapping and poisoning carcasses.

The Ibex population in **Thalay** has been observed to be around 125, meaning a value of Rs. **31,250,000**. The Ibex and Bird population in Thalay has been reported to be increasing since the last few years due to effective conservation practices. The Ibex population in **Upper Braldu** is around 526 having a value of approximately Rs. **131,500,000**., while in **Astak** according to the winter wildlife survey, it has been observed at around 16 heads, having a value of Rs. **4,000,000.** In Astak, the Ibex and Markhor species are under threat, but the Birds and Butterflies population is experiencing a positive trend.

In **Nagar** valley, the **Ibex** and **Bird** population is increasing, with the locals reporting an increase in their population over the last 30 years. The **Ibex** population is also increasing, with the locals reporting a 36% increase in their population over the last 30 years. (Shimshali, Khan, & Gallo, 2016). The numbers of Birds have also has seen a positive trend since the last 10 years. However, various species of Butterflies were common a few decades ago, but their population is experiencing a downward trend.

The valley of **Shigar** locals reported a 41% decline in **Ibex** population over last 30 years that refers to out migration of species either due to climate change or rapid illegal poaching. (Pyara, Abid, & Rizvi, 2016). As for **Thalay**, although the impacts of climate have resulted in the migration of various species, the population of species such as Ibex has been increasing due to conservation efforts. For **Birds,** the population is increasing since the last 5 years due to conservation practices. Although, if compared to the last few decades some birds are still living relatively at higher altitudes, which would be seen in the village before. (Mustafa, et al., 2016)

Upper Braldu is also experiencing a degrading status of Ibex and other fauna, both due to migration of species due to climate change and rapid illegal poaching. According to (Hassan, Vuillermoz, & Listo, 2016), a 70% decrease in ibex population in last 30 years has been observed as per the local perceptions. While in **Astak** valley, faunal biodiversity is at a decline as the Markhor population has completely washed out in the last 30 years. Ibex population also irrespective of conservation efforts is continuously decreasing. For **Birds** and **Butterflies**, a positive trend has been seen in the last few years. (Hussain, et al., 2016).

After estimating the value of wildlife, based on the Winter-Wildlife survey and mainly the Ibex and Markhor populations in this case (the only species being part of the trophy hunting Programme currently), **Haramosh** valley is the most valuable in terms of the wildlife abundance and the future trophy hunting prospects. However, the valleys of **Upper Braldu** and **Hushe**, having the most populations of Ibex respectively, and with greater prospects of Tourism and Trophy hunting in the future, are at par with Haramosh valley.

Since the Forest, Wildlife and Environment secretariat of Gilgit-Baltistan hasn't issued the notification of **Bagrote, Hopar and Hispar** valleys as Community managed conservation areas (CMCA) yet, there is a tendency of illegal hunting/poaching looming in these valleys. Moreover, the game watchers and wildlife guards in **Bagrote, Thalay, Hushe and Hispar** valleys, aren't compensated fairly anymore for their services due to non-existence of projects and are lacking the motivation to fulfill their duty of wildlife census/protection and hence, becomes a barrier in the conservation of these species. Hence, realizing these two factors, along with assessing a huge decline in the Ibex population from 500 in 2015 to a mere 135 in the Winter wildlife survey of 2018, the **Hispar** valley can be considered the most vulnerable relative to other valleys under the scope of this study.

It is interesting to note that the locals claim to observe a decline in overall population of ungulates especially ibex and Urial, but the CKNP Directorate and authorities reports otherwise. According to CKNP's seasonal wildlife surveys, there is overall increase in wildlife population, due to better awareness and conservation endeavors, as proclaimed by the CKNP directorate staff.

Agriculture

Agriculture being the primary source of livelihoods for up to 45% of the total workforce in the country, is a key contributor towards the GDP (21% share) and export base (60% share). (Chaudhry, 2017). This sector however is extremely sensitive to changes in the climate and the consequent intensities of temperatures and precipitation. (Dehlavi, Groom, & Gorst, 2014) suggests that with increasing temperatures of 0.50^{o}C to 2^{o}C, the productivity of the agricultural sector will decline by 8-10% by 2040.

Multiple simulation studies employing the crop-growth simulation modelling have estimated lower yields for major crops in the country, except the Gilgit-Baltistan region which is where CKNP is located. Up to increase of 50% in productivity is expected in the region by 2080, along with a projected decline of 14 days in the length of growing season for wheat if the temperatures rises by 10^{o}C. (Chaudhry, 2017). Further emphasizing the notion is (Hussain & Mudasser, 2007), which indicates the effect of warmer temperatures on the declining growing period for winter season crops. The increased growth season complemented by shorter time periods for plants to mature, would have positive impacts on the yield rates of crops especially in high mountain regions above 1500m, and lead to effective land use such as double cropping systems. (Kazmi, et al., 2015) Therefore, it indicates that while over precipitation might have a negative correlation, water availability and rising temperatures by 2, 4 and 5 degrees, will increase the production of major crops by 5, 10 and 13 percent respectively. (Baig & Amjad, 2014)**.**

While assessing the projected temperatures increases leading to greater productivities for the CKNP region, the threats facing the agro-economy, the economic valuation conducted and the impacts of climate change on the ecosystem, an analysis across the 10 valleys under the scope of this study is conducted.

In **Bagrote**, the value of the 3 crops i.e. Wheat, Maize and Potatoes, sum up to have a value of **Rs. 1,552,604,160/yr.** Yield of wheat in Bagrote valley is 1477kg/ha, which is less the national average of 2833 kg/ha. (Khan, 2015). Bagrote is the one the biggest pear producing areas in the region, while the potatoes of the valley have a huge potential in the regional market. However, the value chain of fruits like apricots, apple, pear and walnut needs a lot of improvement.

In **Haramosh** valley local farmers have developed terraced patches of agriculture fields through land reclamation at different altitudes around their settlements which is forest rich landscapes. In **Haramosh** valley, the values of crops for all villages combined sums up to have an estimate of **Rs. 64,360,000/yr.** Moreover, in order to maximize agriculture production conservation tillage in addition to animal manure has also been practiced by local farmers in Haramosh valley to avoid erosion and increase in fertility. (Vuillermoz, Listo, Raza, & Pyara, 2016)

To sum up the values of all these villages of **Ghulmat valley**, we can estimate the value of these crops at **Rs. 2,415,131,250.** With increasing population and emerging nuclear family system in Ghulmat valley, arable land fragmentation is taking place and area of land holding per household is shirking year by year. (Zaib, et al., 2016)

For the three major crops in all villages of **Nagar** valley including the vegetables/fruits, we can estimate a value **of Rs. 328,150,000/yr.** Although, the water in the streams provide sufficient quantity of mineral to sustain agriculture practices, farmers are facing difficulties now a days due to several insect and flies' pest species which feed on the grains, fruits and other such products. (Shimshali, Khan, & Gallo, 2016)

Hoper is one of the largest apricot producing villages in Nagar together with some other fruits like walnut and pears. Altogether, the sum of the values of wheat and potatoes in Hopar can be estimated at **Rs. 561,035,440/yr.** In Hoper, fruit processing, packaging and marketing of crops and fruits, is not up to the mark leading to substantial loss of the product.

Altogether, the sum of the values of wheat and potatoes in Hispar can be estimated at **Rs. 95,301,600/yr.** To sum up the values of all these villages of Shigar valley, we can estimate the value of these crops at **Rs. 3,655,542,660.**

In **Hushe** valley, Tallis and Marzigond villages are most suitable areas for buckwheat and apricots, while Kanday and Hushe for potatoes and peas. To sum up the values of all these villages of Hushe valley, we can estimate the value of these crops at **Rs. 413,922,256.** Hushe valley has the potential of high value crops such as buckwheat and vegetables like potato and peas, but due to non-availability of a proper market chain the product is seldom sold for earning some disposable income

For **Thalay** valley, we can estimate the value of these crops at **Rs. 131,600,000/yr.** To sum up the values of all these villages of **Upper Braldu** valley, we can estimate the value of these crops at **Rs. 429,483,000/yr.,** while for Astak valley, we can estimate the value of these crops at **Rs. 52,015,000/yr.**

Hence, judging by the economic values of the various crops in various valleys, we can consider **Shigar** to be the most valuable valley in terms of agricultural activity, as it has the highest value of crops i.e. **3,655,542,660,** amongst the 10 valleys under the scope of this study. If solely based on the economic values, Astak valley is the least vulnerable as it has the lowest value of Rs. **52,015,000,** and hence lower amounts are at stake if the climate change impacts are to wreck the agro-economy in the future.

Livestock

Climate change and the speculation surrounding it, has also gained interest regarding the impact of warming temperatures on the Livestock industry and how this will have serious impacts on the productivity of high-quality protein to fulfill human needs and address the food security crisis. (Baumgard, et al., 2012). Despite the fluctuating patterns and climate variabilities, the Fifth assessment report by IPCC indicates of a likely increase of global surface temperatures by 0.3°C to 4.8°C by the end of this century. This will have potentially negative consequences for livestock such as lower productivity and qualities of feed crop, water unavailability, increased diseases and lower reproductive capacity. These impacts are mostly due to rise in atmospheric carbon emissions, increased temperature and precipitation rates etc. (Rojas-Downing, Nejadhashemi, Harrigan, & Woznicki, 2017)

The analysis of **Livestock** is done based on the economic valuation, the loss rates, and the impacts of climate change on the ecosystem across the 10 valleys of the park, under the scope of this study.

Livestock herding is the second largest source of livelihood in **Bagrote** valley followed by subsistence agriculture. With 16418 animals in the valley, the total value of livestock in the valley has been estimated at Rs. 449,363,556. The average number of livestock per household in the valley has been decreased by 20.56% from 21.4 animals per household in 2009 to 17 animals per household. The Annual livestock mortality in the valley is at **12.8%** of the total livestock holding. (Khan, 2015) A predator-proof corral based on the local climatic and topographic conditions of the valley has been built, which will lower the predation rates in the future. Currently, the people in the valleys of Bagrote and Haramosh maintain a decent number of livestock. However, in the future the trend is anticipated to go down due to their locals having easy access to the cities nearby and the employment and educational opportunities that comes alongside it.

The observed downward trend in livestock rearing has both positive and negative impacts. On one hand decreasing trend in livestock rearing is useful as it reduces the pressure on the pastures, by leaving space and food for the wild herbivores and ultimately increasing prey density for wild carnivores. But on the other hand, lower contributions by livestock in annual income per household increases the dependence of local community on natural forest goods. This emphaszies that the dependence of local community on natural resources needs to be evaluated in terms of monetary benefits during each season, so that their economic value can be incorporated into research based decisions, helping resilience, ensuring ecosystem sustainability and lead to sustainable management of the ecosystem. (Baumgard, et al., 2012)

The total value of all livestock in **Haramosh** valley can be estimated as a sum of all animals i.e. **Rs. 2,539,397,080,** while the total value of all livestock in Ghulmat valley can be estimated as a sum of all animals i.e. **Rs. 319,839,270.** According to Ev-k2-CNR, the animals rearing trend is still increasing in **Ghulmat.** While, Locals in **Nagar** have started to rear cross breeds of indigenous cow and improved Jersey breed, which are regarded as highly productive in terms of dairy production. Rearing improved breeds need stall feeding, hence reducing stress on the pastures and reducing the less-productive breeds in the future. The total value of all livestock in **Nagar** valley can be estimated as a sum of all animals i.e. **Rs. 606,113,430.**

Majority of the local people (>80%) are rearing livestock in **Hopar-Hispar**. (Gallo, Khan, Khan, & Khan, 2015). The total value of all livestock in **Hopar-Hispar** valley can be estimated as a sum of all animals i.e. **Rs. 438,681,200.** However, in Hoper village, average herd size has decreased by 23.33 % from 20 animals to 16 animals per household, while in Hisper village, average herd size has decreased by 29%, from 22 animals to 16 in the 2009-2014 time period. The Annual livestock mortality in Hispar is 7% of the total livestock holding. In Hoper the major cause of death in sheep and goats is mammalian predators, and in cattle it is the diseases. In Hisper, predation by large predators was primarily the cause of deaths amongst all categories of livestock. While, "In contrast to Basha and Braldo valleys, animal husbandry in **Shigar** Proper can be described as a m ore contribution to subsistence agriculture than as a source of cash income". (Pyara, Abid, & Rizvi, 2016). The total value of all livestock in **Shigar** valley can be estimated as a sum of all animals i.e. **Rs. 1,151,561,630.**

Majority of the local people (>90%) rear livestock in **Hushe** valley, with a average of 16 animals per household in the valley. However, it has been decreased by 38% during the last five years (from 26 animals in 2009). The total value of all livestock in **Hushe** valley can be estimated at **Rs. 321,309,218.** Similarly, The livestock maintained in **Thalley** vary in terms of animal composition; number of yak, horses and donkeys is considerably higher in the valley, while it is the opposite in case of sheep and goats. Since, Thalley has vast green pastures suitable for Yaks whereas pastures in the surrounding Keris are comparatively steep and barren, suitable for goats and sheep. Therefore, the total value of all livestock in **Thalay** valley can be estimated as a sum of all animals i.e. **Rs. 550,174,380.** While, **t**he total value of all livestock in **Upper Braldu** valley can be estimated as a sum of all animals i.e. **Rs. 876,538,820,** while, the total value of all livestock in Astak valley can be estimated as a sum of all animals i.e**. Rs. 740,561,120.**

Skardu district has the highest livestock numbers and more cattle varieties, while Nagar has the lowest. The reason for this difference is obvious, that is, majority of villages in Nagar Valley are located along the KKH; hence have better exposure and access to business opportunities, therefore, their reliance has shifted from animal husbandry to jobs and other sources of livelihood. (Invernizzi & Locatelli, 2015). While, the villages in Skardu are remotely located and still rely on livestock for their livelihoods. Thus, it is apparent that villages off the Karakorum Highway maintain higher numbers of livestock as compared to villages along the KKH, in the CKNP region.

As for the loss rate within the total livestock population, it is the highest in **Haramosh** with 41% and 26% in Hopar valley. (Vuillermoz, Listo, Raza, & Pyara, 2016)**.** Similarly, the loss rate in Hopar is 10.8% and 8.6% in Haramosh. On the contrary, in the other six valleys, the livestock loss rate observed is less than 3%, even though wildlife conservation activities are not strictly enforced in these valleys. Hence, this is a clear indicator that **Haramosh** valley is the most vulnerable relative to other valleys in terms of the livestock health and sustainabilty. It is interesting to see that in terms of the value of livestock across the 10 valleys under the scope of this study, Haramosh has the highest value with Rs. **2,539,397,080,** which is significantly greater than the lowest value of Rs. **319,839,270** in Ghulmat valley. It can be inferred that Haramosh possesses the highest number of livestock, and hence the consequent highest value and highest loss rate naturally.

While climate coninutes to have significant impacts on the livestock ecosystem, the effects of livestock on climate change also needs to be analyzed. The contribution of livestock in the total annual GHG emissions is approcimatly 14.5%. (Gerber, et al., 2013), while also negatively affecting the various ecossytems, by causing air and water pollution, land degredation and loss of biodiversity.. (Thornton & Gerber, 2010).

Therefore, livestock systems have a major role in the overall GHG emissions globally but also provides sustenance and livelihood options for vast majorities of communities in the developing world. Hence, formulation and implementation of impact assessment frameworks that can address the ideal mitigation and adaptation strategies, impact on livelihoods, and the arising trade-offs amongst income levels, food security and environmental objectives, is the key to solve this paradox. (P.K.Thornton, Steeg, A.Notenbaert, & M.Herrero, 2009)

Pastures

Rangelands in the Himalayan-Karakoram-Hindukush mountain ranges of the world are home to sustenance and livelihood source for around 30 million pastoralists and agro-pastoralists. Not only they store and regulate water, act as carbon sinks, stabilize the climate, soil and nutrients, they maintain air quality, host a great variety of flora and fauna species and hence, nurture a rich set of biodiversity. (Shaoliang & Sharma, 2009)

Climate determines the structure, distribution, composition and production of fodder of rangeland ecosystems such as Pastures. (Gang, et al., 2015). The direct impacts as also experienced in the CKNP region include varying rates of evaporation and runoff, changing vegetative cover and diversity, varying decomposition rates, higher risks of forest fires, varying productivity rates, fluctuating carbon sequestration levels, drying peatlands/wetlands and the effects on wildlife habitats. (Shaoliang & Sharma, 2009)**.** Moreover, it is apparent due to consensus by many studies, that temperatures and precipitation are the key climate variables affecting the grassland dynamics. (Gang, et al., 2015)**.** (Cullen, et al., 2009) points out along with carbon emissions increasing the pasture production, higher precipitation and temperature rates will greatly affect the overall productivity and how the ecosystem adapts to climate scenarios in the future.

Based on the IPCC climate scenarios, the economic valuation of medicinal plants, the Ev-k2-CNR vulnerability index, and the impacts of climate change on the ecosystem across the 10 valleys of the park, an analysis can be conducted to determine the most valuable and vulnerable valleys of the park.

There are only three valleys (**Haramosh, Bagrote and Danyore**) where patcheds of natural pine forest still exists in the pasture lands. As **Bagrote** valley comprises of **960** Households, the value of medicinal plants can be estimated at **Rs**. **75,197,760/yr.** As for **Haramosh**, highest concentrations of livestock fed upon pastures of Haramosh village and hence, the locals have indicated that all pastures in the valley are degrading gradually. As Haramosh valley comprises of 1041 Households, the value of medicinal plants in the valley can be estimated at **Rs. 81,542,571/yr.**

According to (Zaib, et al., 2016), 85% of the pastures of **Ghulmat** valley are degrading gradually accroding to local perceptions. This is due to unsustainable harvesting, coupled with less snow and shift of rainy seasons which contributes to its low productivity. Barren patches among the pastures are notable features indicating the removal of top soil as a result of flooding and landslides. As Ghulmat valley comprises of 1875 Households, the value of medicinal plants in the valley can be estimated at **Rs. 146,870,625/yr.**

As **Nagar** valley comprises of 3432 Households, the value of medicinal plants in the valley can be estimated at **Rs. 268,831,992/yr.,** while the value of medicinal plants in **Thalay** valley can be estimated at Rs. **82,639,205/yr**. In Shigar valley, the FGDs suggest that all pastures of **Shigar** valley are under constant degradation. As Shigar valley comprises of 2838 Households, the value of medicinal plants in the valley can be estimated at **Rs. 222,303,378/yr.**

As Hushe valley comprises of 629 Households, the value of medicinal plants in the valley can be estimated at **Rs. 49,270,199/yr.** In **Hushe** valley, it has been claimed by the locals that 74% of the pastures are degrading gradually. (Khan, Khan, Khan, & Gallo, 2015). The areas of Saicho and Dumsum are heavily grazed due to preference of grazers to stay in these locations for earning some income from tourism activities. In Hushey village 8 out of 17, in Kanday 7 out of 12, in Marzigond 3 out of 5 and in Tallis 2 out of 10 pastures are considered to be “partly degraded”.

According to local perceptions, In **Hopar**, apart from two pastures i.e. Miar and Sumayarbar, the rest are partly degraded. However, in **Hispar**, the health and quality of pastures is relatively better, due to the vastness of the area. As Hopar-Hispar valleys comprises of 940 Households, the value of medicinal plants in the valley can be estimated at **Rs. 73,631,140/yr.** As Astak valley comprises of 832 Households, the value of medicinal plants in the valley can be estimated at **Rs. 65,171,392/yr.** According to (Hussain, et al., 2016) ,79% of the pastures in **Astak** valley are degrading gradually.

(Hassan, Vuillermoz, & Listo, 2016) suggests that only 19% pastures of **Upper Braldo** valley are healthy, while other 81% are degrading gradually based on the local perceptions in the valley. Moreover, according to the FGDs, there have been constant conflicts over this common pool resource i.e. Pastures, as the villages of Sino and Hoto have been in conflict over pasture use rights since the last few decades. As Upper Braldu valley comprises of 428 Households, the value of medicinal plants in the valley can be estimated at **Rs. 33,525,668/yr.**

Based on the Vulnerability Index adapted by (Ullah Baig, 2011), the common denomiator across valleys is that alpine Meadows and extended grasslands (high pastures) above or near tree line are accessible only for short time period which is peak summer season. Most importantly, the scores of the Index suggest that **Thalay** and **Haramosh** valleys are the most vulnerable valleys in terms of pasture degredation and the looming threats in the future. On the other hand, **Hushe** and **Hispar** valleys can be considered relatively less vulnerable, under the scope of our study. As for the valleys having the highest value of medicinal plants according to my research, **Nagar** valley dominates the rest of the valleys with a value of Rs. **268,831,992**. However, **Shigar** valley having a diverse abundance of medicinal plants, is almost at par with minerals possessing a value of Rs. **222,303,378.**

The pastorals across CKNP will continue to face challenges including fluctuations in water availability, varying wind directions and stronger velocity, faster glacier melts and the prevalence of recurring floods, draughts and snowstorms. (Shaoliang & Sharma, 2009). In this regard, high altitude rangelands can be critical in the sustenance of their livelihoods, with respect to habitat for native species and home to an abundant set of economic and medicinal plants.

In addition, owing to the existing land tenure systems, the pastorals strive for immediate gains, rather than focusing on long-term advantages. The results manifests that the overall productivity level is almost **25%** to its potential. Prominent factors reflecting the poor condition include; change in the species composition, overall reduction in the vegetation cover, less quantity of litter, and gullies and rill formation. Thus, Uncontrolled grazing and deforestation are the key factors responsible for downward productivity of pastures and thus of the livestock. However, some pressure can be lifted off the pasturelands in the future, as the trend of livestock rearing has been on a downward trend since the last decade, and will continue to rise with more accessibility, development and business opportunities for the local communities. (Ullah Baig, 2011)

Minerals

Owing to dependence on the natural environment, long-term viability of the industry, access to water resources, a habitable climate , and strategic decision making due to the ecosystem being not relocatable, these minerals are extremely vulnerable to impacts of climate change in the future. (Pearce, et al., 2011). These impacts include both direct impacts i.e. operational and performance based, along with indirect effects such as increased costs of energy and procurement of supplies. (Rüttinger & Sharma, 2016). The Gilgit-Baltistan region and CKNP in particular, which is one of the most important Gems specimen producing areas in the world is under constant threats of the changing climate. (Rehman, Alam, & Khan, 2009). In order to better understand the impacts of climate change, a analysis follows, which is based on the economic valuation and threats facing the 10 vallyes of the park, under the scope of this study.

The most notable mining hotspots in the CKNP area are located in the valleys of **Nagar, Haramosh, Shigar, Astak and Hopar-Hispar**. Without a doubt, **Nagar** valley is the most economically significant in terms of the abundance, the value of minerals, the growing mining sector and its close proximity to the Chinese border. It is emphasized by the fact that the value of minerals in Nagar is estimated at Rs. **235,416,667/yr**., which is almost 10 times the value of other hotspots in the region such as Astak (Rs. **40,019,056**), Shigar (Rs. **33,450,000/yr**.), and Haramosh (Rs. **31,400,004**). It has also been suggested that a group extracted approximately 1000 Kgs of Salajeet in Hopar-Hispar valley in 2014, having an approximate value of **Rs. 1,500,000/yr**., thus indicating a future potential of mining in the valley.

For the future, it needs to be realized by the relevant authorities that the majority of the mines in the CKNP are cracked, damaged and leak, as water seeps into the mines, which make the mines potentially dangerous for the miners. These mines have the tendency to collapse anytime, due to thermal expansions, earthquake jolts and other geological activities. Moreover, 80% of the gemstones extracted in the region, are extracted using primitive methods, indicating the huge extent of value that is lost due to conventional methods such as blasting etc. Such primitive mining practices, if continued in the future, may cause deep cracks in the rock formations, make them disjointed and fractured, which can cause severe damage to mountains and fragile mountain ecosystems, particularly due to frost action during the winter season accelerating the physical and chemical weathering processes that may cause rapid erosion and landslides, and destroy intact wildlife habitats.

Climate change scenarios

While assessing the climate of Gilgit-Baltistan region, various reports along with the IPCC projections have indicated of increase temperatures and precipitation rates. The study (Raza, Hussain, Rasul, Akbar, & Raza, 2015) indicates about the recent decade being warmer by 0.33^{o}C relative to the previous half century, with considerably higher precipitation rates of 5.013mm as compared to 1.045mm previously. (Adnan, et al., 2016) has projected increases of temperature in the Gilgit basin for up to 3.02^{o}C for this decade under the RCP 4.5 scenario, while for the RCP 8.5, it has been projected at 10.76^{o}C by end century. Moreover, increase winter temperatures relative to summer, with winter temperatures to rise by 9.70^{o}C until the end of this century have been projected for the Gilgit catchment. (Ali, et al., 2018) reassures that winter temperatures will be relatively higher compared to summers under all RCP scenarios, from now until 2039. Also, increase in spring temperatures, rise in autumn and winter precipitation rates relative to other seasons, and rising trends of streamflow until the end of this century, have been projected under all RCPs (2.6, 4.5, 8.5). . (Ali, et al., 2018).

While comparing the two main regions of Gilgit-Baltistan i.e. Gilgit and Skardu (the main chunk of the CKNP area) with each other, a study carried out by GTZ for WAPDA indicates that Skardu mean annual temperatures have rose in the last century by 1.4^{0}C, while only 0.82^{0}C for Gilgit. Hence, this indicates that if the trend continues, the valleys close to Skardu will remain more vulnerable to climate change impacts, relative to areas closer to Gilgit.

Therefore, after analyzing the various resources, ecosystems, threats, impacts of climate change, IPCC scenarios, local perceptions, economic value of resources, varying climate parameters and the anthropogenic impacts, It can be assumed that **Shigar** valley is the most valuable owing to the highest value across all resources, while **Nagar** valley is the most vulnerable based on the various factors mentioned above. As for the most valuable and vulnerable resource, **Agriculture** is the most valuable, while **Livestock** and **Wildlife** are the most vulnerable resources across the 10 valleys of CKNP, under the scope of this study.

Limitations

The main aim of the study was determining the economic values of the various resources of the park which are prone to impacts of climate change. Although, both quantitative and qualitative analyses were conducted, certain limitations arose along the way, which can assist future studies and practitioners facing the same set of barriers.

The first and foremost limitation was the small sample size of 35 questionnaires, 10 Interviews and 5 FGD's i.e. 50 in total. This was due to the limited amount of time at hand, but most importantly, given the rough and difficult terrains of the park, it was a challenge to access the respondents in the various remote valleys. With translation issues, the lengthy questionnaire, day-long journeys into the valleys, telecommunication issues (no phone signals in most villages), the women not taking part in the survey due to cultural restrictions, and the men usually busy tending their crops in the fields or working in nearby cities, it was a great task to first locate the relevant respondents and then ask for their valuable time. Hence, the study might be prone to a sample bias, as it does not reflect the majority of the communities in the national park.

Lack of previous research and information available on the selected topic was one of the biggest limitations. The government authorities had little or no data, with most being outdated, on the various demographics, inventories of natural resources and insight into the national park. Even the biggest NGO in the region i.e. Aga Khan Rural Support Programme, weren't able to share any relevant information concerning the national park. Hence, due to lack of data, no statistical analysis could be undertaken, that for e.g. examines correlations between various climate parameters and value of natural resources. However, the situation presented an opportunity to identify gaps in the existing literature and present the need for further research in the various thematic areas.

The valuation of the resources was done solely based on the local knowledge and datasets from organizations such as WWF and Ev-k2-CNR, which might be biased in their own regard. Also, since only the provisioning services of the natural resources was being determined under the scope of this study, only the market valuation method was used, that utilized data of local use and market prices, based on local perceptions solely. This was due to the non-availability of market data owing to the inefficiency of the regulating authorities. Moreover, due to non-existence of any data on water discharge levels of glaciers, water flow rates, average household consumption of water, and water pricing, the valuation of Glaciers/Water could not be conducted as a result.

There also exist limitations with respect to the methodology used in the research. The values of the various resources are based on local perceptions and databases of organizations such as Ev-k2-CNR and WWF. Most importantly, the values of various resources are estimated based on limited information for e.g. the values of forests are based solely on average timber and fuelwood consumption per HH, and not on the forest cover, other non-timber forest products and indirect services of the ecosystem. Moreover, the judgements passed regarding the vulnerability of a certain valley or resource, is based on self-judgement, after analyzing the information from interviews, FGD's and the valuation dataset, which might be relatively less accurate, as compared to a vulnerability index, which would have presented more accurate and systematic results. There was a strong urge to use the 'Environmental vulnerability Index' but wasn't possible due to the non-availability of data, as the Index requires data of about 50 parameters.

Comparison with similar studies in the scientific literature

As with most of the studies valuing the protected areas within Pakistan or irrespective of the location, most of the economic valuations conducted has determined the recreational value of the national parks etc., using methods such as Travel cost methods or stated preference approaches such as Contingent valuation approaches. Most of them have calculated the 'Willingness to pay' or 'Willingness to accept' for benefitting from the ecosystem services of the national parks, wetlands, heritage sites etc. Studies within Pakistan such as **'** (Dehlavi & Adil, Valuing the Recreational Uses of Pakistan's Wetlands: An Application of the Travel Cost Method, 2011), (Himayatullah, 2003), (Khan H. , 2006), all have strived for the recreational values, thus inferring that there haven't been any studies conducted in the country in the past, that has attempted to conduct what this research has strived for i.e. valuation based on market based approaches using a market price analysis. Even within the Asian region, studies conducted in India such as (Bhatta, Nepal, Rai, & Kotru, 2017) have determined cultural values using travel cost methods. Research elsewhere have focused on various other components, as studies such as (Losonci, 2012)' have simultaneously determined the various components such as assessing if there is an uncaptured economic rent associated with ecosystem service protection, reveal the relative importance of the park's ecosystem services to respondents and to reveal factors that explain the variation of a positive willingness to pay, using methods such as contingent valuation. Whilst, (Emerton, Jovetic, & Kaludjerovic, 2011) has determined the economic impacts in terms of contribution of these protected areas in the total economy of the country and to further weigh up the public costs and benefits of investing in these protected areas.

While, a study in Bhutan estimated the value of ecosystem services in order to see its contribution in the national well-being.

On the other hand, a study (Pant, Rasul, Chettri, & Rai, 2012) used the same mechanism of market prices to determine the provisioning services of forests, coupled with employing using benefit-transfer methods to determine the regulating services. Owing to various sample sizes and dynamics, a big difference in estimates is observed amongst the two studies for e.g. the average value of fuelwood harvested was NPR 6,885 per household in Nepal, whilst it was at Rs. 165,186 in my research, which means NPR 119,868 if weighed against the currency. Moreover, a study called (Švajda, Getzner, & Považan, 2014), used the same tools of using market prices to calculate values such as Timber, but didn't determine the value of Non-timber forest products such as Medicinal plants, as the collection of plants in prohibited in all national parks of Slovakia. Furthermore, they estimated the value of freshwater provision based on average water consumption per resident and the current price of water at EUR 5.699 million/yr. In my research, a similar analysis wasn't possible due to no recorded data or local knowledge on the precise water consumption, along with non-existent water pricing to determine the market prices of water. Similarly, a research by WWF on the (Dalberg, 2013) has used similar methods of market-based approaches to calculate values of consumption goods for e.g. fisheries, along with regulating services such as carbon sequestration and non-use values. However, this study differs in a way as they've determined values based on two scenarios which itself is based on assumptions; the current valuation scenario based on unstable last 12 months and a potential value scenario if the park is sustainably managed.

Conclusions and Recommendations

The research aimed to explore and determine the economic benefits i.e. mainly the provisioning services generated by the park, in order to identify the most vulnerable and valuable valleys and resources encompassing the national park. Based on the quantitative and qualitative analysis, it can be concluded that **Shigar** valley can be considered the most valuable, while **Nagar** valley as the most vulnerable, given the ongoing trends, local perceptions, economic valuations and future projections based on IPCC scenarios, amongst other variables. While, for the most valuable and vulnerable resources of the park, **Agriculture** and **Livestock/Wildlife** take these slots respectively.

As for the climatic changes, studies have revealed that the warming and precipitation rates have been considerably higher in the North western Himalayan region and Indus Upper basin (which are both part of CKNP) to the rest of the globe and the country respectively. Many local and international studies have confirmed of night-time and winter temperatures to have risen considerably relative to daytime and summer temperatures, in areas in and around the Central Karakoram National Park. The increasing night-time temperatures could have serious implications for the biodiversity of the park, as it would lead to less snow accumulation and consequently, less water to feed the Indus River basin, that is the primary source of fresh water for the entire country and beyond.

Based on the IPCC scenarios of A1, B1, A2, B2 - RCPs (2.6, 4.5 and 8.5), there have been predictions of global temperatures to increase on average between 2°C to 5°C by the end of the century, while the Himalayas-Hindukush-Karakoram region and CKNP in specific, to experience rates up to 3.02ºC under the RCP 4.5 scenarios, and considerably higher winter temperatures up to 3.22ºC by mid-century. The impacts of these projections on the biodiversity of CKNP will have varying effects dependent on the ecosystem, as forests, agriculture and pastures are expected to experience higher productivity in the future, primarily due to extreme climatic conditions of higher temperatures and precipitation rates. While for resource systems such as Glaciers/water and Wildlife, the current trends of faster melt rates and increase in altitudinal shifts are expected to follow.

With regards to resource ecosystems, we observed that various resources have its own set of problems, with the locals possessing the knowledge but not having the necessary skills of adaptation and mitigation strategies to resolve them. It is interesting to analyse that what might be perceived to be an issue by the locals, is originating due to local use and unsustainable practices. For e.g. the problems related to drinking water, irrigation water supply and the threats of glacial lake outburst floods, are all linked to glacier ice extraction in Bagrote valley, where 30-45 persons would cut around 222 Kg of Ice, three times a week for three months (June, July, August) on average, for domestic use and commercial uses such as Ice creams, refrigerators in shops etc.

An underlying and/or distinguishing trait of each resource were revealed while analysing each ecosystem. For forests, it was observed that although the resource is prone to harvesting pressures and diseases, the growth of natural forests is projected to rise owing to rising temperatures, precipitation and the consequent photosynthetic capacity. The harvesting pressures are in return dependent on accessibility to natural forests, enforcement of customary laws/regulations and the availability of alternatives, while diseases are reliant on the growth of pests, which is itself dependent on rising temperatures.

As for Glaciers/water, although, a snowline shift has been observed, the glaciers in the Gilgit, Shigar and Shyok basins appear to be stable, with increase in total volumes observed in the Shigar and Shyok basins. In contrast, Hunza-Nagar basin has experienced a slight shrinkage since the last decade. Water being free to access, doesn't seem to affect the water availability for the livelihoods in the region, but the rising changes in land use, outdated customary laws and inward migrations, have and might lead to conflicts in the future. This research was able to identify a massive information gap in scientific literature, with respect to water discharge levels, water potential and pricing, glacial and water quality monitoring, as a database encompassing these, could greatly assist future researchers in determining the value of water and glaciers of the region.

With regards to wildlife and avian diversity, the species of Ibex and Markhor have been under the spotlight for the last few decades, due to their various uses and the demand of their trophy. The trophy hunting programme have been successful in conserving their populations in areas such as Haramosh and Hushe, but considerable downward trends have been experienced in valleys such as Hopar, Hispar and Ghulmat, owing to illegal hunting, predatory killings and diseases. The introduction of livestock insurance schemes has partially helped the cause but is prone to loopholes and lack of funds.

Agriculture and Livestock have been observed to be the primary sources of sustenance and livelihood for the communities, regardless of being in the core or buffer zone of the park. Due to low yields and crop infections/pests, many locals have undertaken the transition from sustenance towards cash crops and fruits such as Potatoes and Cherries. As for livestock, it is an essential livelihood source, but the trend of livestock rearing has declined considerably since the last decade due to lack of veterinary facilities and reallocation of priorities towards market jobs and education. This has reduced the overdependence of livestock on pastures, which were prone to overgrazing in the past, although, the local perceptions indicate that the status of pastures is still degrading in most valleys, which can be partially attributed to the communal nature of this ecosystem, and the non-implementation of customary laws. The diverse medicinal plants growing in these pastures have multiple uses, and a significant value, but the locals are unaware of their uses and economic significance. As for minerals, only 5% of the locals are predicted to exercise mining in CKNP's designated buffer zone. Although, a wide diversity of gemstones in the area exist, the miners still practice primitive mining techniques that has observed to lower the quality and values of these minerals.

As for the use-rights and associated customary laws, we saw that they're existing and having positive impacts on the conservation for some areas, but many valleys experience non-existence or non-implementation of these laws for many resources including forests, water, wildlife, pastures etc. The existing loopholes and the indigenous nature of these, requires a major revision and/or replacement with CKNP rules and guidelines, in order to align them to the existing dynamics of overpopulation and climate change. With regards to anthropogenic effects on the health of the park, it is apparent now that the human dependency and pressures on resources such as Forests for timber and fuelwood, Glaciers/Water for domestic and agricultural uses and Pastures for livestock rearing, is considerably high and will follow the same patterns, unless a transition towards effective use rights, alternative renewable sources and efficient frameworks/policies are in place. Hence, multi-tier assessment framework, specific to the region and in keeping with the community's social mores and appropriate indicators must be established in order to ensure proper measurement and tracking of progress of household practices and regulatory interventions.

Frameworks such as 'National Climate change policy' and 'Gilgit-Baltistan Climate strategy and action plan' should be revisited and catered for IPCC projections and the impacts of climate change on the various ecosystems, along with the changing dynamics arising out of the China Pakistan Economic corridor (CPEC). Moreover, studies on the projected impacts on the biodiversity due to major development projects such as CPEC should be undertaken, in order to inform priorities for the regulatory bodies and initiatives such as Environmental Impact Assessments (EIA). Integration and mainstreaming of climate change in the policy and development planning will help address the vulnerabilities facing the region.

Further research is required to determine the effects of for e.g. grazing on the productivity and quality of pastures or on natural forests regeneration. Future studies also need to study attitudinal shifts and perceptions of the community on areas of sustainable management of natural resources, in order to ensure a participatory approach while designing policy frameworks, and most importantly, in order to make interventions that makes them more responsible citizens and the guardians of their resource ecosystem. Adaptation and mitigation knowledge must be imparted to mountain communities, given their vulnerability in the face of climate change.

An additional gap in the present repository of literature is the non-availability of data on the status and impacts of climate change on various ecosystems across the park, may it be Wildlife, Forests or Pastures. At present, decisions on conservation are made without data-backed evidence, either due to a lack of methodological knowledge or expertise. These studies can help managers to undertake several challenges including assessing vulnerability and prioritizing key species and areas, based on the climate change impacts. A remotely sensed, bio-physical dataset that studies the link between climate change and biodiversity, needs to be formulated in order to design plans for benefit sharing payments of eco-system services.

Ecological baselines of ecosystems such as Forests and Pastures should be formulated in order to make way for studies striving to understand relationships such as the Phenological shift of the floral species and their impact on the biodiversity. Moreover, several adaptation and mitigation measures are needed to be taken for each resource ecosystems, in which sustainable management, infrastructure resilience, capacity building, institutional planning and stakeholder's participation might prove to be the key cross cutting themes.

Initiatives such as remote sensing to study land-use changes and constant monitoring of ecosystems through GIS for e.g. Glacier monitoring system, will ensure real-time data of the species and the ecosystem in which they exist, is available across to all segments, both to understand the spatial and temporal changes by researchers and for ensuring fully focused and appropriate interventions by the authorities in the future. Moreover, there exists a gap of ecosystem-based decision support tools that can be ensured through integrating climate change into quantitative and qualitative modelling of socio-ecological system dynamics. Hence, a dedicated research-driven collaboration focusing on hydrology, meteorology and glaciology for different climatic and elevational zones.

Data inhomogeneities at weather stations and related to manual recording of observations, station relocations and instrumentation might be causing distortions in the estimates of trends of key climatic parameters, as recorded by Pakistan Meteorological department and Water and Power Department Authority (WAPDA), and thus an upgrade and/or installation of automated weather stations is the need of the hour. This is extremely crucial, as all researchers conducting studies in the region are making projections based on climate data provided by these two institutions. Innovative initiatives, and outside-the-box approach is required for re-thinking life-supporting systems, like a shift from species to a more holistic ecosystem and landscape approach.

The biodiversity, its health and the ability to deliver economic services and goods are all hampered by the ack of interdisciplinary resources, governance mechanisms, cross-sectoral policies, consumption patterns of an increasing urban population demography. There is a need for concerted regional efforts across all levels, particularly in sharing best practices, experiences, and knowledge to develop a comprehensive strategy that provides a road map for the management of socio-ecological systems, which are heavily reliant on a constant flow of ecosystem service.

In the same vein, political leadership and policy makers across the region must be empowered and have an overarching and cross-disciplinary knowledge base. (Singh, Bassignana-Khadka, Karky, & Sharma, 2011) On the other side of the coin, policy advocacy, backed by research and evidence, should be pushed for across topics ranging from mitigation by the green sector, climate change adaptation and the resilience of ecosystems. It is fundamental to further bolster climate change research by improved modelling methods, biophysical observations; develop climate change adaptation and mitigation programmes driven by analyses and policy research. (Singh, Bassignana-Khadka, Karky, & Sharma, 2011)

Multiples IPCC projects all predict of increasing temperatures and precipitation rates, with winter and nighttime temperatures to rise relative to annual and summer temperatures across the Gilgit-Baltistan region and CKNP in specific. While increased rainfall could enhance land degradation through surface runoff, soil erosion and landslides, higher temperatures will temper the availability and productivity of multiple resources such a Forests, Glaciers, Pastures, Livestock and so on. (Hussain, Mudasser, Sheikh, & Manzoor, 2005)**.** Given the numerous projections pointing towards far-reaching and multi-level impact of climate change on biodiversity, it only means that the scientific community and ecologists must develop guidelines on curbing the biodiversity degradation and conservation strategies. (Jo, Alagador, Cabeza, Nogues-Bravo, & Thuiller, 2011)**.**

One of the salient features of conservation strategies is to spell out designs for reserve networks to support in-situ efforts for biodiversity conservation. Additionally, modelling methods for climate change predictions can inform future decisions around protected areas such as, location, layout, size, and potential risks for certain species (Jo, Alagador, Cabeza, Nogues-Bravo, & Thuiller, 2011)**.** In fact , protection efforts should be focused on locations and ecosystems that positively affect and regulate local climatic conditions such as forests, which are a haven for biodiversity. (Carnaval, Hickerson, Haddad, Rodrigues, & Moritz, 2008)

As mentioned earlier, there is also a need to re-think the very premise of biodiversity management with a shift from species-driven focus to a species interaction network, which also includes various aspects of biodiversity like phylogenetic framework and functionality (P.Dawson, T.Jackson, House, Prentice, & Mace, 2011)**.** There also needs to be a more robust implementation mechanism through better screening, risk assessments, early warning methods, and an integrated management approach in areas of alien species—will become more rampant in areas affected by climate change. (Bellard, 2012)

There is a consensus amongst all scientists and practitioners that biodiversity management will be affected by global climatic changes and hence, need adapting. Whether its about wildlife exploitation, challenges related to agronomy, competing ecosystems such as natural and agriculture for water, adaptation of cropping systems (Ziska, Blumenthal, Runion, Jr, & Diaz-Soltero, 2011), strategies to fight diseases and pest outbreaks, or improving infrastructure to address the food security issue, there needs to be a formulation and knowledge transfer of context based adaptive and mitigation strategies between the policy makers and the communities at the grass root level. (Harvell, et al., 2002)

Hence, future research and projections generating reliable datasets of ecological profiles of various ecosystems, working towards mountain resource ecosystems, will be vital sources for global studies on climate change. This will not only inform climate change impacts on various ecosystems but would provide a solid ground for predicting future scenarios. Therefore, it is crucial to have a better understanding of the biophysical processes taking place in and around the protected areas of the world, and most importantly, the Central Karakoram National Park, in order to inform sound decision making, risks and vulnerability assessments, and formulating the right adaptation and mitigation strategies, for the effective and sustainable conservation of our precious ecosystems across the globe.

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Appendix

Appendix – A

Intervieews list:
Central Karakoram National Park Directorate - Raja Abid Ali, Syed Yasir Abbas Rizvi
EV-K2-CNR - Riaz ul hasan, Ashiq Ahmed Khan, Aurangzeb Buzdar
International Centre for Integrated Mountain Development - Haris Ayub
Global Change Impact Studies Centre - Muhammad Arif Goheer
Pakistan Meteorological Department - Dr Zeenat Yasmin
National Agricultural Research Council - Dr ashiq Rabbani, Dr Sadar uddin

Sustainable Development and Policy Institute - Dr. Hina Aslam, Dr Vaqar Ahmed, Shakeel Ramay
Ministry of Climate Change - Malik amin, Naeem Ashraf
International Union for Conservation of Natural Resources (IUCN) - Saeed Abbas
UNDP - Irfanullah, Fawad Mir, Muhammad sohail, Amanullah
Mountain and Glacier Protection Organization - Ayesha khan
Karakoram International University - Dr Attaullah VC
University of Baltistan – Dr. Raza, Dr. Zafar, Dr. Qamar, Dr. Sher Wali Khan
Pakistan Council of Research in Water Resources (PCRWR) - Faizan ul hassan
Water and Power Development Authority - Sardaraz, Shahid hamid
Pakistan Wildlife foundation - Dr Waseem, Dr Safwan
Snow Leopard Foundation - Hussain ali
Himalayan wildlife foundation - Mr Sekhawat
REDD + - Muhammad Ismail
Pakistan Meteorological Department Gilgit - Mohammad Atif Wazir DD
Minerals, commerce, industries dept - Syed zulfiqar shah, Shahid hussain, zubair
Environmental Protection Agency Gilgit - Shahzad shigri, waqar, nasir, munawar
Agriculture Livestock Fisheries department - Khadim hussain
Aga Khan Rural Support Programme – Akhtar Ali
Pakistan Agricultural Research Council – Dr. Arshad Ashraf

QUESTIONNAIRE

GENERAL INFORMATION

1. **Name of Interviewee: ____________________Date: ___________________ Serial No:______**
2. **Village: ___________________ Valley: _________________ District: _________________**
3. **Name of Interviewer:_______________________ Occupation: _____________________**
4. **Age: ______ Gender: Male ☐ Female: ☐ Income: ________________________**

TIMBER-FUELWOOD

Which specie, purpose, quantity and price of trees do you harvest for domestic and commercial use?

Specie	Domestic/Commercial	Quantity/Yr.	Market Price

How much do you earn from harvesting timber yearly?

____

How much does it cost to grow or procure timber for all uses? E.g. seed, cutting, transportation etc.

____

In which season (summer, winter etc.), do you harvest timber the most? Mention month timeline.

____

Has the quantity/quality/price of Timber changed over the last 30 years? Reasons? Examples?
Quantity:____
Quality: ____
Price: ____

What are the threats facing the forests/trees in the village? E.g. Deforestation

____

Has the Climate (Temperature, Precipitation, Wind, Snowfall) affected the forest? Which and how?

____

What solutions do you propose for the sustainable use and management of this ecosystem?

____

NON-TIMBER FOREST PRODUCTS (Medicinal plants)

What types of non-timber products do you procure around the year?

Type	Quantity/Yr.	Market price	Purpose

How much do you earn from harvesting NTFPs yearly?

____

Has the quantity/quality/price of NTFPs changed over the last 30 years? Reasons? Examples
Quantity:____
Quality: ____
Price:____

What are the threats facing the NTFPs in the village? E.g. Deforestation

____

Has the Climate (Temperature, Precipitation, Wind, Snowfall) affected the NTFPs? Which and how?

____

What solutions do you propose for the sustainable use and management of this ecosystem?

____

WATER RESOURCES (Glaciers, Watershed)

How much water do you use for domestic/agricultural purposes? Monthly or Yearly

____

How much do you pay for using the water in your area? Monthly

____

How much does it cost to procure water on a monthly basis? E.g. Laying pipes, Maintenance etc.

____

Do you pay for electricity generated through hydro-powered stations? If yes, how much? Monthly

____

Which season is the most economically viable i.e. has the highest flow? Monthly timeline.

____

Has the quantity/quality of water increased/decreased in the past 30 years? Reasons? Examples?
Quantity:____
Quality:____

____

What are the threats facing the water resources? E.g. Pollution, Human pressures

____

Has the Climate (Temperature, Precipitation, Wind, Snowfall) affected the water resources? Which one and how?____

____

What solutions do you propose for the sustainable use and management of this ecosystem?

____

<u>WILDLIFE</u>

Which species and what quantities are found in this area?

Specie	**Quantity**

Which species do you harvest for domestic or commercial use?

Specie	**Purpose/Use**	**Market price**

How much do you earn from wildlife yearly? E.g. Sale of parts, Trophy hunting

____

Which species have moved in and out of the area in the last 30 years?

____

Does the sightings/availability/growth of species vary with various seasons (summer, winter)? How?

____

What are the threats facing the species in your village?

____

Has the Climate (Temperature, Precipitation, Wind, Snowfall) affected wildlife? Which one and

how?

___

What solutions do you propose for the sustainable use and management of this ecosystem?

___

AGRICULTURE (Subsistence/Cash Crops, Vegetables, Fruits)

Which crops and fruits do you grow, in what quantity and at what price do you sell in the market?

Type	Yield in season/kg/mann	Market Price/kg/mann

How much do you earn from harvesting Agri/fruit products yearly?

___

Which season is the most economically viable i.e. has the highest yield? Why? Month timeline.

___

Has the quantity (growth), quality and price changed over the lastt 30 years? Reasons? How much? Give examples.

Quantity: ___

Quality: ___

Price: ___

___

What are the threats facing the agricultural products? E.g. diseases

___

Has the Climate (Temperature, Precipitation) affected Agri-products in last 30 years? How?

___

What solutions do you propose for the sustainable use and management of this ecosystem?

___

LIVESTOCK – PASTURES

What are the types, quantities and market price of the livestock that you own? State for each type

Types	Quantity	Market Price

Which, what quantity and for how much do you sell livestock goods such as milk, meat, ghee etc.?

Livestock product	Quantity/kg	Market Price/kg

How much do you earn from Livestock and Livestock products yearly?

____

Has the quantity/quality of pastures and livestock changed in the last 30 years? How?
Livestock: ____
Pastures: ____
What are the threats facing the Livestock/pastures in your village?

____

Has the Climate (Temperature, Precipitation, Snowfall) affected Livestock/Pastures in the last 30 years? Which one and how?

____

What solutions do you propose for the sustainable use and management of this ecosystem?

____

MINERALS

What types, quantity and market price of Minerals do you or have harvested in the past?

Type/Name	Quantity/kg/	Market Price

How much do you or did you earn from these minerals monthly/yearly?

____

What are the threats facing the Mineral resources?

____

Has the Climate (Temperature, Precipitation, Snowfall, Wind, Cloud cover, Humidity) affected minerals in the last 30 years? Which one and how?

____

What solutions do you propose for the sustainable use and management of this ecosystem?

____

FOCUS GROUP DISCUSSION

General Information

1. Name of Interviewer: ____________________Date: ___________________ Serial No:___________
2. Village: ___________________ Valley: __________________ District: ________________________
3. No of People present: ____________ Total Population: _________ GPS coordinates: _____________

Timber-Fuelwood

Do you have any indigenous rights over the forest cover in the area? Customary laws?

____

How much of timber is located in your village?

____

What types of trees/timber are located in your village?

____

What are the various uses of timber generally practiced in your valley?

____

Do you have any rights over the timber you use?

____

What is the change in the quantity of timber in the last 30 years? How much and why?

____

What is the change in the quality of timber in the last 30 years? How much and why?

____

What is the change in the price of timber in the last 30 years? How much and why?

____

What are the threats facing the forest ecosystem?

____

How does seasonal variations affect the forest ecosystem?

____

Do you think climate variations such as temperature, precipitation, wind had an impact on forests?

____

What do you recommend to ensure the effective and sustainable utilization of this resource?

____

Non-Timber Forest Products (Medicinal Plants)

Do you have any indigenous rights over the NTFPs in the area? Customary laws

____

What types of NTFPs are located in your village?

____

How much of NTFPs is located in your village?

____

What are the various uses of NTFPs generally practiced in your valley?

____

What is the change in the quantity of NTFPs in the last 30 years? How much and why?

____

What is the change in the quality of NTFPs in the last 30 years? How much and why?

____

What is the change in the price of NTFPs in the last 30 years? How much and why?

____

What are the threats facing the NTFPs ecosystem?

____

How does seasonal variations affect the NTFPs ecosystem?

____

What do you recommend to ensure the effective and sustainable utilization of this resource?

____

Water resources (Glacier, Watershed)

What is the source of water in your area?

____

Which glaciers are located in your area?

____

Do you have any rights over the water you use?

___

Do you store water? How and for what uses?

___

What are the various uses of the available water resources in your area?

___

What is the change in the quantity/quality of water in the last 30 years? How much and why?

___

Is the availability of water affected by various seasons? Which season has the lowest/highest flow?

___

What are the threats facing the Water ecosystem? Climatic, Human induced, Other ecosystems

___

What do you recommend to ensure the effective and sustainable utilization of this resource?

___

<u>Wildlife</u>

Which species are present in your area? (Animals, birds, pollinators)

___

In what quantity are these species present in your area?

___

For which species is there a permit and for how much? (Big game and game birds)

___

How much is the fine for illegal hunting of a specie?

___

How much does each person benefit from trophy hunting? (80% community share)

___

Do you make any products out of these species? What exactly and from which species? For how much do you sell them in the market?

___

What is the change in the quantity/quality of wildlife in the last 30 years? How much and why?

___

What is the change in the price of permit/wildlife products in the last 30 years? How much and why?

___

What are the threats facing the wildlife ecosystem? Climatic, Human induced, Other ecosystems

___

How does seasonal variations affect the wildlife ecosystem?

___

What do you recommend to ensure the effective and sustainable utilization of this resource?

___

<u>Agriculture</u>

What types of crops do you grow in your area?

___

How much of wheat, potatoes, maize etc. is grown per HH in your village?

___

What are the single cropping and double cropping dynamics? If there was a shift, why?

___

What is the change in the quantity of Agri-products in the last 30 years? How much and why?

___

What is the change in the quality of Agri-products in the last 30 years? How much and why?

____

What is the change in the price of Agri-products in the last 30 years? How much and why?

____

What are the threats facing the Agri-products? Climatic, Human induced, Other ecosystems

____

How does seasonal variations affect the Agri-products ecosystem?

____

What do you recommend to ensure the effective and sustainable utilization of this resource?

____

Livestock

Which types of livestock do you own?

____

What is the average quantity of each type of livestock in the village?

____

How many households take part in animal husbandry?

____

What are the various uses of Livestock generally practiced in your valley?

____

What is the change in the quantity/quality of Livestock in the last 30 years? How much and why?

____

What is the change in the price of Livestock in the last 30 years? How much and why?

____

What are the threats facing the Livestock ecosystem? Climatic, Human Induced, Other ecosystems

____

How does seasonal variations affect the Livestock?

____

What do you recommend to ensure the effective and sustainable utilization of this resource?

____

Pastures

What products does the pastures provide?

____

What are the various uses of pasture products?

____

How often do you take livestock to pastures?

____

How much fees do you give to get access to these pastures?

____

If not fees, do you pay in-kind or barter? E.g. exchange of milk for x amount of grazing days

____

If free, how much would you be WTP to pay to access these pastures all year around? (% of income)

____

What is the change in the quantity of Pastures in the last 30 years? How much and why?

____

What is the change in the quality of Pastures in the last 30 years? How much and why?

____

What is the change in the price of Pastures in the last 30 years? How much and why?

____

What are the threats facing the Pastures ecosystem? Climatic, Human Induced, Other ecosystems

____

How does seasonal variations affect the Pastures ecosystem?

____

What do you recommend to ensure the effective and sustainable utilization of this resource?

____

Minerals

Which types of minerals are found in the area?

____

How many mining groups exist in the area?

____

In what quantities are the respective minerals found in the area?

____

What is the average market value of the minerals in the area?

____

What is income of each group early?

____

What is the change in the quantity/quality of Minerals in the last 30 years? How much and why?

____

What is the change in the price of Minerals in the last 30 years? How much and why?

____

What are the threats facing the Minerals ecosystem? Climatic, Human induced, Other ecosystems

____

How does seasonal variations affect the Minerals ecosystem?

____

What do you recommend to ensure the effective and sustainable utilization of this resource?

____

-

Climate variations

What is the change in the maximum/minimum temperature that you've noticed in the past 30 years? Future?

____

What is the change in the precipitation levels that you've noticed in the past 30 years? Future?

____

What is the change in wind speed and direction that you've noticed in the past 30 years? Future?

____

What is the change in the solar radiation that you've experienced in the past 30 years? Future?

____

What is the change in humidity levels that you've experienced in the past 30 years? Future?

____

What is the change in cloud cover that you've experienced in the past 30 years? Future?

____

What is the change in the snowfall-snowmelt that you’ve experienced in the past 30 years? Future?

____

Risks and hazards

Have the floods increased or decreased in the last 30 years? Future projections?

____

Have the landslides increased or decreased in the last 30 years? Future projections?

____

Have the avalanches increased or decreased in the last 30 years? Future projections?

____

Have any other natural disasters/disturbances affected the area in the past? Future projections?

____

<u>Society and Environmental change</u>

Has the rights and access to natural resources changed in the last 30 years?

____

Has there been conflicts over resources in the past? Which resources and why? Resolution how?

____

Has the traditional/indigenous knowledge and belief systems had an impact on decisions regarding use of natural resources?

____

How has the infrastructure development had an impact on the destruction, conservation and use of resources?

____

Which economic goods are the most economically significant and which ones are the most under threat from climate change in CKNP?

____

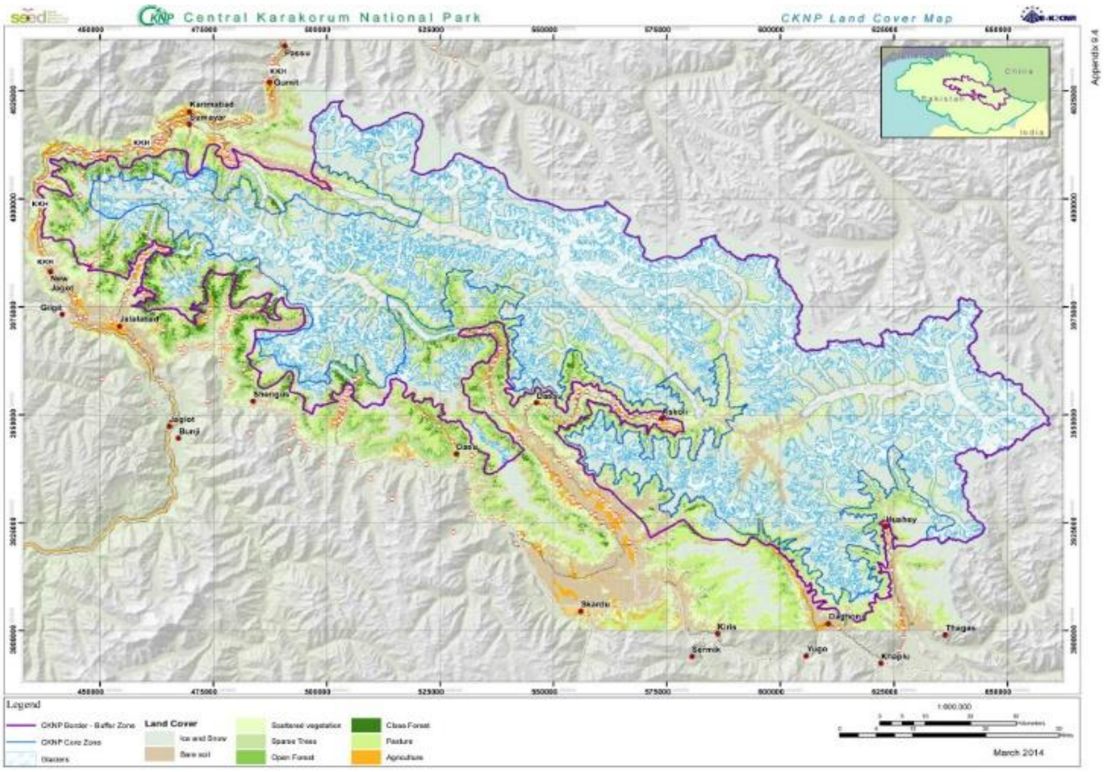
<u>Spiritual/Religious values</u>

Do people associate spiritual values with certain ecosystems in the valley?

____

Does culture influence the use and trends of natural resource practices in the valley?

____



Name of Valley	Water				Forest				Pastures				Medicinal Plants				Wildlife Hunting			
	Sustainable	Unsustainable			Sustainable	Unsustainable			Sustainable	Unsustainable			Sustainable	Unsustainable			Sustainable	Unsustainable		
		L	M	H		L	M	H		L	M	H		L	M	H		L	M	H
Nagar	✓	-	-	-	-	✓	-	-	-	-	✓	-	✓	-	-	-	✓	-	-	-
Ghulmat	✓	-	-	-	-	-	-	✓	-	-	✓	-	✓	-	-	-	-	-	✓	-
Danyore	-	✓	-	-	-	-	✓	-	-	-	✓	-	✓	-	-	-	-	-	✓	-
Haramosh	-	✓	-	-	-	-	✓	-	-	-	✓	-		-	-	-	-	-	✓	-
Astak	✓	-	-	-	-	-	-	✓	-	-	-	✓	✓	-	-	-	-	✓	-	-
Tormik	✓	-	-	-	-	-	✓		-	-	-	✓	✓	-	-	-	-	-	✓	-
Lower Braldo	✓	-	-	-	-	-	-	✓	-	-	✓	-	✓	-	-	-	-	-	✓	-
Upper Braldo	✓	-	-	-	-	-	-	✓	-	-	-	✓	✓	-	-	-	-	-	✓	-
Shigar	✓	-	-	-	-	-	-	✓	-	-	-	✓	✓	-	-	-	-	✓	-	-
Thalay	✓	-	-	-	-	-	-	✓	-	-	-	✓	✓	-	-	-	-		✓	-
Daghoni	✓	-	-	-	-	✓	-	-	-	-	✓	-	✓	-	-	-	-	✓	-	-

- Nil, L=Low, M= Medium, H=High

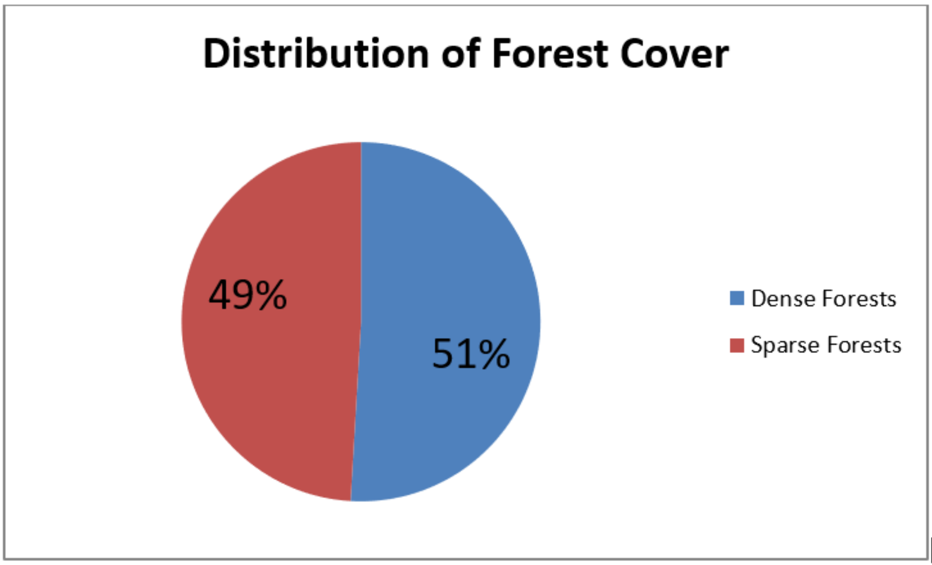
Appendix - B

Distribution of forest area in different districts

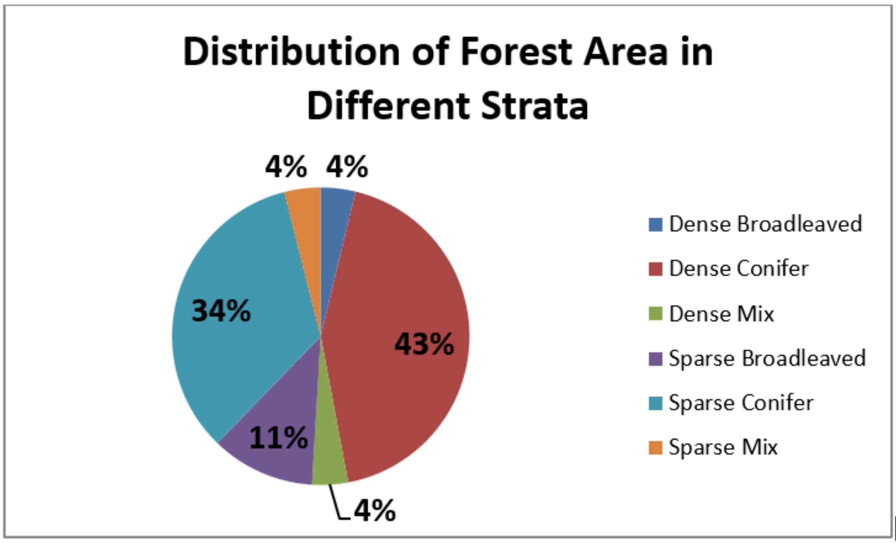
Gilgit-Baltistan comprises of 10 districts. Diamer has the highest forest cover (71%) followed by Astore (12%) and Gilgit (10%). These three districts together contain 93% of the total forest area of Gilgit Baltistan. Ghizer, Nagar and Skardu districts have 2.5%, 1.86% and 1.12% forest area respectively. The district-wise distribution of forest area is given in the following table:

District	Forest Area	%age
Diamer	177,324	71.16
Astore	30,018	12.05
Gilgit	25,399	10.19
Ghizer	6,314	2.53
Nager	4,644	1.86
Skardu	2,793	1.12
Hunza	382	0.15
Ghanche	429	0.17
Shiger	1,354	0.54
Kharmang	548	0.22
Total	**249,205**	**100**

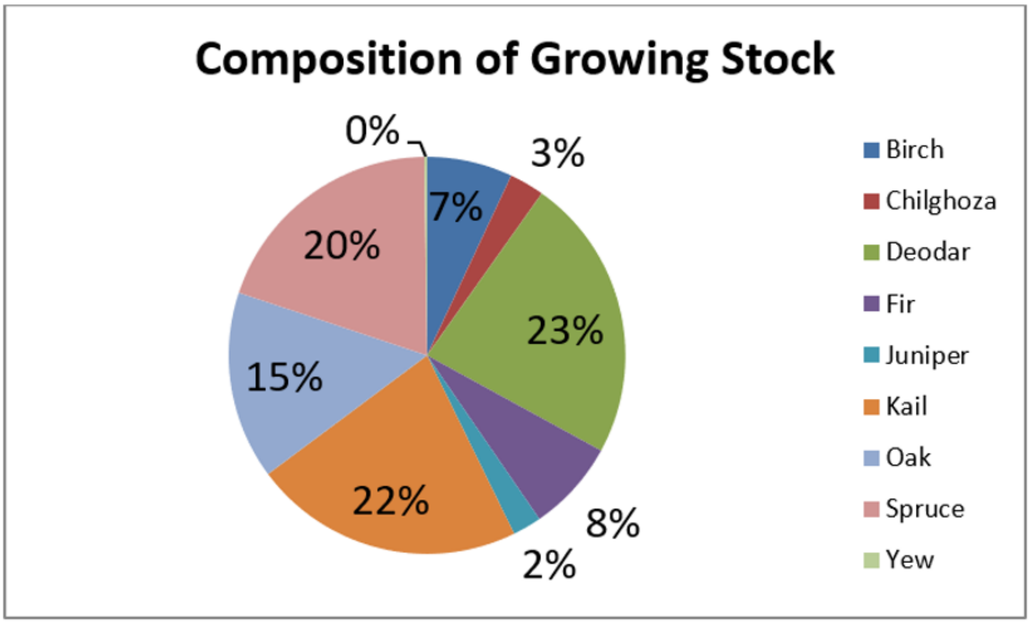
In the study conducted by the GB's Forest, Wildlife and Environment department to determine the forest inventory and the carbon stocks in the forest of Gilgit-Baltistan, it was concluded that about 51 % (126,927 ha) of the forests are dense forests, having a canopy cover of greater than 35%. On the other hand, about 49% (122,277 ha) are sparse forests which have crown density of less than 35%, as shown in the figure below:



The highest amount of forest cover falls under the dense coniferous class (43%) followed by sparse conifers (34%) and sparse broad-leaved forest (11%). The remaining forest cover consists of dense mix, dense broad-leaved and sparse mixed forests each having 4% cover, denoted by the figure below:



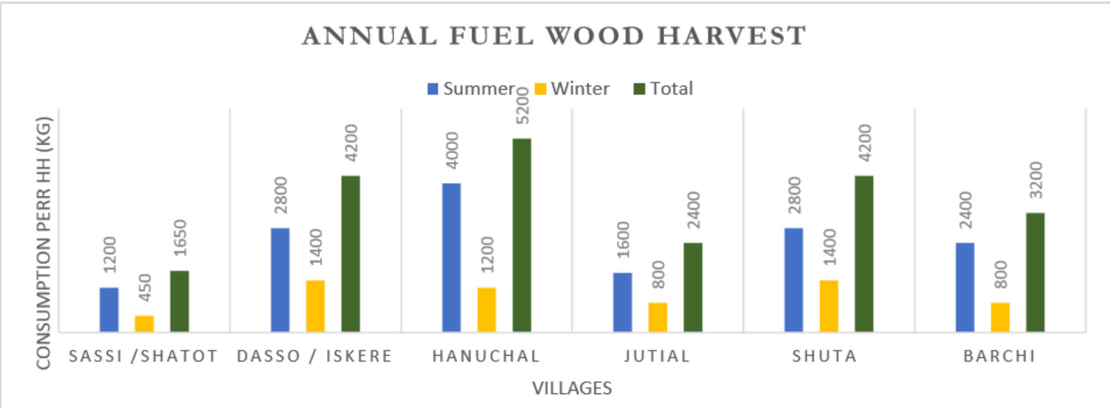
As for the total growing stock, Deodar (Cedrus deodara) is the dominant specie (23%), followed by Kail (Pinus wallichiana) with 22%, 20% of Spruce (Picea smithiana) and Fir (Abies pindrow) having a 7% share. Thus, 72% of the total growing stock consists of these four species. Juniper and Chilghoza have small proportions in total number of trees with 2.34% and 2.84% shares, respectively. Thus, it is clear from the data that the forests of Gilgit Baltistan have relatively less diversity of tree species. About 78% of the total growing stock consists of conifers and only 22% are broad-leaved species as shown below:



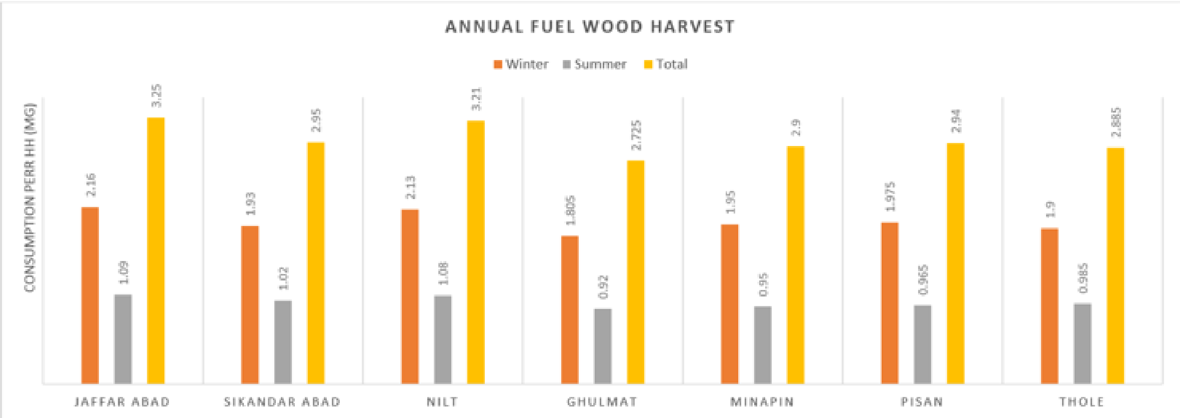
The results of the inventory indicate that the forests of Gilgit Baltistan are mostly young. About 65% of the trees are considered immature, followed by a sub-mature class of 27.5% sample trees. This mean that about 93% of the trees are young and only 7 % of the sample trees are mature. Therefore, the prospects of higher levels of carbon sequestration increase, as younger species can sequester a higher amount of carbon at faster rates. The carbon stocks sequestered in the forests of

GB has been estimated at 16.95 million ton, with 80% of the carbon stock being aboveground and 20% belowground, according to a carbon stock study conducted by the Forest, Wildlife and Environment department.

Village	Houses constructed in last 5 years (2010-2015)	Number of trees used	Tree species used
Sassi /Shatot	75	4	Pine, Juniper, Blue pine
Dasso / Iskere	70	10	Pine, Blue Pine
Hanuchal	5	2	Pine
Jutial	7	5	Pine
Shuta	10	3	Pine
Barchi	60	4	Pine



Village	Houses constructed in last 5 years (2010-2015)	Number of trees used	Tree species used
Jaffar Abad	25	05	Poplar, Mulberry, Willow
Sikandar Abad	225	05	Poplar, Mulberry, Willow
Nilt	25	05	Poplar, Mulberry, Willow
Ghulmet	25	03	Poplar, Walnut
Minapin	20	04	Poplar
Pisan	30	04	Poplar, Walnut
Thole	30	04	Poplar

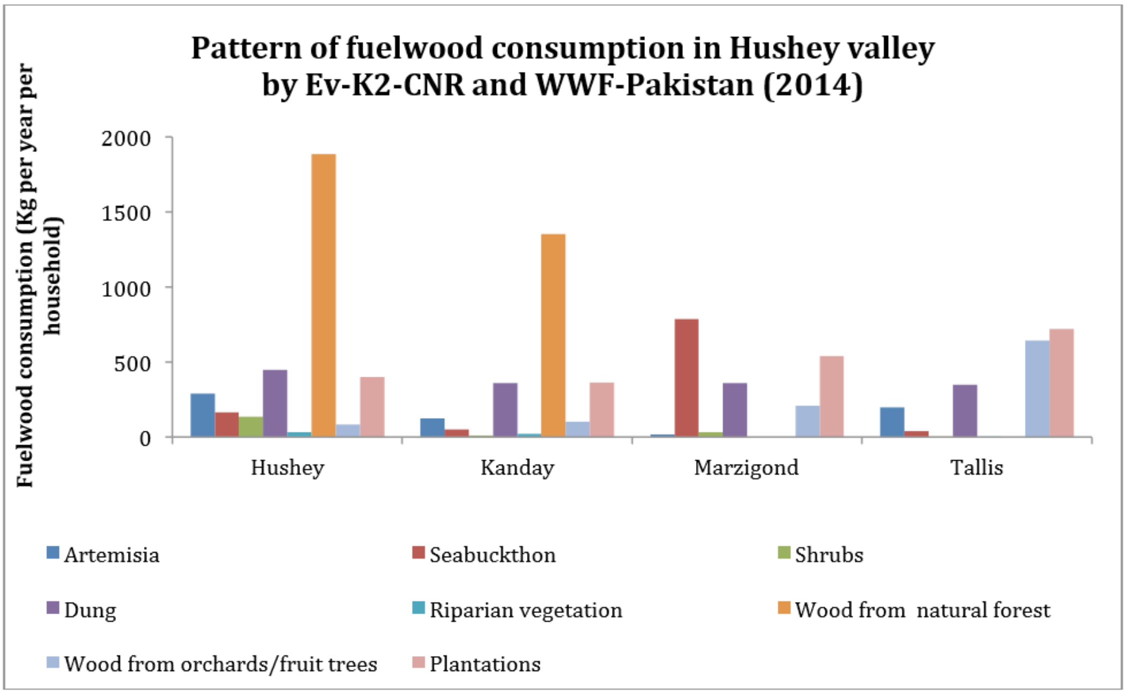


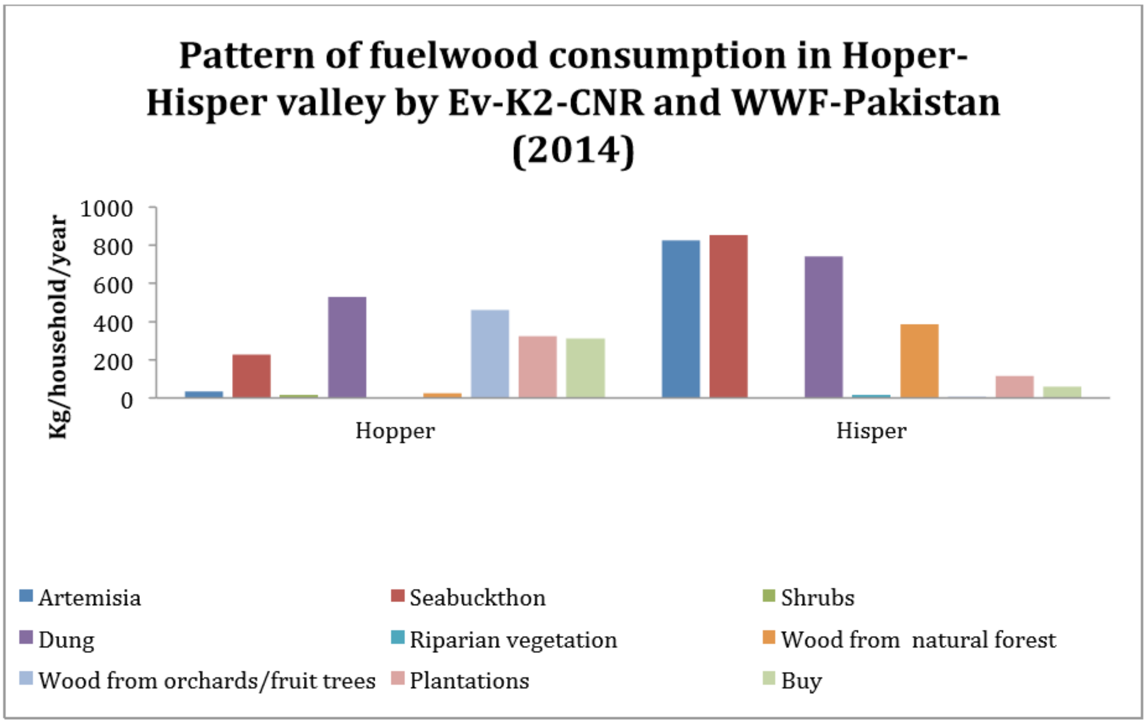
Village	Houses constructed in last 5 years (2010-2015)	Number of trees used	Tree species used
Askurdas	200	50	White Poplar , Juniper
Miacher	55	30	White Poplar, Mulberry ,Juniper
Shayar	25	40	White Poplar,
Sumayar	100	250	White Poplar, Walnut
Phakar	150	220	White Poplar,
Hakuchar	15	80	White Poplar,
Proper Nagar	250	475	White Tree, Mulberry, Juniper, Walnut

Village	HH	Consumption Per Household (Mg yr^{-1})			Consumption Per Village (Mg yr^{-1})		
		Winter	Summer	Total	Winter	Summer	Total
Askurdas	450	1.29	0.65	1.94	580.5	292.5	873
Miacher	250	1.2	0.8	2	300	200	500
Shayar	120	1.6	0.6	2.2	192	72	264
Sumayar	820	1.4	0.8	2.2	1148	656	1804
Phakar	512	1.2	0.8	2	614.4	409.6	1024
Hakuchar	80	1.2	0.8	2	96	64	160
Proper Nagar	1200	1.25	0.77	2.02	1500	924	2424

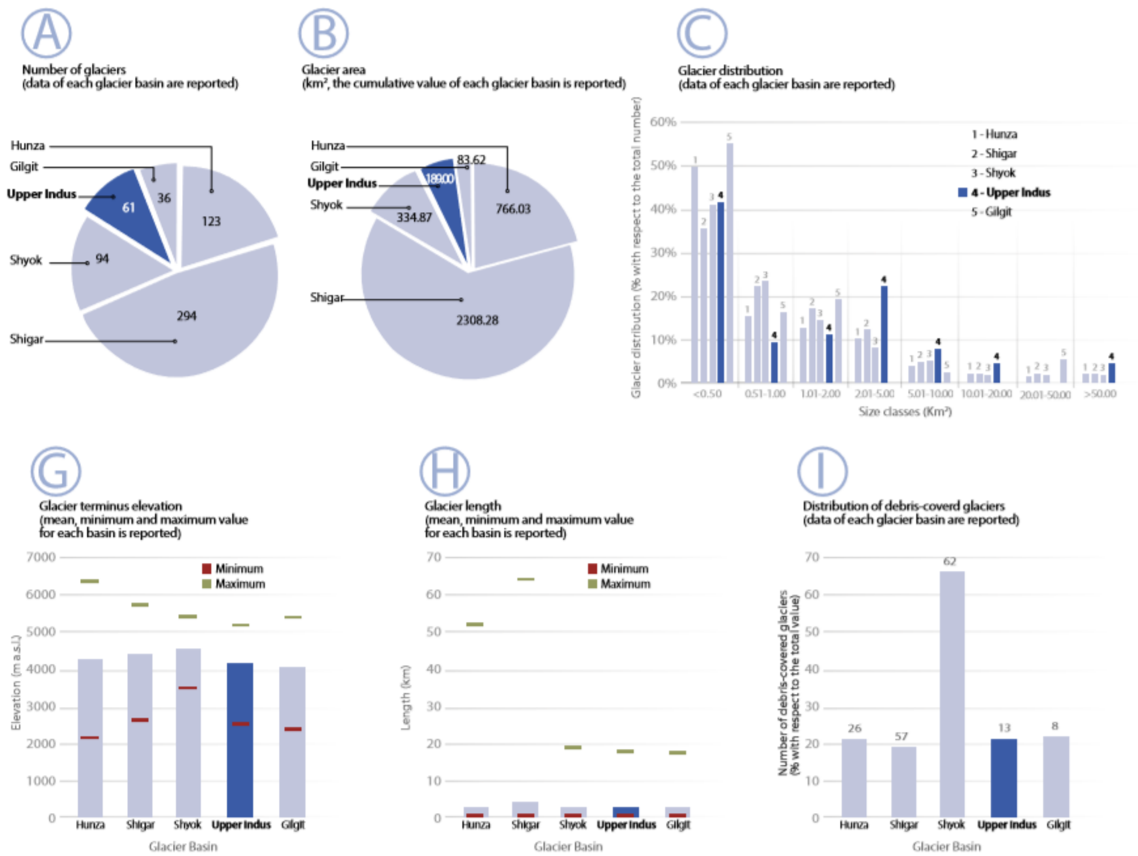
Village	Timber consumed on construction of houses in the last five years		Species used for timber	From where timber was collected
	Number of logs	Volume (CFT)		
Hoper	4410 timber logs and 381	16,769 CFT	Kail, Spruce, Deodar, Popular and Willow	Local market and/or used from their own plantation
Hisper	917 timber logs and 106 patawa	12,805 CFT	Kail, Juniper, and Popular	the local market and/or used from their own plantation.

Village	Timber consumed on construction of houses in the last five years	
	Number of logs	Volume (CFT)
Hushey	1434	5019
Kanday	990	3465
Marzigond	273	956
Tallis	759	2656



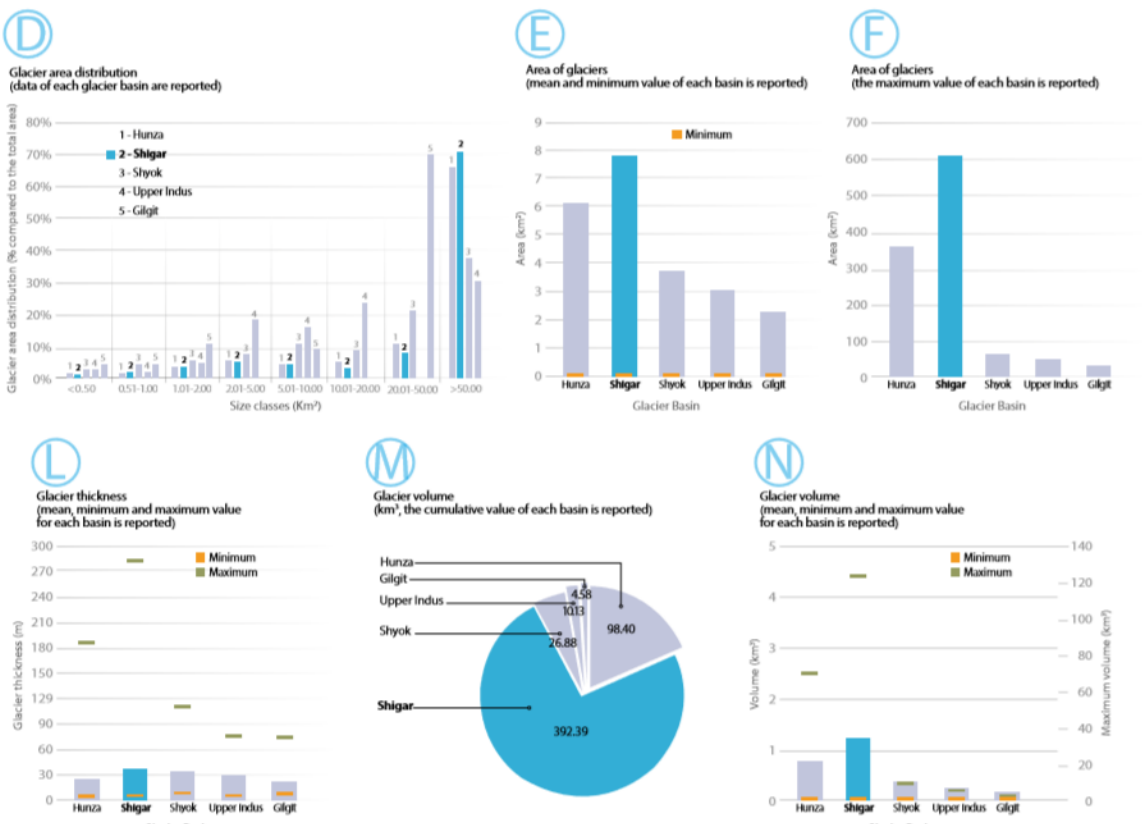

Pattern of fuelwood consumption in Hoper-Hisper valley by Ev-K2-CNR and WWF-Pakistan (2014)
Kg/household/year
1000
800
600
400
200
0
Hopper
Hisper
Artemisia
Seabuckthon
Shrubs
Dung
Riparian vegetation
Wood from natural forest
Wood from orchards/fruit trees
Plantations
Buy

APPENDIX- C


A
Number of glaciers
(data of each glacier basin are reported)
Hunza
Gilgit
Upper Indus
Shyok
Shigar
61
36
123
94
294
B
Glacier area
(km², the cumulative value of each glacier basin is reported)
Hunza
Gilgit
Upper Indus
Shyok
Shigar
83.62
189.00
766.03
334.87
2308.28
C
Glacier distribution
(data of each glacier basin are reported)
Glacier distribution (% with respect to the total number)
1 - Hunza
2 - Shigar
3 - Shyok
4 - Upper Indus
5 - Gilgit
Size classes (Km²)
G
Glacier terminus elevation
(mean, minimum and maximum value for each basin is reported)
Elevation (m a.s.l.)
Minimum
Maximum
Hunza
Shigar
Shyok
Upper Indus
Gilgit
Glacier Basin
H
Glacier length
(mean, minimum and maximum value for each basin is reported)
Length (km)
Minimum
Maximum
Hunza
Shigar
Shyok
Upper Indus
Gilgit
Glacier Basin
I
Distribution of debris-coverd glaciers
(data of each glacier basin are reported)
Number of debris-covered glaciers (% with respect to the total value)
26
57
62
13
8
Hunza
Shigar
Shyok
Upper Indus
Gilgit
Glacier Basin

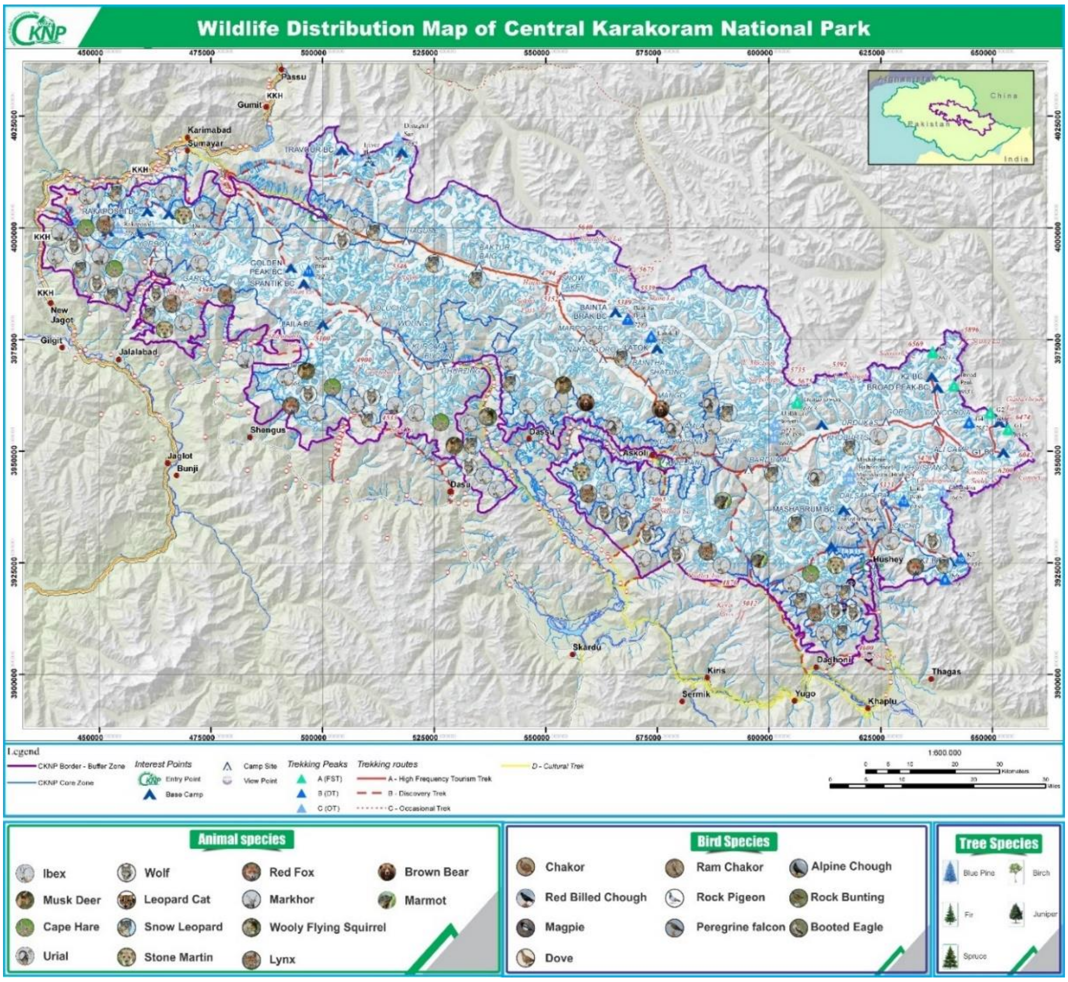
Size class (km²)	2001 Area		2010 Area		Δ2001-2010	
	km²	%	km²	%	km²	%
<0.5	26.21	1.1%	26.18	1.1%	-0.03	-0.001%
0.5–1.0	46.24	2.0%	46.29	2.0%	+0.05	+0.002%
1.0–2.0	76.69	3.3%	76.6	3.3%	-0.09	-0.004%
2.0–5.0	118.43	5.1%	119.7	5.2%	+1.27	+0.055%
5.0–10.0	106.88	4.6%	107.23	4.6%	+0.35	+0.015%
10.0–20.0	86.77	3.8%	89.3	3.9%	+2.53	+0.110%
20.0–50.0	213.89	9.3%	213.75	9.3%	-0.14	-0.006%
>50.0	1633.17	70.8%	1629.55	70.6%	-3.62	-0.157%
Total	**2308.28**	**100.0%**	**2308.60**	**100.0%**	**+0.32**	**+0.014%**

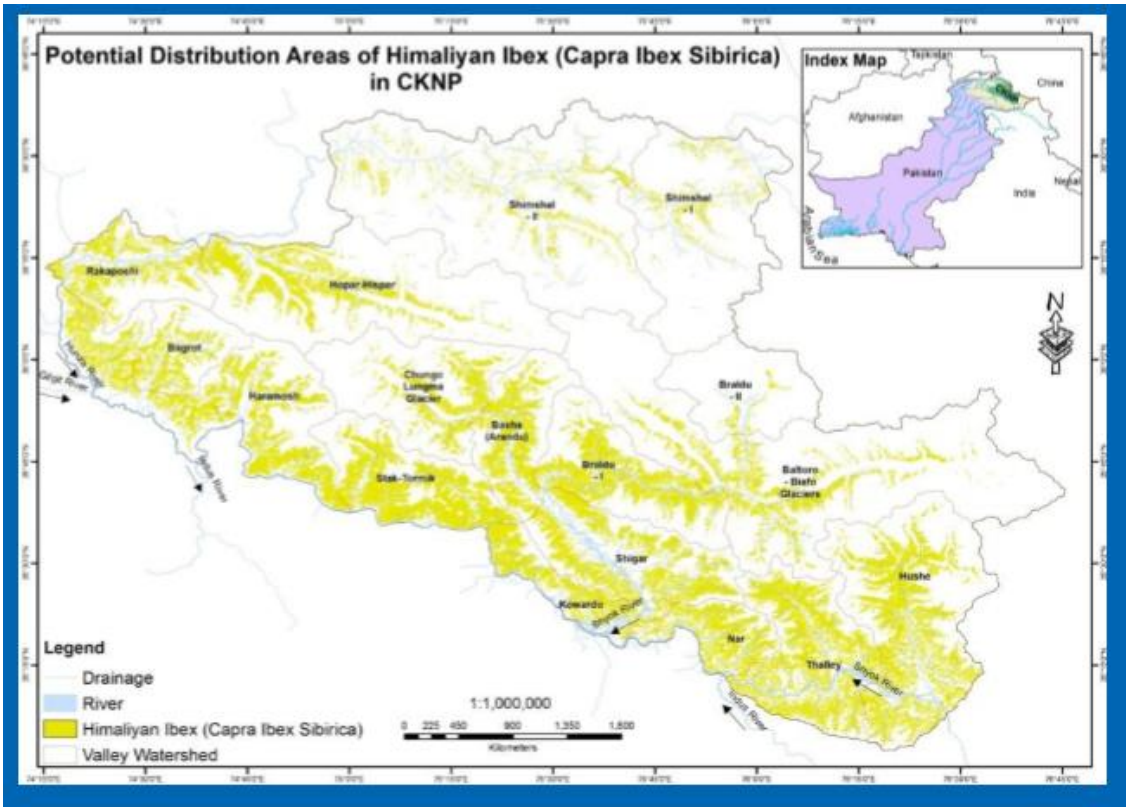
Table 1: Glacier coverage in 2001 and 2010 and glacier area change in the time window 2001-2010 (km²) sorted according to 2001 size classes, and reported also as percentage (%) calculated with respect to their total values.

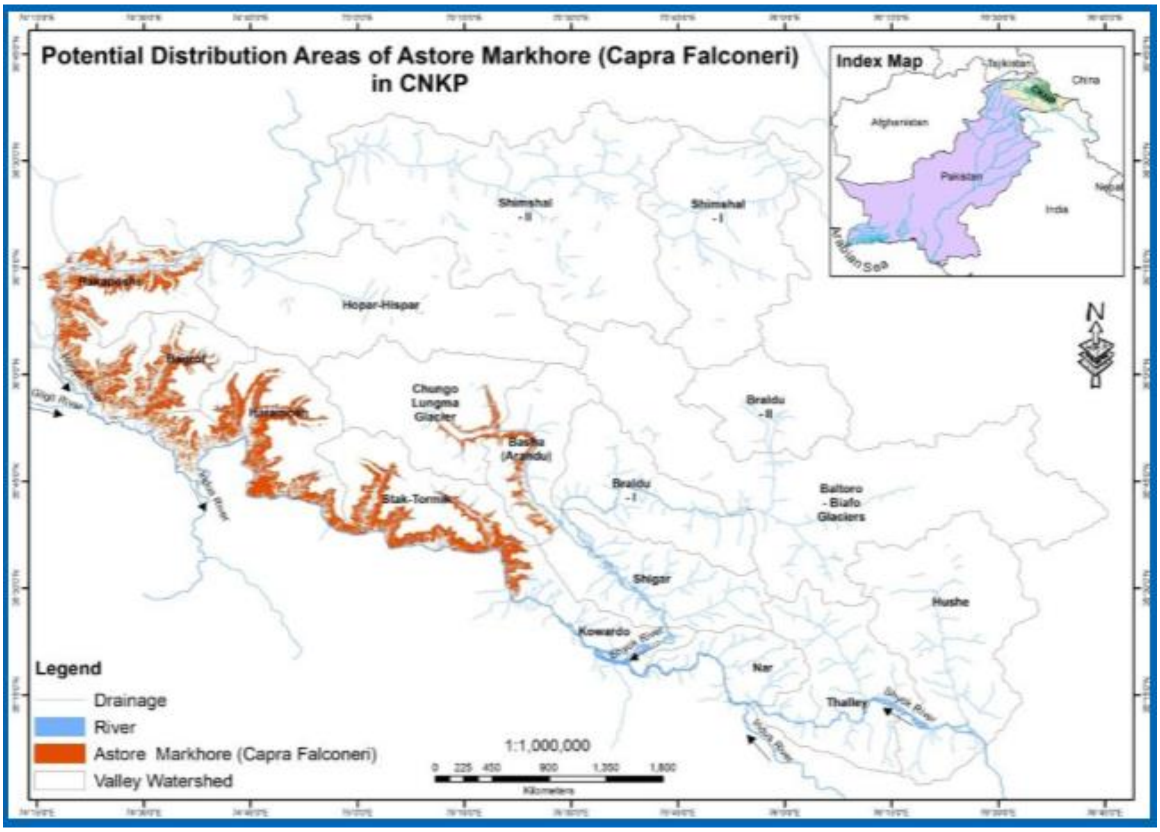


Source/Facilities	Name of Location	GPS Coordinate (UTM WGS84)	Elevation (m a.s.l.)	Used by No households	Administrative Units	Type of water Water Courses (Spring, Gl.)	Water condition
Spring	Chubagin nallah	74°34'0.28"E, 36° 2'52.75"N	2729	240	Bagrote UC	Spring	Clear
Pipe line	Chubagin nallah	74°33'5.19"E, 36° 1'47.51"N	2495				Clear
Water tap	Bulchi Bala	74°33'5.50"E, 36° 1'34.76"N	2318				Clear
Reservoir	• Reservoir small (near source) • Main reservoir	74°34'0.85"E, 36° 2'52.10"N 74°33'5.19"E, 36° 1'47.51"N	2746 2495				Clear

Appendix- D




Potential Distribution Areas of Himaliyan Ibex (Capra Ibex Sibirica) in CKNP
Index Map
Legend
Drainage
River
Himaliyan Ibex (Capra Ibex Sibirica)
Valley Watershed
1:1,000,000
Rakaposhi
Hopar Hispar
Bagrot
Haramosh
Chungo Lungma Glacier
Basha (Arandu)
Braldu - I
Braldu - II
Stak-Tormik
Baltoro - Biafo Glaciers
Shigar
Hushe
Kowardo
Nar
Thalley
Shimshal - II
Shimshal - I


Potential Distribution Areas of Astore Markhore (Capra Falconeri) in CNKP
Index Map
Legend
Drainage
River
Astore Markhore (Capra Falconeri)
Valley Watershed
1:1,000,000
Rakaposhi
Hopar-Hispar
Bagrot
Haramosh
Chungo Lungma Glacier
Basha (Arandu)
Braldu - I
Braldu - II
Stak-Tormik
Baltoro - Biafo Glaciers
Shigar
Hushe
Kowardo
Nar
Thalley
Shimshal - II
Shimshal - I

VALLEY WISE RESULTS OF WINTER WILDLIFE SURVEY IN CENTRAL KARAKORAM NATIONAL PARK GILGIT-BALTISTAN (DECEMBER 01 to 14 2018)

Mountain ungulates (Himalayan Ibex, Markhor, Ladakh Urial)

Himalayan Ibex survey has been conducted in 21 potential sites and sighted 2086 individuals, while Markhor survey has been conducted in all 6 habitat sites of CKNP and sighted 111 individuals. Hence the total No of ungulates cited in CKNP during the current survey is 2197.

S. No	Valley/Sub valley	Number of individuals/Group Composition						
		Male	Female	Yearling	Kids	ND	Total	Trophy Size
A		**HIMALAYAN IBEX**						
		DISTRICT GHANCHE						
1.	Hushey	91	94	51	106	39	383	38
2.	Kanday	19	21	19	23	-	82	12
3.	Thalay	33	41	17	30	4	125	12
4.	Kharkoo	8	9	2	7	0	26	2
Sub Total Ghanche		**151**	**165**	**89**	**166**	**43**	**616**	**64**
		DISTRICT SHIGAR						
5.	Upper Braldo Dumurdo Areas	48	102	27	34	-	211	5
6.	Upper Braldo Biafo Areas	62	115	37	45	-	259	13
7.	Upper Braldo Jula-Paju Areas	13	18	10	15	-	56	-
8.	Basha-Arindu	109	128	20	44		301	7
Sub Total Shigar		**232**	**363**	**94**	**138**		**827**	**25**
		DISTRICT SKARDU						
9.	Tormik	22	23	15	10	-	70	4
10.	Baghicha &Khomera	31	23	15	14	-	84	8
11.	Astak	6	5	2	3	-	16	-
Sub Total Skardu		**59**	**51**	**32**	**27**		**170**	**12**
		DISTRICT GILGIT						
12.	Upper Haramosh	14	22	7	-	-	43	8
13.	Bagrote	11	25	7			43	5

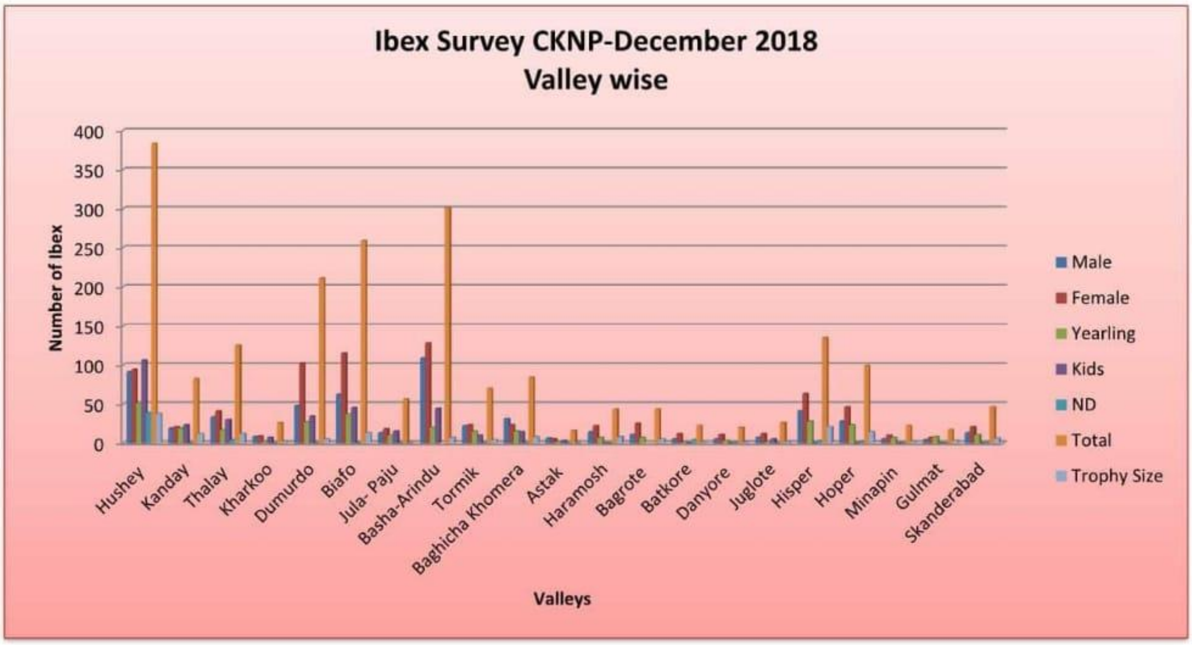
CKNP 2

CKNP Winter Wildlife Survey-December 2018

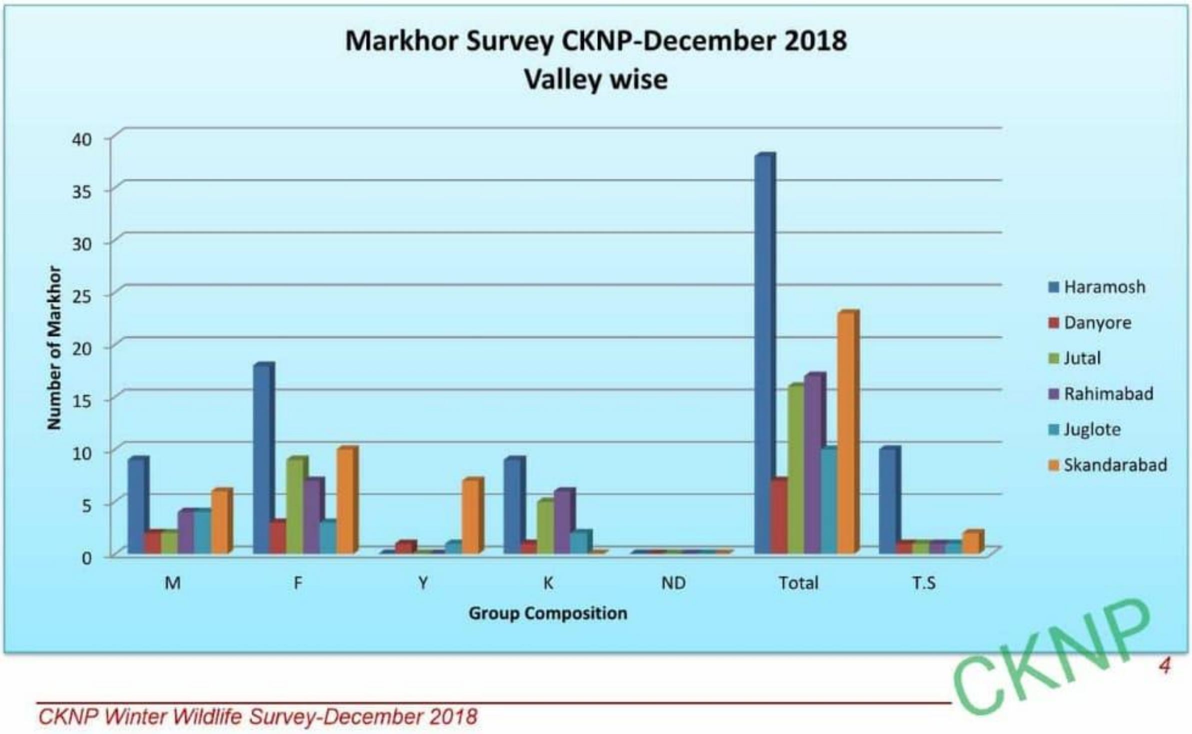
14.	Batkore	5	12	1	-	4	22	1
15.	Danyore	5	11	3	-	1	20	1
16.	Juglote	7	12	2	5	-	26	2
Sub Total Gilgit		**42**	**82**	**20**	**5**	**5**	**154**	**17**
DISTRICT NAGAR								
17.	Hisper	41	63	28	-	3	135	21
18.	Hoper	28	46	23	-	2	99	14
19.	Minapin	5	10	7	-	-	22	2
20.	Gulmat	4	7	8	-	-	17	3
21.	Skanderabad	13	21	11	-	1	46	6
Sub Total Nagar		**91**	**147**	**77**	**-**	**6**	**319**	**46**
Grand Total Ibex CKNP		**575**	**808**	**312**	**336**	**54**	**2086**	**164**
B	**MARKHOR**							
DISTRICT GILGIT								
1.	Haramosh lower	9	18	-	9	-	38	10
2.	Danyore	2	3	1	1	-	7	1
3.	Jutal	2	9	-	5	-	16	1
4.	Rahimabad	4	7	-	6	-	17	1
5.	Juglote	4	3	1	2	-	10	1
Sub Total Gilgit		**21**	**40**	**2**	**23**	**-**	**88**	**14**
DISTRICT NAGAR								
6.	Skandarabad	6	10	7	-	-	23	2
Sub Total Nagar		**6**	**10**	**7**	**-**	**-**	**23**	**2**
Grand Total CKNP		**27**	**50**	**9**	**23**	**-**	**111**	**16**

*(Note: *ND-Not determined)*

GRAPHS:



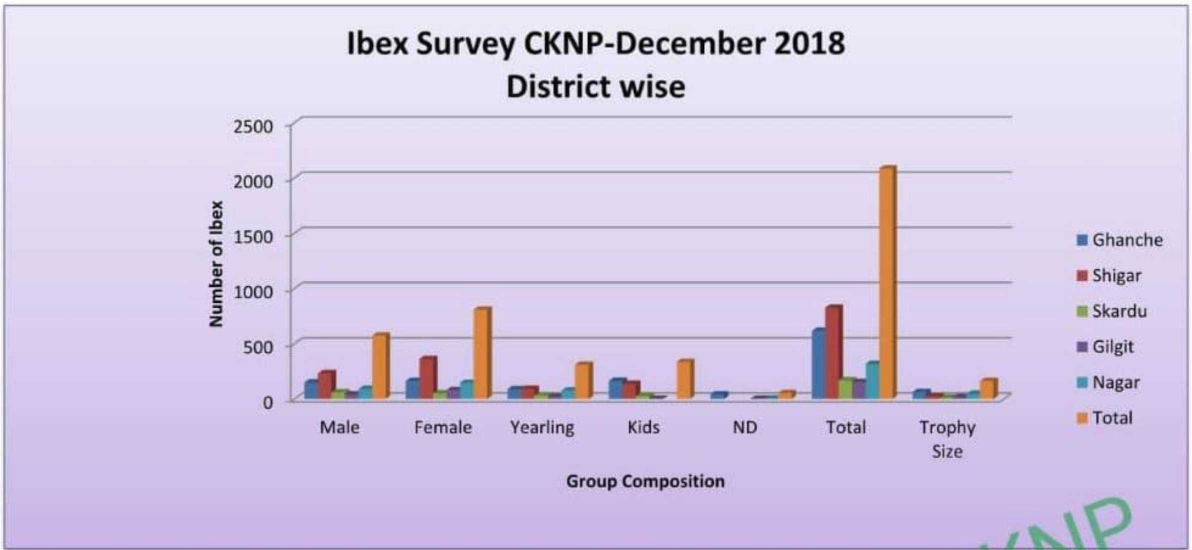
Ibex Survey CKNP-December 2018
Valley wise
Number of Ibex
400
350
300
250
200
150
100
50
0
Hushey
Kanday
Thalay
Kharkoo
Dumurdo
Biafo
Jula- Paju
Basha-Arindu
Tormik
Baghicha Khomera
Astak
Haramosh
Bagrote
Batkore
Danyore
Juglote
Hisper
Hoper
Minapin
Gulmat
Skanderabad
Valleys
Male
Female
Yearling
Kids
ND
Total
Trophy Size



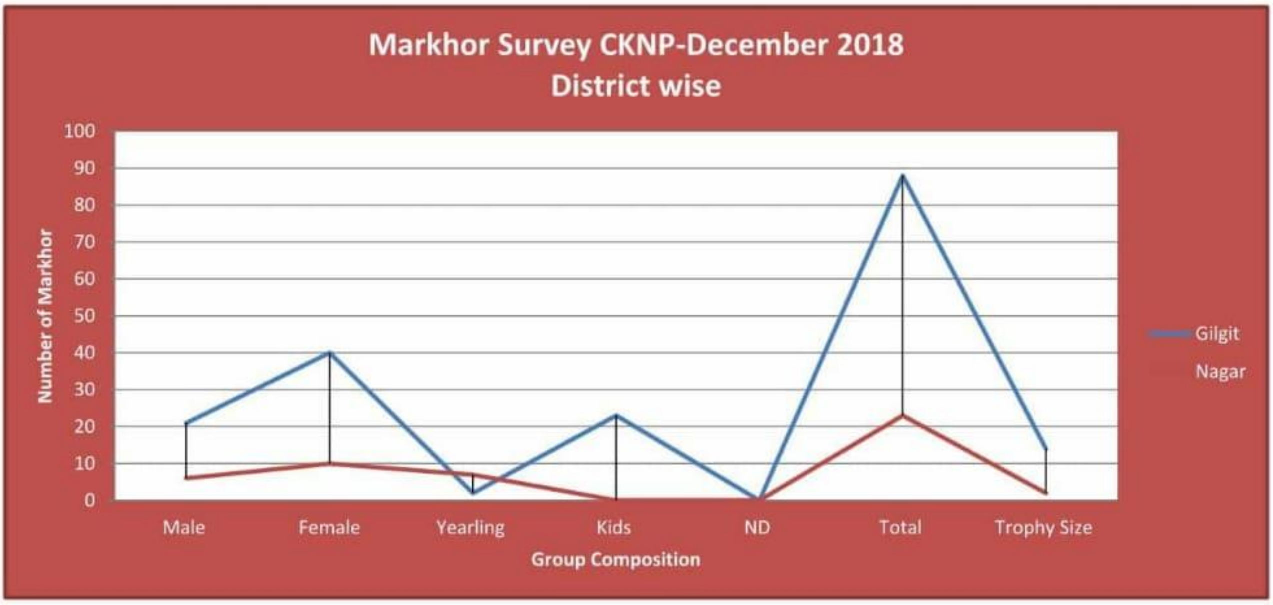
Markhor Survey CKNP-December 2018
Valley wise
Number of Markhor
40
35
30
25
20
15
10
5
0
M
F
Y
K
ND
Total
T.S
Group Composition
Haramosh
Danyore
Jutal
Rahimabad
Juglote
Skandarabad
CKNP
4
CKNP Winter Wildlife Survey-December 2018

DISTRICT WISE RESULTS OF WINTER WILDLIFE SURVEY IN CENTRAL KARAKORAM NATIONAL PARK GILGIT-BALTISTAN (DECEMBER 01 to 14 2018)								
S. No	**Valley/Sub valley**	**Number of individuals/Group Composition**						
		Male	**Female**	**Yearling**	**Kids**	**ND**	**Total**	**Trophy Size**
A		**HIMALAYAN IBEX**						
1.	Ghanche	151	165	89	166	43	616	64
2.	Shigar	232	363	94	138	-	827	25
3.	Skardu	59	51	32	27	-	170	12
4.	Gilgit	42	82	20	5	5	154	17
5.	Nagar	91	147	77	-	6	319	46
Grand Total CKNP		**575**	**808**	**312**	**336**	**54**	**2086**	**164**
B		**MARKHOR**						
1.	Gilgit	21	40	2	23	-	88	14
2.	Nagar	6	10	7	-	-	23	2
Grand Total CKNP		**27**	**50**	**9**	**23**	-	**111**	**16**

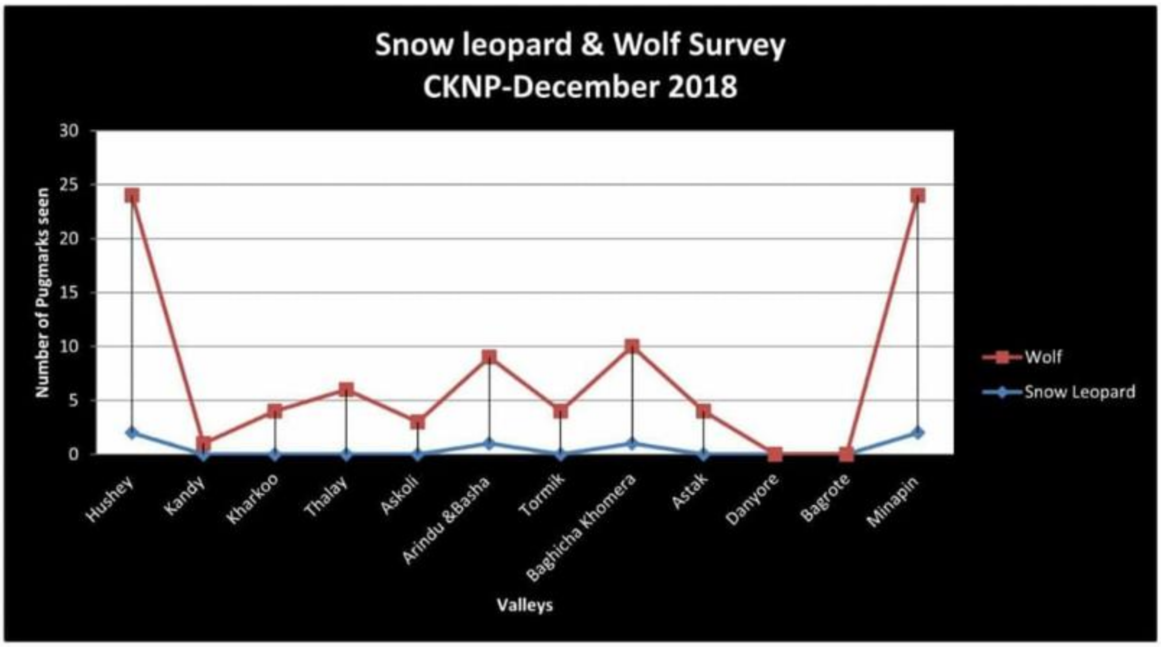
GRAPHS:



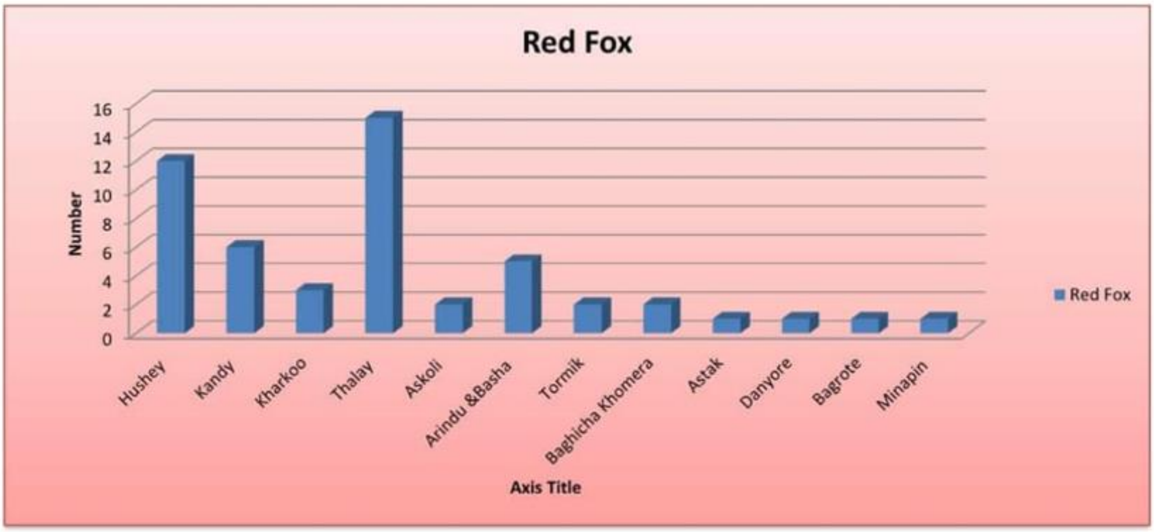
CKNP



CARNIVORES OBSERVATIONS			
S. No	Valley	Species	
		Snow Leopard (Pugmarks)	Wolf (Pugmarks)
1.	Hushey	2	22
2.	Kandy	-	1
3.	Kharkoo	-	4
4.	Thalay	-	6
5.	Askoli		3
6.	Arindu &Basha	1	8
7.	Tormik		4
8.	Baghicha Khomera	1	9
9.	Astak	-	4
10.	Danyore	-	-
11.	Bagrote	-	-
12.	Minapin	2	22
	Total	**4**	**61**



Snow leopard & Wolf Survey
CKNP-December 2018
Number of Pugmarks seen
30
25
20
15
10
5
0
Hushey
Kandy
Kharkoo
Thalay
Askoli
Arindu &Basha
Tormik
Baghicha Khomera
Astak
Danyore
Bagrote
Minapin
Valleys
Wolf
Snow Leopard



Red Fox
Number
16
14
12
10
8
6
4
2
0
Hushey
Kandy
Kharkoo
Thalay
Askoli
Arindu &Basha
Tormik
Baghicha Khomera
Astak
Danyore
Bagrote
Minapin
Axis Title
Red Fox

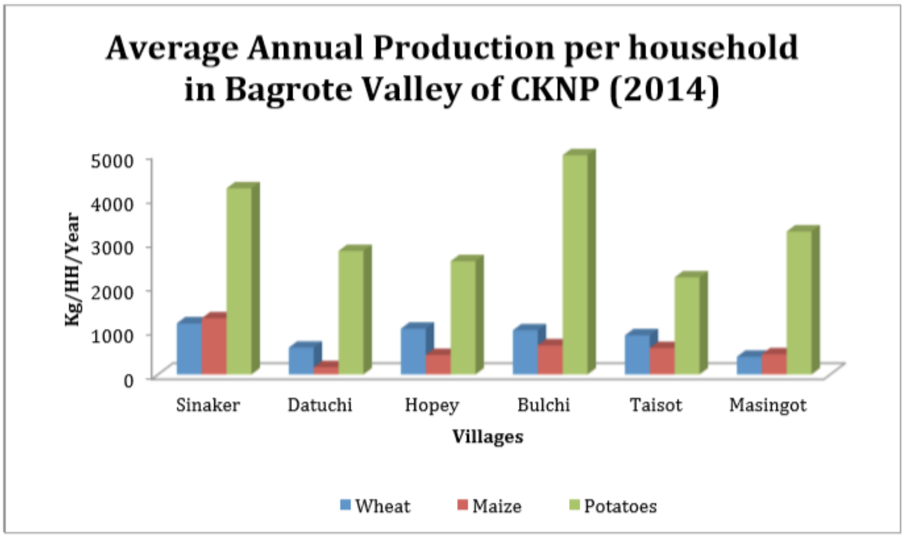
APPENDIX – E

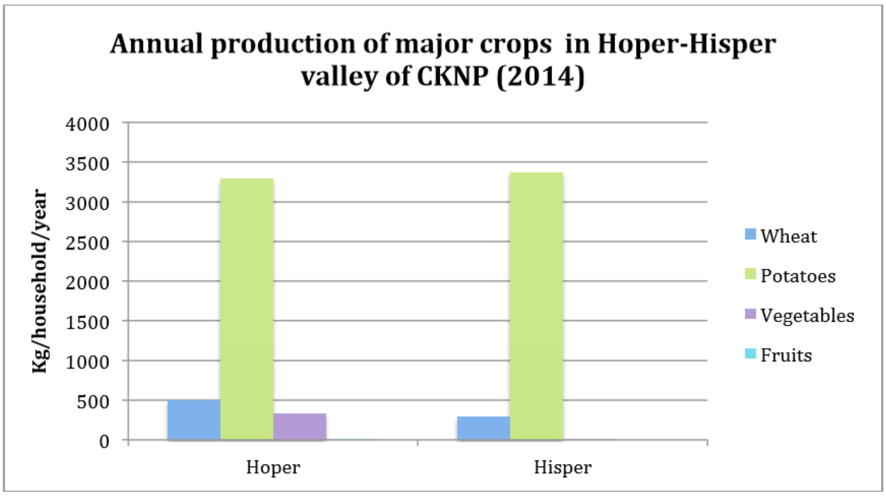
Village	Major crops	Yield (kg/ha)	Average production per household (Kg/year)	Consumption (%)	
				Domestic	Sale
Sinaker	Wheat	3217	1158	100	0
	Maize	3533	1272	100	0
	Potatoes	11731	4223	6.8	93.2
Datuchi	Wheat	875	608	97	3
	Maize	235	163	50.6	2.4
	Potatoes	4030	2801	12.5	81.6
Hopay	Wheat	1919	1036	100	0
	Maize	819	442	100	0
	Potatoes	4756	2568	6.6	88.6
Bulchi	Wheat	1351	1000	99.2	0.8
	Maize	892	660	100	0
	Potatoes	6722	4974.1	6.2	92.9
Taisot	Wheat	1136	886	100	0
	Maize	769	600	100	0
	Potatoes	2822	2201	10.8	89.2
Masingot	Wheat	364	400	100	0
	Maize	415	457	75	25
	Potatoes	2948	3243	4.5	87.8

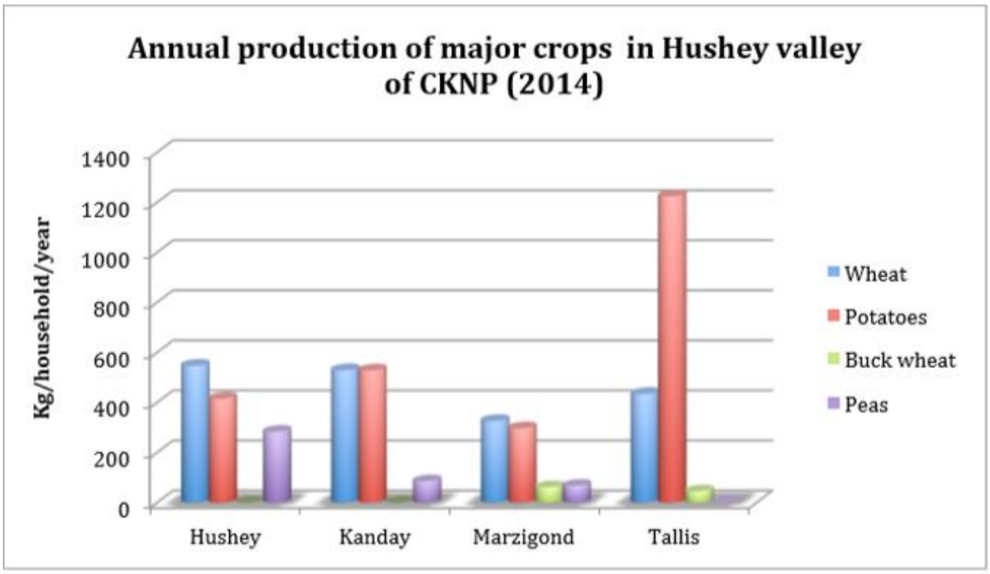
Village	Average size of Land holding (Ha)	Major crops	Average Yield (kg/ha)	Average production per household (Kg/year)	Consumption (%)	
					Domestic	Sale
Hoper	0.346	Wheat	1434	496	100	0
		Potatoes	9500	3287	20	79.81 @ Rs. 35/kg (2014)
		Vegetables	87	30	65	43
		Fruits	966	333	47	53
Hisper	0.438	Wheat	669	293	100	0
		Potatoes	7703	3374	22	76.16 @ Rs. 35/kg (2014)
		Vegetables	156	69	88	10
		Fruits	4	1.7	100	0

Village	Kind of crops	Consumption (%)	Sale (%)	Average Income/HH/yr	Average Value/HH/yr
Baltoro	Wheat	100	0	80000	120000
	Barley	100	0		
	Maize	100	0		
	Potato	5	95		
	Millet	0	0		
	Buckwheat	100	0		
	Vegetable /Fruit	100	0		
Harrangus	Wheat	100	0	80000	130000
	Barley	100	0		
	Maize	0	0		
	Potato	5	95		
	Millet	0	0		
	Buckwheat	0	0		
	Vegetable /Fruit	100	100		
Chundu	Wheat	100	0	50000	90000
	Barley	100	0		
	Maize	0	0		
	Potato	10	90		
	Millet	0	0		
	Buckwheat	0	0		
	Vegetable /Fruit	100	0		
Yarkhor	Wheat	100		30,000	60000
	Barley	100	0		
	Maize	100	0		

Village	Kind of crops	Consumption (%)	Sale (%)	Average Income/HH/yr	Average Value/HH/yr
	Potato	0	0		
	Millet	10	90		
	Buckwheat	0	0		
	Vegetable /Fruit	0	0		
Taghari	Wheat	100	0	60,000	100000
	Barley	100	0		
	Maize	0	0		
	Potato	10	90		
	Millet	0	0		
	Buckwheat	0	0		
	Vegetable /Fruit	100	0		
Kashumik	Wheat	100	0	70,000	125000
	Barley	100	0		
	Maize	0	0		
	Potato	100	0		
	Millet	0	0		
	Buckwheat	100	0		
	Vegetable /Fruit	100	0		
Bordas	Wheat	100	0	40000	80000
	Barley	100	0		
	Maize	100	0		
	Potato	5	95		
	Millet	0	0		
	Buckwheat	0	0		
	Vegetable /Fruit	100	0		
Daltar	Wheat	100	0	--	100000
	Barley	100	0		
	Maize	0	0		
	Potato	0	0		
	Millet	0	0		
	Buckwheat	0	0		
	Vegetable /Fruit	100	0		
Bloqpa	Wheat	100	0	50000	70000
	Barley	0	0		
	Maize	0	0		
	Potato	100	0		
	Millet	0	0		
	Buckwheat	0	0		
	Vegetable /Fruit	100	0		
Parangus	Wheat	0	0	30000	600000
	Barley	100	0		


Average Annual Production per household in Bagrote Valley of CKNP (2014)
Kg/HH/Year
5000
4000
3000
2000
1000
0
Sinaker
Datuchi
Hopey
Bulchi
Taisot
Masingot
Villages
Wheat
Maize
Potatoes


Annual production of major crops in Hoper-Hisper valley of CKNP (2014)
Kg/household/year
4000
3500
3000
2500
2000
1500
1000
500
0
Hoper
Hisper
Wheat
Potatoes
Vegetables
Fruits


Annual production of major crops in Hushey valley of CKNP (2014)
Kg/household/year
1400
1200
1000
800
600
400
200
0
Hushey
Kanday
Marzigond
Tallis
Wheat
Potatoes
Buck wheat
Peas

APPENDIX- F

Table 1: District and valley wise estimated livestock population (Year 2010)

S.#	Name of Valleys	Yak (including zo, zomo)	Cow	Sheep	Goat	Horse	Donkey	Total No. of Animals
1	Upper Braldo 1	1706	2,120	8,560	9,460	40	66	21,952
2	Upper Braldo 2	5,505	6,900	8,200	7,200	330	670	28,805
3	Lower Braldo	1020	3,020	4,360	4,880	0	0	13,280
4	Basha	12432	20,310	23,960	22,126	0	0	78,828
5	Wazirpur	1447	3,530	8,625	6,290	0	0	19,892
6	Markunja	1287	3,385	4,420	5,500	45	0	14,637
7	Marapi	1560	4,972	12,410	11,580	10	14	30,546
8	Stak	638	260	1,900	1,275	137	40	4,250
9	Tormic	2943	14,150	12,200	7,550	0	15	36,858
10	Baghicha/ Khomra	1140	1,450	1,500	2,500	11	32	6,633
11	Nar/Ghoro	711	890	1,205	1,630	0	0	4,436
A	**Skardu**	**30389**	**60987**	**87340**	**79991**	**573**	**837**	**260,117**
12	Keris/Gone	553	2,700	10,400	11,900	0	0	25,553
13	Thalay	1279	470	6,600	3,150	104	640	12,243
14	Hushey	486	892	638	390	3	3	2,412
B.	**Ghanche**	**2318**	**4062**	**17638**	**15440**	**107**	**643**	**40,208**
15	Haramosh	1400	8300	9200	24000	8	1170	44,078
16	Bagrote	45	5140	5550	10360	137	242	21,474
17	Danyore	0	2480	6900	10680	4	84	20,148
C	**Gilgit**	**1445**	**15920**	**21650**	**45040**	**149**	**1496**	**85,700**
18	Rakaposhi	4	3000	1500	2200	0	210	6,914
19	Sikandarabad	0	300	444	600	0	0	1,344
20	Jafferabad	0	500	300	400	0	1	1,201
21	Thole	4	150	250	100	0	0	504
22	Hopper	870	2900	11200	6900	1	44	21,915
23	Hisper	400	616	1580	1130	1	209	3,936
D	**Nagar**	**1278**	**7466**	**15274**	**11330**	**2**	**464**	**35,814**
Total population by animal type (A+B+C+D)		**35,430**	**88,435**	**141,902**	**151,801**	**831**	**3,440**	**421,839**

Ghulmat

Pastures	Village	Other uses	Status	Grazing period	Sheep	Goat	Dairy cattle	Yak	Equids	Tot
Multer*	Jaffar Abad	Medicinal plants	PD	May-Nov	400	420	10	10	_	790
Barul*		-do-	-do-	May-Nov	400	600	25	10	_	1035
Shamal*		-do-	-do-	May-Nov	170	150	05	05	_	330
Badi rong		-do-	-do-	May-Nov	22	15	_	5	_	42
Ba-e-maly		-do-	-do-	May-Nov	140	150	13	10	_	313
Hopai gotom		-do-	-do-	May-Nov	25	10	_	7	_	42
Moondar		-do-	-do-	May-Nov	25	30	_	8	_	63
Daching	Sikandar Abad	-do-	PD	May-Nov	Abandoned for grazing					
Fulatohara		-do-	-do-	May-Nov	Abandoned for grazing					
Tropho		-do-	-do-	May-Nov	Abandoned for grazing					
Sho hara		-do-	-do-	May-Nov	Abandoned for grazing					
Kolich		-do-	-do-	May-Nov	420	400	70	_	_	890
Batalyhur		-do-	-do-	May-Nov	Abandoned for grazing					
Beyachin		-do-	-do-	May-Nov	300	300	100	_	_	700
Xhaltar		-do-	-do-	May-Nov	350	330	120	_	_	800
Kamoroo	Nilt	-do-	-do-	May-Nov	110	130	45	_	_	285
Phoghulom		-do-	-do-	May-Nov	50	110	13	_	_	173
Bagdorki		-do-	-do-	May-Nov	50	140	26	_	_	216
Silbe	Ghulmat	-do-	-do-	May-Nov	150	190	10	10		360
Kato khor		-do-	-do-	May-Nov	250	160	13	5		428
Shah shuwaran		-do-	-do-	May-Nov	250	270	40	15		575
Talo ghutom		-do-	-do-	May-Nov	200	300	40	5		545
Dariya		-do-	-do-	May-Nov	150	150	60	5		365
Boyee		-do-	-do-	May-Nov	300	250	100	5		655
Chakiran		-do-	-do-	May-Nov	300	180	20	5		505
Rakaposhi base camp pasture	Minapin	-do-	-do-	May-Nov	Abandoned for grazing					
Bangi das		-do-	-do-	May-Nov	22	400	70	10	_	502
Hapakun		-do-	-do-	May-Nov	150	150	40	15	_	355
Teltotote		-do-	-do-	May-Nov	Abandoned for grazing					
Tamaray		-do-	-do-	May-Nov	Abandoned for grazing					
Charkin		-do-	-do-	May-Nov	250	300	30	18	_	598
Dagaphari		-do-	-do-	May-Nov	150	150	60	13	_	373
Kachili		-do-	-do-	May-Nov	230	300	70	20	_	620

Nagar

Villages	Kind of livestock	Population per village	Av. Income/HH/yr	Rearing trend
Askurdas	Goat	1700	30000	Decrease
	Sheep	1000		
	Cattles	405		
	Yaks	200		
	Equids	_		
	Donkey	_		
Miacher	Goat	1400	25000	Decrease
	Sheep	550		
	Cattles	70		
	Yaks	82		
	Equids	0		
	Donkey	0		
Shayar	254	360	32000	Decrease
	350	300		
	30	300		
	9	0		
	0	0		
	0	0		
Sumayar	Goat	1000	33000	Decrease
	Sheep	1000		
	Cattles	170		
	Yaks	0		
	Equids	0		
	Donkey	0		
Phakar	Goat	1100	35000	Decrease
	Sheep	1200		
	Cattles	800		
	Yaks	50		
	Equids	0		
	Donkey	0		
Hakuchar	Goat	250	32000	Decrease
	Sheep	150		

Shigar

Exhibit 12: Contribution of livestock in economics of Shigar Valley

Villages	Kind of livestock	Population per village	Population per HH	Av. Income per HH	Rearing trend
Alchori	Goat	3000	07	22000	Inc
	Sheep	2025	4.5		
	Cattles	1250	03		
	Yaks	05	-		
	Equids	70	0.15		
Hashupi/hurchas/Tharaghama	Goat	3000	44	21000	Dec
	Sheep	2000	29		
	Cattles	1200	18		
	Yaks	04	-		
	Equids	60	01		
Haider abad /Baha	Goat	400	06	15000	Dec
	Sheep	100	1.5		
	Cattles	300	05		
	Yaks	05	-		
	Equids	200	03		
Kashmal	Goat	400	07	20000	Dec
	Sheep	300	05		
	Cattles	200	04		
	Yaks	05	-		
	Equids	50	01		
Kiahonng	Goat	2000	27	25000	Inc
	Sheep	2500	33		
	Cattles	90	1.2		
	Yaks	-	-		
	Equids	40	0.5		
Khurid	Goat	750	03	25000	Dec
	Sheep	660	2.6		
	Cattles	280	01		
	Yaks	-	-		
	Equids	125	0.5		
Lagaf	Goat	200	03	20000	Dec
	Sheep	400	06		
	Cattles	200	03		
	Yaks	-	-		
	Equids	70	01		
Markonja	Goat	800	02	25000	Inc
	Sheep	900	2.2		
	Cattles	400	01		
	Yaks	150	0.4		
	Equids	70	0.1		
Saldi	Goat	250	03	30000	Dec
	Sheep	300	04		
	Cattles	200	2.5		
	Yaks	-	-		

Thalay

Villages	Kind of livestock	Population per village	Av. Income/HH/yr	Rearing trend
Baltoro	Sheep	2000	70000	Decrease
	Goat	1000		
	Cattle	100		
	Yak	200		
	Equids	100		
Harrangus	Sheep	600	30000	Decrease
	Goat	300		
	Cattle	60		
	Yak	100		
	Equids	30		
Chundu	Sheep	2500	24000	Decrease
	Goat	2000		
	Cattle	0		
	Yak	300		
	Equids	120		
Yarkhor	Sheep	1500	24000	Decrease
	Goat	800		
	Cattle	90		
	Yak	130		
	Equids	80		
Taghari	Sheep	400	15000	Decrease
	Goat	150		
	Cattle	80		
	Yak	145		
	Equids	70		
Kashumik	Sheep	1500	35000	Decrease
	Goat	700		
	Cattle	150		
	Yak	50		
	Equids	50		
Bordas	Sheep	500	40000	Decrease
	Goat	250		
	Cattle	200		
	Yak	160		
	Equids	70		
Daltar	Sheep	400	25000	Decrease
	Goat	200		

APPENDIX - G

1.8.3. Grazing Cycle in Bagrote valley of CKNP

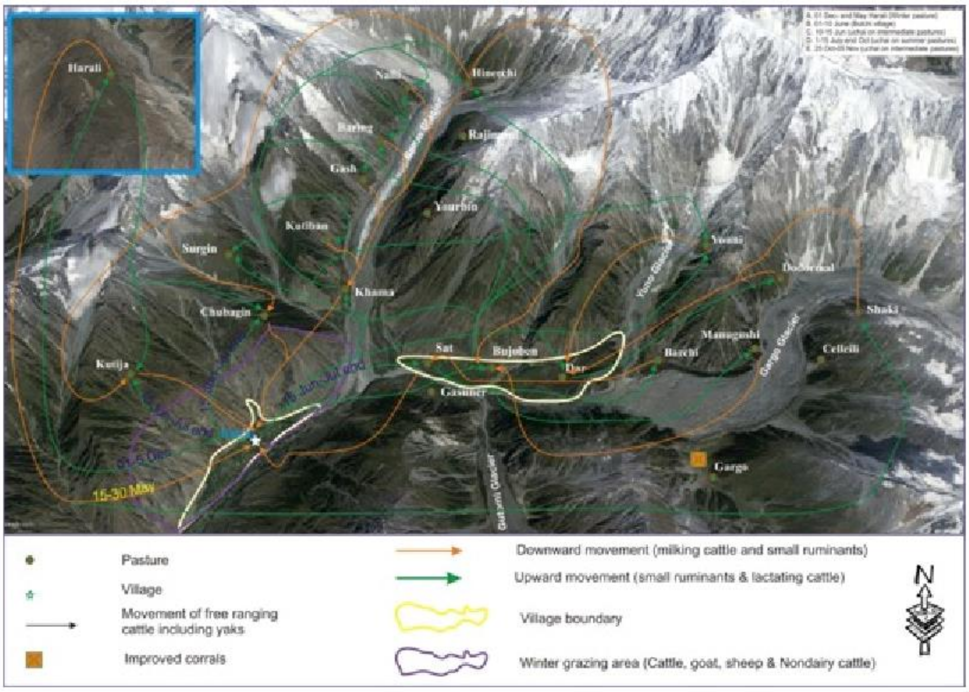


Figure 9 Pastures grazing cyle in Bulchi village of Bari Bar

Exhibit 15: Grazing Pressure by livestock on pastures Nagar Valley

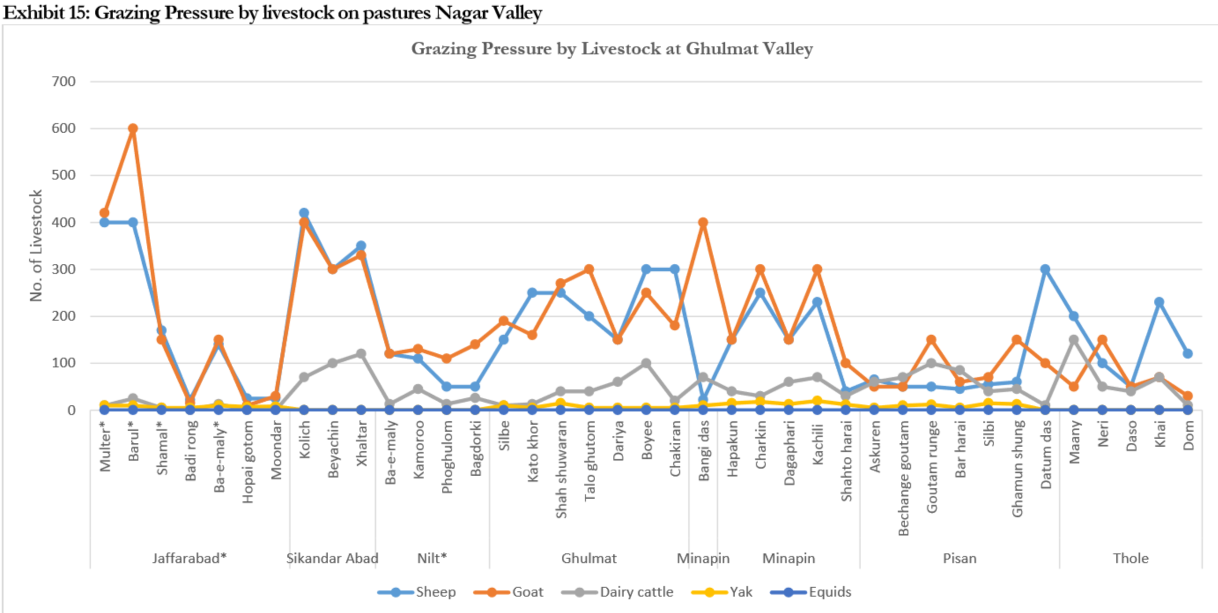


Exhibit No. 11: Assessment of grazing pressure from each livestock classes on pastures of NagarValley

Pasture / Village	Status	Other uses	Grazing period	Kind of livestock			
				Sheep	Goat	Dairy Cattle	Donkeys
Asqurdas							
Harangashi	PD	Wood and herbal collection	May-September	350	200	60	_
Manbolate				300	100	40	_
Harai				250	100	60	_
Manobul				200	100	70	_
Chhilgi				150	200	65	_
Maridas				200	150	50	_
Shilkiyan				250	150	60	_
Miacher							
Ethan	PD	Wood and herbal collection	Mar-November	180	50	14	_
Terchik Nala				150	40	7	_
Barai Rich				170	120	7	_
bojo channel				120	60	8	_
dasi channel				250	100	7	_
thas channel				130	50	9	_
Shahbaran Eethan				150	70	12	_
Shahbaran				250	60	6	_
Shayar							
Manobul	PD	Wood and herbal collection	May-October	20	45	3	_
.Chhilgi				40	40	5	_
Maridas				40	35	3	_
Shilkiyan				30	50	3	_
.Rung				25	40	4	_
Harangoshi				30	30	3	

Exhibit 16: Grazing Pressure by livestock on pastures of Shigar Valley

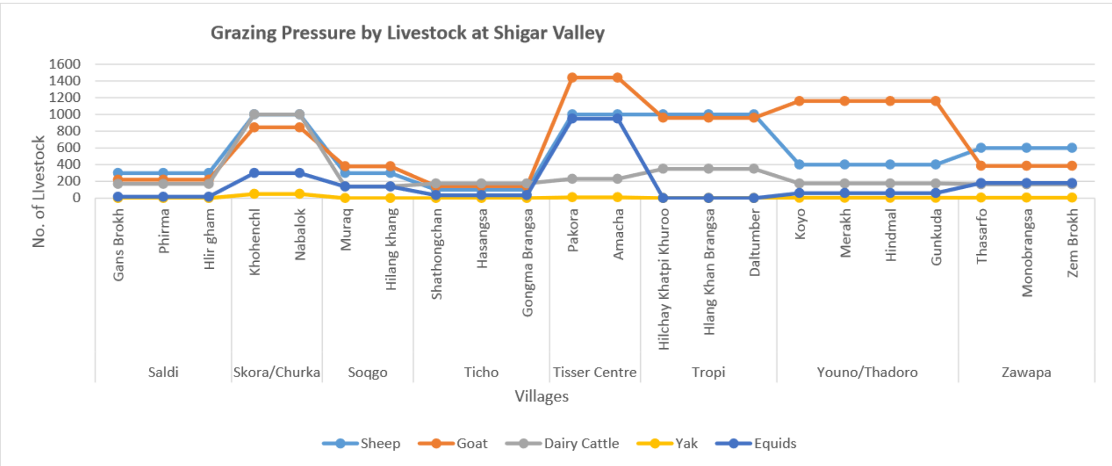
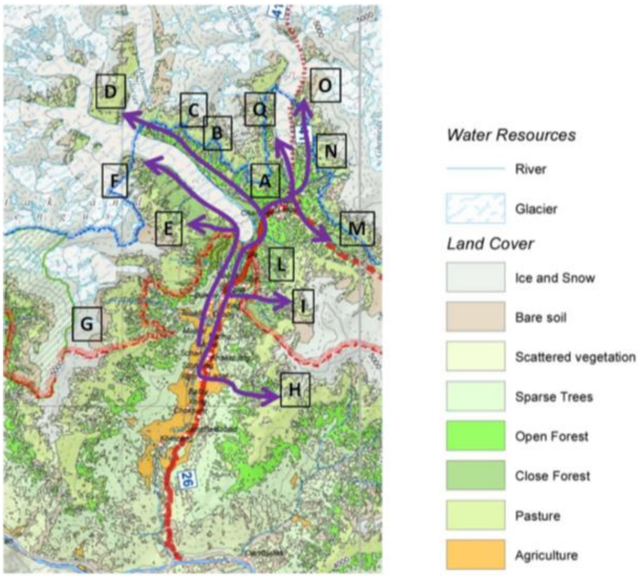


Exhibit 13: Movement of livestock at few Astak valley during the season



A) Chambet (April/May->Sept/Oct), B) Marphalungma (June/August), C) Saralpa (June-August), D) Chas polo (August); E) Kutja (May/September), F) Shkango (June/August); G)Tuglano (June/August); H)Servogir (July/August); I)Matumbur (July/August); L) Lassar (June/August); M) Lahamosh (June/August); N) Drumaso (June/August) O)Hlarzing (July/August), Q) Liglidlmo (June/August)

Pastures	**Status**	**Change (days/ %age)**	**Trend**			**Adaptation Measures by local community**
			30 y ago (1985)	**10 y ago (2006)**	**Future prediction**	
Alpine and sub-alpine pastures	Degrading	10	Less degraded as compared to present	Degrading	More degradation is expected	Nil
Mid and low land grazing	Degrading	15	Less degraded as compared to present	Degrading	More degradation	Nil

ID	Hushey		Kanday		Marzigond		Tallis	
	Pasture Name	**Status ***	**Pasture Name**	**Status ***	**Pasture Name**	**Status ***	**Pasture Name**	**Status ***
1.	Chhari (Lithiaq, Namakhoto, Chariging)	PD	Khotit	D	Koonday broq (Zaigo) and surrounding pastures	PD	Hachor	D
2.	Ongmajing	PD	Nangbroq	PD	Koonday Broq (Skillmal) and surrounding pastures	PD	Katcha	PD
3.	Wasoq	PD	Karpobraqbo	PD	Gholong boq (Sachat) and surrounding pastures	PD	Shubrangsa	PD
4.	Onghdongstan	PD	Andaq	PD	Gholong broq (Ghodong) and surrounding pastures	H	Tassibrangsa	H
5.	Saicho	PD	Apobroq	PD	Gone Ali Sher Khan	D	Ongdongstan	H
6.	Ghondoghoro	H	Tinis	PD	Village and surrounding pastures	D	Gaghdong	H
7.	Dalsangpa	H	La	H			Chuskistonma	H
8.	Alday, Gholdongpa, Ghorsit	H	Chheley	D			Serchumik	H
9.	Dumsum	PD	Jorti	PD			Phorondas	H
10.	Tirsir	H	Minguilo broq	PD				
11.	Ghaam	PD	Nangma	H				
12.	Shakhsha	H						
13.	Choghospang	H						
14.	Aling	H						
15.	Humbroq	PD						
16.	Chogholingsa	H						
17.	Spangsar	H						

* D degraded, PD partly degraded, H healthy

A summary of pastures status in the valley indicating degraded and partly degraded valleys is given as under:

ID	Bulchie		Taisot			
	Pasture Name	**Status***	**Pasture Name**	**Status***	**Pasture Name**	**Status***
1.	Harali	PD	Becili Bar			
2.	Chubagin	H	Hopsar			
3.	Khama	H	Margushi			
4.	Surgin	H	Gamasar			
5.	Baring	PD	Bilchar			
6.	Hinarchi	H	Kotowal			
7.	SBD	D	Serkon Harai			
8.	Barchi	PD	Shotal harai			
9.	Manugushi	H	Yourai Harai			
10.	Dodormal	H	Walo Harai			
11.	Shaki	H				
12.	Celleili	H				
13.	Rajimani	H				
14.	Surroundings of the village	D				

* D degraded, PD partly degraded, H healthy

Hoper village:

Id	Name	Coordinate (at pasture center)	Altitude	Estimated surface	Facilities[1]	Other use[2]
1.	Supulter	74.851131	36.182413	3428	4 small accommodation, 10 closed pens for small animals, 3 open pens for small animals	Fuelwood*, Dung, medicinal herbs
2.	Dalter	74.729800	36.160150	3781	4 small accommodation, 10 closed pens for small animals, 7 open pens for small animals	Fuelwood, Dung
3.	Dranchi	74.733839	36.218399	3834	1 small accommodation, 4 closed pens for small animals, 1 open pens for small animals	Fuelwood, Dung
4.	Hununo	74.728468	36.202175	3952	3 small accommodation, 10 closed pens for small animals, 3 open pens for small animals, 1 improved corral	Fuelwood, Dung
5.	Baulter	74.830929	36.168328	3735	4 small accommodation, 10 closed pens for small animals, 4 open pens for small animals	Fuelwood, Dung
6.	Shishkin	74.818129	36.185274	3523	4 small accommodation, 7 closed pens for small animals, 4 open pens for small animals	Fuelwood, Dung
7.	Maruk	74.802496	36.198077	3455	1 small accommodation, 5 closed pens for small animals, 1 open pens for small animals	Fuelwood, Dung
8.	Hapakun	74.824145	36.143424	4174	10 small accommodation, 20 closed pens for small animals, 15 open pens for small animals	Fuelwood, Dung
9.	Barpu	74.874188	36.161559	3899	10 small accommodation, 30 closed pens for small animals, 15 open pens	Fuelwood**, Dung

APPENDIX – H

Exhibit 20: Economic revenue from Mining in Nagar Valley, 2016

Village	Since	No of Mining Groups	Mining products	Revenue/Year/Village (PKR)	Revenue /Year/Group (PKR)
Asqurdas	--	--	--	--	--
Miacher	--	--	--	--	--
Shayar	--	--	--	--	--
Sumayar	1967	1988	Aquamarine, Tourmaline, Topaz, Ruby, Fluorite, Beroj, Quartz, Morganite	300000	21000000
Phekar	1949	1990	Aquamarine, Tourmaline, Topaz, Ruby, Fluorite, Beroj, Quartz, Morganite	25000	2250000
Hakuchar	--	--	--	--	--
Proper Nager	1950	20000	Aquamarine, Tourmaline, Topaz, Ruby, Fluorite, Beroj, Quartz, Morganite	200000	5000000

Exhibit 26: Economic revenue from Mining in Shigar Valley, 2016

Village	Since	No of Mining Groups	Mining products	Revenue/Year/Village (Rs.)	Revenue/Year/Group (Rs.)
Alchori	2000	08	Quartz, Beroj, topas	10,000,000	1250000
Hashupa/ hurchus/Tharaghama	1995	06	Topaz, Quartz, Beroj,	7,050,000	1,175,000
Saldi	1994	03	Aquamarine, quartz, Beroj, Topaz	3,000,000	1,000,000
Kashmal	1985	03	aquamarine, Tourmaline, Topaz, Ruby, Fluorite, Beroj, Quartz, Morganite	3,000,000	1,000,000
Youno/Thandoro	1995	10	Aquamarine, Tourmaline, Topaz, Beroj, Quartz,	11,500,000	1,150,000

Exhibit 24: Economic revenue from Mining in Astak Valley, 2016

Village	Since	No of Mining Groups	Mining products	Revenue/Year/Village (PKR)	Revenue/Year/Group (PKR)
Jamshed Abad	-	-	-	-	-
Xhoxum	1980	1	Aquamarine, Tourmaline, Topaz, Ruby, Fluorite, Beroj, Quartz, Morganite	-	-
Lagaf	1990	2	-	-	-
Kharchung	2006	1	-	-	-
Lachoo	-	-	-	-	-
Riging	1990	3	-	-	-
Shano	1980	4	Aquamarine, Tourmaline, Topaz, Ruby, Fluorite, Beroj, Quartz, Morganite	-	-
Gudapa/ Ishkandas	-	-	-	-	-
Tugla	1980	10	Aquamarine, Tourmaline, Topaz, Ruby, Fluorite, Beroj, Quartz, Morganite	5,000,000	500,000
Soosa/Thangus	1988	55	Aquamarine, Tourmaline, Topaz, Ruby, Fluorite, Beroj, Quartz, Morganite	8,250,000	150,000
Burdia	2008	3	-	-	-
Mopa	1980	2	-	-	-
Stonging	1970	7	Aquamarine, Tourmaline, Topaz, Ruby, Fluorite, Beroj, Quartz, Morganite	5,000,000	714,286