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HKKH Partnership
for ecosystem management

COMMUNITY PERCEPTIONS ON
Climate Change in Bagrote Valley, Pakistan

A Case Study

International Union for Conservation of Nature

supported by

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Annexures

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Acronyms and Abbreviations

AKRSP	Aga Khan Rural Support Programme
ARO	Asia Regional Office
CBO	Community Based Organization
CFCs	Chlorofluorocarbons
CH4	Methane
CKNP	Central Karakoram National Park in Pakistan
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
DGCS	Directorate General for Development Cooperation, Italian Ministry of Foreign Affairs
FAO	Food and Agriculture Orgazniation
GHG	Greenhouse Gas
GMOs	Genetically Modified Organisms
HFCs	Hydrofluorocarbons
HKKH	Hindu Kush – Karakoram – Himalaya
ICIMOD	International Centre for Integrated Mountain Development
IUCN	International Union for Conservation of Nature
LPG	Liquified Petroleum Gas
LSO	Local Support Organization
N20	Nitrous Oxide
NGO	Non Governmental Organization
NTFP	Non Timber Forest Product
PA	Protected Area
PCAN	Pakistan Clean Air Network
PES	Payment for Ecological Services
PFCs	Perfluorocarbons
QNP	Qomolangma Nature Preserve
SF6	Sulphur hexafluoride
SNP	Sagarmatha National Park
TAP-CC	Technical Advisory Panel on Climate Change
UNFCC	United Nations Framework Convention on Climate Change
VCC	Village Conservation Committee
WSSD	World Summit on Sustainable Development
WWF	World Wide Fund for nature

Executive Summary

Central Karakoram National Park (CKNP) is situated in the Gilgit-Baltistan region of Pakistan and is the county's largest Protected Area (PA), covering over 10,000km² and encompassing the world's largest glacier outside the Polar Regions. It is an ecologically fragile region, characterized by extremes of altitudes that range from 2000m to over 8000m, including K2, the second highest peak in the world. As with other high altitudinal niche ecosystems, the region is significantly impacted by global warming and climate change, which in turn affects the natural environment and subsequently the lives of the locals.

Hence, considering the amplified effect of climate change on mountain ecosystems, a case study was carried out in Bagrote valley in Gilgit District, to study community perception on changes in climate and its impacts, coping strategies and adaptation process. The study formed part of the 'Institutional Consolidation for the Coordinated and Integrated Monitoring of Natural Resources towards Sustainable Development and Environmental Conservation in the Hindu Kush – Karakoram - Himalaya Mountain Complex' Project (also known as the HKKH Project). The study also contributed to the study requirements of the Technical Advisory Panel on Climate Change (TAP-CC) that provides technical support to the Government of Pakistan and also assists in incorporating research findings into policies. The study results are not based on scientific data, but on anecdotal evidence of community members. The findings will be a stepping stone in determining the direction for further research.

As part of the study, a survey was conducted in all the ten villages in Bagrote, the region selected to serve as a model area for CKNP, due to its socio-ecological significance. For a detailed stocktaking and analysis of the prevalent situation, the study addressed some key parameters, including changes in local climate - precipitation and temperature, fuelwood use, flowering time, pasture site location and unusual weather patterns, water resources (glaciers and meltwater), livelihoods, agriculture (crops, cropping calendar, yield and pests / diseases), livestock, biodiversity (animals, birds and natural environment) and lifestyle pattern (construction style, clothing and diseases). Some key steps undertaken in conducting the survey include preliminary research, concept note development, consultative session with the local Community Based Organization (CBO), survey tool development, pre-testing of tool, data collection, database development, data analysis and report writing (survey synthesis and recommendations).

As reflected in the survey conducted, the response of community members clearly indicates that they perceive the climate of Bagrote to have changed greatly in the past few years; they feel that the changing climate has affected the natural environment and the traditional lifestyle of the local population. One of the most affected areas is that of water resources; the respondents reported a severe decline in winter and summer precipitation. A reduction in the length and thickness of various glaciers was also observed. With regard to weather conditions, the community members identified an increase in mean temperature (which has increased the risk of droughts and floods). Consequently, there has been a drastic reduction in the quantity of meltwater in water channels; however, water usage rights have provided some level of security to residents. The changing weather pattern and consequent impact has also contributed to a change in the cropping pattern (cropping calendar, crop variety, crop yield, crop diseases), as well as an earlier blossoming of fruit trees. In the livestock sector, the most overwhelming impact of climate change was perceived to be the drying up of grass in pastures thus reducing the availability of natural fodder, and the shifting of some pasture sites to higher altitudes, especially for those living in high altitudes. In addition to this, the respondents felt that the altered climatic regime has had a significant impact on the overall natural environment, in the form of depletion of resources, such as natural vegetation, forest cover and medicinal plants. Many species of birds (e.g. *chakor*, crow and *gasharing*) and animals (e.g. black bear, *keil,* leopard, *markhor* and wolf) are not being sighted anymore, according to local residents.

Since communities have long experience of coping with variable climate, local knowledge and existing coping strategies have been considered when planning responses targeted towards cultural and resource conservation, and management of CKNP. Spontaneous adaptation strategies adopted by the community have been noticed in the construction of buildings, clothing, agriculture and fuelwood use. However,

coordinated efforts by concerned authorities is required to institute an effective and planned adaptation response, which constitutes local knowledge, but also builds capacity of the community to adopt scientifically suggested practices.

Considering the present gap in aptly addressing climate change, this report attempts to suggest a sector wise action plan (for mitigation and adaptation) and management implications, to integrate climate change in the CKNP management plan. In doing so, the CKNP region, more specifically Bagrote valley, can transform into a model for conserving other vulnerable ecosystems and heritage, as part of a regional climate change induced management strategy.

1. BACKGROUND

The 'Institutional Consolidation for the Coordinated and Integrated Monitoring of Natural Resources towards Sustainable Development and Environmental Conservation in the Hindukush – Karakoram - Himalaya Mountain Complex' Project (also known as HKKH Project) is committed to the development of CKNP. The Project realizes that there is tremendous pressure on the CKNP ecosystem (see Annexure I for more project information). With the change in climatic conditions (temperature, wind / snow / rain pattern) and associated ecological changes, the Project has identified an urgent need for identification and awareness of ecoogical changes, and sustainable adaptation by local communities, for improved livelihood. Hence, in this study an examination and analysis of the climate change induced vulnerabilities has been undertaken, against the backdrop of the physical, economic, and social environment of the region.

Study Area

CKNP falls into the administrative districts of Ghanche, Gilgit and Skardu, in Northern Areas - which has recently been named Gilgit-Baltistan. CKNP was officially gazetted as a national park in 1993. It is Pakistan's largest PA, covering over 10,000km² and encompassing the world's largest glacier (formed by Baltoro, Hispar-Biafo and Siachen) outside the Polar Regions. It thus forms a major source of fresh water for Pakistan. The area is characterized by extremes of altitudes that range from 2000m to over 8600m, including K2, the second highest peak in the world. Due to its geographical position, and rich cultural and ecological heritage CKNP receives thousands of mountaineers and trekkers each year.

The buffer zone (7,400 km²) of CKNP is home to about 97,608 people residing in 230 village settlements. The local communities are characterized by a great social and cultural diversity, where religion and ethnicity are strongly influences in defining norms and institutional relationships. Livelihoods are mostly based on subsistence agro-pastoral activities with limited landholdings.

Bagrote valley forms part of the CKNP buffer zone and is the model region for CKNP, owing to its socio-ecological significance. The valley is approximately 17km from Gilgit Town. The valley floor ranges in altitude from 1,500m to 2,900m. Alpine pastures are located on the valley slopes up to an altitude of nearly 5,000m. Outstanding physical features in the vicinity include Rakaposhi (7,788m) and Diran (7,269m) peaks in the northwest and northeast respectively, and Dubani peak (6,143m) in the east.

Bagrote valley is inhabited by approximately 14,700 people in 10 villages. The 5 largest villages, where the majority of the population in the valley lives, are Bulche, Datuchi, Farfooh, Hopay and Sinaker. Permanent settlements lie between altitudes of 1,700m to 2,400m; summer settlements and high pastures reach to heights of 3,500m to 4,000m.

The mainstay of the locals is mixed mountain agriculture, heavily supplemented by cash income from commercial and public service. Barley, maize, potatoes and wheat are commonly grown. In the settlements of the upper Bagrote Valley, where rich alpine pastures provide sufficient fodder for large flocks, livestock herding contributes a significant share to household subsistence.

The valley's proximity to Gilgit, as well as an increase in the purchasing power of the locals, higher population growth rates, declining food subsistence, and increasing dependence on external food supply, has resulted in growth in the commercial sector. According to the locals, in Bulche and Farfooh numerous shops have been set up using earnings from selling livestock, wood and glacial ice, which has also contributed to resource exploitation.

Owing to such factors, the livelihood pattern in Bagrote has substantially changed in the past few years. With regard to family systems, some family units have moved from a joint family system to a single family system (average family size is 12 people). This has had its own repercussions. Firstly, changes in family system have meant division of the available livestock amongst households, which has contributed to reduced dependence on livestock rearing. Also, residents assert that they generally do not have time to take livestock to higher pastures and spend the required duration there. This is because in recent years, people are mostly engaged in attaining

education, jobs and other business related activities, including selling of increased variety of crop produce.

However, the opportunities to earn cash income locally are still very limited and the available options are subject to heavy seasonal fluctuations, due to weather conditions and associated accessibility issues. Due to the scarcity of local non-farm income sources, villagers migrate to Gilgit and to the lowlands, in search of work. These mostly include people from remote villages, such as Bilchar and Taisot. These people have migrated to downtown areas, especially Jalalabad, where it is claimed that there are better educational and economic opportunities (jobs taken up include government service, armed forces and business ventures). Despite migration, these households have not abandoned their native homes and agricultural land, where they still grow crops and travel back at sowing and harvesting time.

2. INTRODUCTION

Climate change and its impact is becoming increasingly evident in Pakistan, especially in the mountainous regions. Mountain ecosystems are considered to be sensitive indicators of global warming, as even slight variations in temperature can lead to significant shifts in the local climate, which can in turn drastically affect the natural environment and subsequently the local people's lives and livelihoods. Though limited climate change focused research has been carried out in CKNP region, it is felt that as with other high altitudinal niche ecosystems, the target region (Bagrote valley) is significantly impacted by global warming and climate change. Hence, need was identified for a study that identifies changing climatic conditions and consequent local socio-ecological dynamics, and based on the findings it recommends area specific plans that will contribute to the overall management plan.

Hence, keeping in view the identified gaps and requirements, this case study has been designed to provide an overview of climatic changes from the local communities' perspective, and the current and prospective climate change impacts on natural resources, lifestyle and livelihoods. The study also helps identify vulnerabilities and suggests recommendations for areas where immediate interventions are needed, to help the local communities adapt.

This study has been conducted in congruence with other research work being conducted. This means that the study highlights areas not completely addressed by existing studies. It thus serves as an ancillary tool that support the ongoing studies on biodiversity, glaciers, wildlife and forestry - all directly affected by climate change patterns - while also supporting existing evidence and addressing priority areas highlighted in the Project operational plan. Additionally, the study will contribute towards raising awareness among local communities on climate change and its impacts, which is a crucial first step towards effective response.

3. OBJECTIVE

The study generates basic information on how changes in the climate are perceived by local communities, what socio-ecological changes have occurred, and how people are or should be coping with and adapting to them. More specifically, it assesses how changes in climatic parameters, such as temperature and precipitation, have affected the natural environment of the area and the lives and livelihoods of the local population. The report also gives an insight into the type and level of vulnerability, adaptations that have occurred over the course of time and expected changes in the future. Resultantly, the study provides a roadmap for climate change induced mitigation and adaptation strategies. It will thus lay the ground for climate change integration in the CKNP management plan. The study findings may induce revisions in current strategies and future programmes, including research initiatives.

4. STUDY APPROACH

4.1 Scope of Study

Target Area
The study focuses on Bagrote valley (Union Council), in Gilgit District, Gilgit-Baltistan, Pakistan. The detailed plan for geographical scope covered is attached as Annexure II.

Duration
The field work for the case study was conducted from 22 - 26 July 2008.

4.2 Structure and Methodological Approach

i. Research Design
The study gathered the required information from primary and secondary sources. Primary field data was collected through documenting observations of local communities.

Triangulation through various sources of information was used as a tool to ensure reliability of data. As the study was conducted in Urdu and regional language(s), interview translations and interpretations were also required. To ensure validity of data, a peer debriefing session was held with the research team, as well as CBO head and other local heads.

ii. Research Instrument
A survey questionnaire was used to gather primary data for the study.

i. Sampling Design

Sector Characterization
The research study focused on all the 10 villages in Bagrote valley (villages are listed in Annexure II).

Research Participants (refer to Annexure III)
- Primary target group: household members residing in the selected area
- Secondary target group: relevant key government departments, local organizations, village heads and notables in the area

Sampling Type
After selection of the relevant group, data was gathered through stratified random sampling, with support of the CBO head.

Sampling Criteria
Effort was made to select a varied audience that well represents gender, the different socio-economic groups (e.g. based on income, profession and education) and age groups in the community. However, due to the nature of the study, more people from the older age group were interviewed, to get an overview of a larger timescale and a deeper understanding of changes that have occurred over time. Likewise, the team paid particular emphasis on inquiring from those who have closer interaction with the natural environment (e.g. shepherd, farmer, forest department / scout / CBO members).

Sample Size
As this research is only a case study with a pre-defined focus, an approximately 3% representative sample was selected from the total population.

iii. Language
For easy comprehension by locals, the language used for verbal communication (interviews, discussions) was Urdu or the local language, Shina, which ever was preferred by respondents. However, the written communication language was English,

as the survey has been executed and administered directly by the research team. Reporting in English language also eases the process of validity by external groups with whom the study is to be shared.

4.3 Research Phases and Activities

The study process involved several steps, including:

ii. Preliminary Research
Information on Bagrote valley was not readily available. IUCN staff in Gilgit office, along with the local CBO, was consulted for area specific information. Secondary data on temperature and precipitation was obtained from various sources, including WWF Pakistan. Besides this, other literature and internet based research helped in identifying the main climate change concerns specific to areas that are similar to Bagrote valley in terms of geography, climate, physiographic features, as well as adaptation strategies.

iii. Concept Note
A concept note was developed and presented to the Project coordinator and Project technical advisor. The document included the study design and tool, and attempted to highlight research objectives aimed at achieving Project targets. Based on the feedback received, the study format was revised and the field survey was planned.

iv. Consultative Session
The study team held a meeting with the CBO head to:

- Select representative villages to be included in the survey;
- Get basic demographic and topographic information on the target area;
- Determine sample size for the survey;
- Finalize the survey tool to be used for data collection; and
- Reach to a consensus on the process of study.

Further discussion sessions on the study approach were held in IUCN Pakistan's Gilgit office, with the CBO head and IUCN programme and administrative staff.

v. Questionnaire
On the basis of information gathered on climate change and Bagrote, a questionnaire was designed, to serve as a tool to gather contextual information on the topic. A draft questionnaire was developed and circulated for finalization within the concerned departments of IUCN Pakistan. The format of the questionnaire was semi-structured, with three broad sections:

- General information
- Household information
- Information on climate change and its impact

The questionnaire is attached as Annexure IV. It follows the qualitative nature of the study, which aimed at gathering information on community views and experiences related to their climate induced evolving lives and natural environment.

vi. Field Visit Plan
The field visit schedule (attached as Annexure II) encompassed the following components:

- Target area
- Villages covered by each of the two survey teams
- Distance of each village from a centre point (in this case, it was the CBO head's residence)
- Total number of households in each village
- Sample size selected in each village, for the survey

- Total number of household members (male and female) interviewed
- Date of visits made by each of the two survey teams

vii. Pre-testing

The approved questionnaire was pre-tested in a village called Hopay. Based on the interview conducted, slight revisions were made in the questionnaire, to incorporate contextual evidence and to make the tool more focused (on climate change related indicators) and concise, so that utility and targeted response is ensured. It was felt that any additional or supporting information required for the study could be made available from other Project studies underway.

Certain indicators that were reviewed or excluded from the final tool include the following:

- The question titled 'legal ownership of assets' was rephrased as 'land use'
- Individual questions on fuel used for cooking, heating and lighting were combined
- A question titled 'change in forest cover' was removed on basis of redundancy
- A question on 'resources (natural, physical, human, financial and social) most important for coping easily to climate change' was removed, as it induced vague responses

viii. Data Collection

A field survey was led by Fizza Shah and Muhammad Aqib Uddin from IUCN Pakistan, with the support of Arif Afridi (intern at IUCN Pakistan), Project coordinating team at IUCN Gilgit Office and local CBO head. The CBO head also appointed interpreters for the survey. The research team was divided into two groups and the target area was divided between the groups, for the purpose of collecting information efficiently.

A major duration of the field visit was spent in carrying out semi-structured interviews - guided by the pre-tested questionnaire - and in recording the collected information. A total of 46 individual interviews were conducted with community members (13 females and 33 males). In addition to interview sessions with general community members, local key persons were also interviewed (see Annexure III for list of respondents).

Since the Project partners were already working on the field and had developed linkages with the local CBO, retrieving relevant information, making focused visits and conducting interviews with relevant persons was made convenient through the assistance of CBO head.

ix. Database Development

A format was designed to feed in the field data gathered. All the information gathered was consolidated and stored electronically.

iv. Data Analysis

The data analysis procedure involved preliminary coding and sorting of data, mostly through data reduction (write-ups of field notes) and data reconstruction (development of categories, findings, conclusions, connections to existing literature, integration of concepts). The data was then presented in a narrative report of findings with descriptive and interpretative detail.

x. Report Writing - Survey Synthesis and Study Analysis

The report reflects information from various sources, including anecdotal evidence, HKKH Project documents (concept note, operational plan, project proposals and tools), and data from external local and international sources highlighting climate change related indicators and experiences.

Based on the information gathered from the interviews, discussions, observations and secondary data, this report has been developed to provide a situational analysis as well as share the forecasted position and related recommendations.

xi. Dissemination

The report is expected to be shared with Project partners, local organizations and other concerned parties, in an effort to provide supplementary information to support Project research work, management planning, capacity building initiatives and conservation efforts. A debriefing session is also planned after internal report review.

xii. Follow-up

Once the study results have been shared and discussions have been held on the future course of action, the team will conduct follow-up visits on initiatives undertaken to ensure improved condition at a local level.

4.4 Assumptions

A few assumptions made by the research team include:

- Respondents live in comparable socio-economic conditions;
- Male and female respondents live in similar socio-economic conditions;
- Respondents have similar access to resources (financial, physical and natural);
- The respondents face similar changes in the natural environment (forest, water, wildlife);
- All respondents will have the required information expected of them;
- Male and female respondents have similar exposure and knowledge on information being gathered through them;
- The respondents will interpret the question well;
- The respondents will provide relevant information;
- The respondents will share correct information;
- The translators will translate the question without altering the meaning;
- The research tools are able to gather the required information; and
- Certain uniform inferences can be derived for the whole of Bagrote valley.

4.5 Study Constraints

Limitations faced by the study team include language barrier. The research team was not well versed in the regional language and vice versa. In addition to this, in some traditional areas, where there was limited community mobilization, the response was skewed. Further, several impacts described by the respondents (e.g. with reference to change in lifestyle) are attributable not only to climate change but also other factors, such as population expansion, and enhanced access to better goods and services (e.g. seed, fertilizers, electricity and livelihood options). Hence, due to such confounding factors, it was difficult to wholly attribute certain impacts to climate change.

Despite the constraints, the study manages to provide an overview of the situation in Bagrote with respect to impacts of climate change, and determine the direction for further research and development, as well as define climate change related management priorities. Considering the scope of the research, particular attention has been paid to quality, to ensure validity and implementation of recommendations. However, as there are less socio-ecological management based research studies available or done in Northern Pakistan, there is a need to extend the research to other dimensions of the topic, for a holistic view.

4.6 Previous Work and Studies

A similar study was conducted by IUCN Pakistan in Shigar Town in Skardu, Gilgit-Baltistan, under the Shigar Project. The field study provided an alarming insight and confirming evidence that reflected a clear link between climatic conditions, livelihood pattern and natural environment. Based on the results obtained, the course of future intervention required alteration, to incorporate consistent understanding and improved strategic planning aimed at environmental management and community adaptation.

The survey tool used for the study in Shigar Town was customized for research work in Bagrote, after consultation with internal experts and key persons in Bagrote. The field study approach adopted was comparable. Both studies aimed to further the sector specific scoping studies and recommendations made for better ecosystem management in the specified area. The study team involved in the two studies mentioned here was well versed in conducting field studies on climate change.

4.7 Study Outputs

The outputs planned for the Bagrote study include:

- A study analysis and recommendations report
- Debriefing session with stakeholders, including community members, CBO staff, government and other related members
- A joint session with Project partners, especially the researchers, on experience sharing, data compilation and management action plan development, in collaboration with related government agencies and local bodies

5. STUDY FINDINGS

Results and Discussion

The respondents were asked to provide their input, with regard to the situation in 2008 and 2003 (baseline year for study), for the various parameters considered under this study. For some parameters however, the baseline period was taken to be 1998, since a significant change could not have been expected in a short duration of five years, such as change in glaciers and grazing sites.

The response of community members clearly indicated that they perceived the climate of Bagrote to have changed greatly over since 1998. They felt that the changing climate has affected the natural environment, traditional lifestyle and livelihood of the local population. A synopsis of the community's perceptions is presented below.

5.1 Changes in Local Climate - Precipitation and Temperature Analysis

The aspects of changes in local climate that were assessed included the following:

<u>Change in winter temperatures</u>
The general perception was that there has been an increase in mean temperature. Residents felt that warmer temperature is exacerbating the risk of droughts (from land surface drying) and floods (from increased water vapor). In general, minimum temperature for winter and maximum temperature for summer is increasing. Winter season has become milder and shorter, and summer is now considerably warmer. There is hardly any snowfall anymore, while 10-15 years ago snowfall was a continuous feature in winter. Discussions revealed that there has been a drastic reduction in the use of woolen clothing and woolen carpeting in homes.

<u>Change in flowering time and quantity and quality of fruit trees</u>
The variety of fruit tree species in Bagrote has increased in the past few years. Current species grown include not only apricot (its tree branches are used as fuelwood) and walnut, but also almond, apple, cherry, grape, *lokat*, peach, pear, plum and pomegranate. The taste has also been reported to be changed over time. Villagers say the diversity is due to introduction of new seeds and foreign variety of apples introduced by AKRSP.

The quantity of apricot produced in 2008 was above average in the whole of Bagrote valley, except in Bilchar village. However, other fruit trees generally produce less quality and quantity of fruit in recent years. Some reasons shared for this change in fruit availability include warmer climate, disease and changed budding time of fruit trees.

A shift in the flowering time of fruit trees by about 7–15 days was reported to have taken place during the past 5-10 years. Previously, flowering took place in mid-April, but in 2007 and 2008, apricot trees (which blossom first) blossomed between the last week of March and the first week of April, which is *Nauroz* time for the locals.

Change in quality, location and altitude of pasture sites
In Bagrote, there are different pastures for summers (in mountains) and winters (in lowlands). There are numerous pasture sites accessed by the villagers. Over the years, an indigenous system of usage has been developed and strictly followed by the residents whereby selected households use specific sites at designated time periods.

The residents who visit pasture sites, including females, (not everyone travels to pastures; some people take livestock to their own land close to home, for grazing), reported a noticeable deterioration in the quality and quantity of natural resources (especially grass) at pasture sites. They say that the grass at the sites is dry and less green, due to less rain. It has also become shorter – from 4.5 feet earlier to 1.5 feet presently.

Less precipitation in recent years has had a drastic impact on the pasture sites. There is very less forest cover left. The indigenous shrubs are also vanishing, as reported by someone from Hopay. In some areas, the change is being felt only in winter pastures (which are rain-fed areas).

The respondents were asked to quantify the number of hours it takes to travel to the pastures ten years ago as opposed to at present. The response to this question was divided. However, it needs to be mentioned that the disparity in response may be due to the varying locations of the pastures that have been used by the respondent. The villages located at higher altitude mostly reported a change.

On average, travel time to winter pastures was identified as 2-5 hours, or 10-15 km. Residents reported an extension in time of 5-6 hours, which translates to one day of trekking. Alternatively, those who accessed the sites Baching and Surgin, pointed out a reduction in the travel time.

With regard to the change in the duration of stay at pasture sites, the response was largely unanimous. The shepherds still take the livestock for the same duration of time as they have been for years. Goats and sheep are taken to pastures from May to October, while cows are taken from May to September.

Unusual weather patterns
The respondents were of the opinion that the climate of the area has definitely changed over the past 5-10 years. The amount of precipitation (both rainfall and snow) has reduced substantially. There has hardly been any snowfall since 2004. Additionally, precipitation (snow and rain) predictability, frequency and extent have also undergone a change. People also referred to certain erratic weather events, especially the replacement of snowfall with rainfall, in winters. Some pointed out that the climatic condition has become very variable. There has also been a change in occurrence of floods, though the change is varied across villages. The reason for the variance was attributed to erratic weather conditions and rainfall, as well as loose soil (due to arid conditions), causing floods. Floods seemed to be a constant feature in Bagrote, however, recent floods in summer period (e.g. in Bulche) caused physical and human loss.

5.2 Water Resources

The impacts of climatic changes on water availability were investigated through:

Change in precipitation (snow and rain)
All respondents reported that there has been a drastic reduction in the amount of precipitation over the past 10 years, which is leading to water shortages and warmer climate, they said. Respondents shared that snow cover on the ground used to be at least 2-6 feet thick (at least

knee high) and snowfall would continue up to March-April. There were more small scale avalanches, therefore more snow. There would be so much snow that it would not melt. Glacier melt used to be upto the village. Since the last 4-7 years, hardly any snowfall has occurred in the valleys (3-6 inches by January). Consequently, the risk of landslides has increased due to decreased snowfall and forest cover.

Though there is more rainfall than snow, annual rainfall in the area has reduced in the last 6-7 years. The weather has also become dry and arid. Earlier, it rained almost all year, especially after spring season. Rain would start in April and there would be continuous rain (6-9 times). In summers, monsoon (*jari*) season would occur between July to August. Frequent and heavy rainfall would make mud houses leak or collapse. Now, it rains 2-5 times in a year. When it does rain, it is heavy and causes floods. In highlands, people reported more rainfall in June-July this year – one week of *jari* caused floods.

Change in size of glaciers

Since glaciers are located higher in the mountains and most community members do not travel there, many respondents had not personally seen any change in the size of glaciers. However, they reported having heard of a reduction in glacier size by people such as shepherds who take the livestock to pasture during summers. Others assumed a change in glacier size due to change in temperature and precipitation.

Respondents, who were shepherds and traveled to areas where the glaciers were situated, identified a major difference in the size of glaciers since 10-15 years. They felt it is due to climate change and less snowfall. They reported a shortening in the length of several glaciers, including Bulche glacier. The reduction in the size was given to be 2-3 feet or 1000 meters. The community members shared that 30 years ago, the glacier in the area caused landslides and avalanches in summers (mid April-May). Glaciers were so close to the village and the waterway that villagers had to walk over glaciers at times; now, glaciers can hardly be seen. Due to the shrinking of glaciers and warming temperature, some reported an increase in availability of water from glacial melt.

Change in quantity and time of arrival of meltwater in channels

Meltwater from snow and glaciers is the main source for the fulfillment of irrigation and other water related needs of the people of Bagrote, except in Sinaker, where water is available from spring water and is dependent on rainfall. The villages Bulche and Datuche, for instance, are exclusively dependent on glacial melt for water. Meltwater usually arrives in water channels by as early as March (15 days earlier); streams start filling up by April-June till September-November. This phenomenon is present because due to warmer climate snow melts earlier now.

However, all respondents reported that there has been a drastic reduction in the quantity of meltwater in water channels over the past 10 years. The amount of meltwater available to households depends on the amount of snowfall that has occurred. More snowfall means more avalanches, which in turn means more rain. However, now that glaciers have shrunk and snowfall has reduced (on land and on mountains) there are less avalanches and hence less meltwater available. Earlier, there was so much meltwater that it was almost a flood-like situation and crossing the river was not possible. Now, water is scarce. There is no water for drinking purpose, though tap water is available to some people (since the year 2000). In some areas (especially Hamaran), there is water scarcity in August – September, as there is no water from glaciers in these months. Other factors contributing to less meltwater and water shortage include lack of channeled water. There has been an increasing use of spring water in most villages, especially in colder season. Earlier, water would be released in April. Now, water is released as early as *Nauroz* period.

The respondents noted no change in turbidity time, which was mostly observed to occur from May-August. Residents said that there is also no turbidity in spring water.

5.3 Livelihoods

Traditionally, the people of the area depended upon agriculture and pastoral farming for their livelihoods. Although a large section of the population is still engaged in these occupations, the socio-economic situation in Bagrote has altered rapidly in the recent past. Over the last decade, the livelihood pattern has diversified, due to enhanced communication channels with the rest of the country and strengthening of market economy in the region. Hence, many people are now engaged in commercial or business endeavors (e.g. tourism, banking, construction and carpentry) and public sectors (government service – e.g. armed forces and police). The study findings did not indicate any discernible impact of climate change on livelihoods in general. The aspects of agriculture and livestock have been dealt with separately in subsequent sections.

5.4 Agriculture

The effect of the changing temperature and precipitation regimes on local agriculture were assessed through the following parameters:

Change in crops cultivated

Agriculture is the mainstay of the people of Bagrote, and is mostly practiced for subsistence. However, as compared to previous times, there has been a change in the number and types of crop species grown. In general, less crop is produced presently. The diet of the people has also shifted from consumption of local organic food (e.g. apricots, barley, millet and vegetables) to packaged food available in the market - e.g. *Dalda* (cooking oil), rice and tea.

Earlier, only one crop was grown per year, as winters were harsh and lasted for a longer time (November - February). Since the last few years, two crops are grown each year, as there is a longer duration of suitable time available for crop cultivation - when one crop is ready for harvesting, there is still enough time for the second crop to be sown and harvested. However, not all households avail the opportunity of the extended crop growing season; some still grow one crop (maize) and that also for domestic use.

Potato is grown commercially since the past 5-6 years by almost all households; it has gained importance as a cash crop and it gets a good price in the market. Wheat and tomato is also grown commercially. Maize is another major crop grown. Other vegetables grown, mainly for domestic consumption, include cabbage, carrot, onion, radish and red beans. Some crops that were grown earlier include barley and millet (*bajra*) – cooler temperature in earlier days was more suitable for these crops. Even in those days, some households rotated between crops – barley, maize and wheat. However, no crop was grown commercially.

Change in cropping calendar (sowing and harvesting times of agricultural crops)

In Bagrote, most places have two cropping seasons per year: February-March (*Sharobani*) and November-December (*Bazonobani*).

The respondents were unanimous in their opinion that the sowing and harvesting time of crops has undergone a change and sowing now takes place earlier. However, there is some difference of opinion on the number of days by which the sowing time has changed. This difference in response can be attributed to the variations in the location of the agricultural fields. Most respondents reported a shift of about 10-20 days, while some reported a shift of as much as one month.

The responses regarding the harvesting time of various crops were also varied, with some respondents reporting no change in harvesting time, while others reporting a shift of up to 7-15 days or even a month.

The reason given for these changes is the change in weather conditions and precipitation, due to warmer temperature in recent years leading to early harvesting of crops.

Change in crop yields

A comparative increase in yield (in terms of field utilization and productivity) was reported by a majority. However, in some areas, especially in the lowest and highest altitude areas, where there is relatively less water and snow now, yield has reduced for many households. The general trend is a 30-40% change in yield. A few changes in the agricultural practice that has occurred in the past few years include adoption of imported High Yielding Varieties (HYV) of seed and intensive farming techniques, including the use of nitrophosphate / *urea* / imported chemical fertilizers (from China and Punjab) as opposed to the local / natural / organic fertilizer used earlier. Most farmers recognized that the use of chemical fertilizers is reducing the natural productivity of their land. They have also noticed that the land quality has reduced over the years, thus requiring increased dependency on fertilizer use, pulling them into a vicious cycle of fertilizer use.

Change in incidence of crop pests and diseases

When asked to comment on the incidence of crop pests and diseases in relation to the change in climatic conditions, the response varied based on altitudinal differences. However, it is evident that there were hardly any crop diseases in the area a decade ago, except *lom* on leaves.

The respondents in most areas reported a definite increase in disease incident in crops. The reason was linked directly to warmer climate, especially during winter in recent years. One respondent pointed out that increased rainfall causes more disease. Another resident informed that the land closer to glacier catches less disease and is of better quality, which suggests that receding glaciers has affected the quality of land as well, thus increasing risk of pest attack.

A list of prevailing crop diseases was provided by the interviewees. These include a big sized pest on grass, vegetables and wheat; *lojomi* (disease in which holes form in potato crop); *lom / shor* (pest in which leaves dry up due to less rain), *ashore* (pest in which wheat grain becomes weak and slack), *kinuroogh*: (disease in which wheat grain becomes black), *lomboroney* (disease in which the stem turns yellow and the crop falls or limps), *oludumi* (pest on potato crop), *mulagai* (worm in potato crop); and earthworms that damage and kill plants.

Since the past 5-10 years, all fruit trees (apple, apricot, pear and walnut) catch disease and also cause itching in humans. Therefore, fruit trees are hardly grown, especially in highlands.

5.5 Livestock

Though livestock number and ratio per household has reduced, all households maintain livestock to meet their own requirements of meat (in funerals and religious festivals), dairy products and fertilizer. Livestock includes cow, donkey, goat, ox and sheep.

Most respondents reported no substantial change in livestock health. However, they did highlight a change in the source of food for livestock which feeds on market food now, since natural fodder (grass) and rainfall has reduced at pastures.

Most of the owners shared that milk production has increased with an increased amount of food being fed (wheat *chappatis* and mustard oil) and use of chemical fodder. Also, they said that the quantity of butter has increased, though the reason for this was not attributed to the livestock health but the easy use of machines resulting in easy extraction.

Those who reported lessened quantity of milk production owed it to the reduced availability of natural fodder. These members said that in the fields where fodder was grown earlier, potato cultivation is now being done instead. Hence, there is less grass available particularly in the potato cultivation season.

Despite the improved feed and consequent production per herd, overall production from livestock has been adversely affected by heat intensity causing rotting, reduced number of livestock per household and increase incident of disease in livestock.

5.6 Biodiversity

Variations in the incidence of diverse species in the region were assessed with reference to the following aspects:

Changes in sighting of bird species

Bagrote valley and its adjoining areas used to be very rich with regard to bird species, including migratory birds. The main bird species of the area were *baaz*, *chakor*, crow (*kayein*), *churya*, dove (*fakhta*), eagle, falcon, *gasharing* (were raised to pick up goat kids), hawk, *kaakas*, *katayi*, *keen*, *khakeo*, *khashap*, *kuarey*, *kuharo*, *kunulisyun*, owl, partridge, peacock, pigeons (*neeli, kunooli*), *ram chakor* (*bulaij)*, sparrow and wild pigeons. However, due to hunting, change in weather conditions and loss of habitat from deforestation, a number of species have become extinct in the area. A noticeable difference has been observed in sighting of crows which respondents claimed have become almost extinct. The surviving bird species of the area are doves, sparrows and wild pigeons. Locals link this disappearance of certain species with the prevalent hunting practices, noticeable changes in weather and dwindling number of trees.

Changes in sighting of animals

In terms of wildlife, Bagrote is home to black bear, fox (Vulpes Vulpes), ibex, keil (Capra Ibex Sibrica), leopard (Felis Bengalensis), markhor (Capra Falconari falconari), urial (Ovis orient talis vignei) and wolf (Canis Lupus). However, due to poaching, black bear is totally extinct from the locality, whereas leopards and wolves are sighted rarely. The population of keil, markhor and some reptiles (lizard and snake) has also decreased considerably, due to hunting and scarcity of grazing sites. In recent years, the surviving wildlife in the area can hardly be seen in the valley or the lower slopes of the mountains. People speculate that due to a warmer climate regime, food for the animals is available on higher terrain only.

Changes in natural environment

Biodiversity in the area includes forests by the following names: Asare, Bajeja, Barchi, Barring, Barshonal, Botomi, Bushana, Busoner, Chak, Cheendar, Daar, Damye, Darja, Diaga, Dodiroon, Gargoh, Goshal, Gotomi, Hinali, Khaama, Khoja, Khotai, Khotum, Kushupal, Poshna and Tagabari. In Sinaker, there is no glacier thus no forest exists, as reported by a respondent.

The resources used by the local communities (largely for construction, fuelwood and grazing) include trees of *deodar*, juniper (*cheer*) and *katal*. These trees are still seen in the area, but the quantity has reduced drastically, due to excessive use of these trees as fuelwood. In recent years, social forestry is practiced in the region. B*air*, *beo*, poplar (also used as fuelwood), mulberry (*shahtoot)* and willow are some of the trees grown by locals.

Medicinal plants are available but risk of extinction is feared. The medicinal plants available include *biyar, bujhfuner* (used for curing typhoid)*, chenaru* (used for curing back pain)*, karchool, kasoonar, kayoli, kinidar, lolo, makholo, neerko, pashkara, phesan, roon, surgeon* and *tumoro*. However, these are not extracted anymore. Improved access to modern medicine, through the establishment of hospitals and clinics, has reduced community dependence on traditional medicine.

80% of the respondents reported a reduction in natural vegetation on mountain slopes, drying up of pastures and a decline in tree / forest cover (birch, juniper, *kasoonar* - shrub used for firewood – is extinct now). They attributed it to warmer climate, less precipitation, overexploitation of resources (mostly for fuelwood use and construction) and deforestation. Population increase and deforestation has also meant increased use of timber. Resultantly, the remaining forest sites have moved further uphill.

Due Since a few years, tree cutting is forbidden by the government since a few years. Therefore, locals use dried tree branches and plants as fuelwood. Apricot, *bair*, *beau*, *payalo*, mulberry, poplar and walnut trees are mostly used for the purpose. Timber is bought from market, if need be. In Taisot, earlier own (walnut) trees were used for fuelwood, but now that they are longer exist; hence, forest trees are being cut for use.

5.7 Lifestyle Patterns

The changes in the lifestyle of the community over the past 5-10 ten years, which may be attributed to climate change, were assessed through:

Change in construction style and materials used
The construction design and construction material that was used has undergone a drastic change due to the warming of the climate. Earlier, indigenous construction material (mud walls, soil bricks, stone and wood) and woolen carpets were used, which would provide better insulation in extreme temperatures. Every house had a large underground room, which was heated and the whole family would live there during winters. Sometimes, cattle were also accommodated in the same room for greater warmth.

However, since the winters are not very cold any longer, cement and RCC blocks are commonly used for house construction, which is not only more convenient to use but also allows the houses to be kept cleaner. Underground rooms are also not being constructed anymore or used; the family can comfortably live on the ground floor for the whole year. Infact, family members now live in separate rooms, since it is not necessary to conserve heat anymore.

Change in clothing
The people in Bagrote used to wear heavy hand-made woollen clothing in winter. Women who used to make these woollen clothes/caps now work in the field instead, as warm clothing are not needed as much since the past 10 years; instead, lighter Chinese jackets are being used now.

Change in quantity of fuelwood required for heating in winters
Respondents reported a definite reduction in the use of fuelwood needed per person during winter, since the past 5 years. Earlier, people used to sit around fire stove (*bukhari*) all day, as it would be too cold to step out and do anything else. Substantial amount of wood be needed to be stored for winter. In recent years, consumption per household has reduced by 30-50%, on average. Reasons given for per head reduction in fuelwood use is availability of heater and electricity, less intensity of winter cold and less snowfall. Presently, for 100 maunds used per year, 50-70 *maunds* are consumed in winters. In highland villages, people in the area migrate to lower areas in winter.

Though per head fuelwood consumption has reduced due to warming climate, population increase has resulted in an overall increase in fuel usage. With the increase in the number of rooms used per house, there has been an increase in the number of fireplaces and hence fuelwood use (depending on family size and number of rooms). Earlier, the whole family used to live in only one room with a centre stove.

Change in incidence of diseases
Respondents noted an increase in the type of diseases prevalent in recent years. Diarrhea has been reported to have become quite common. Asthma, back pain, blood pressure, cancer, cardiac diseases, cholera, flu, goiter, joint pain, malaria, paralyses, pneumonia, TB and typhoid also prevail. Many of these diseases were not known earlier. In the past, fever was the only known illness; elders used to get sick more, while currently women and children catch more disease. Immunity is decreasing. Residents felt that replacement of organic food with synthetic market food (such as *Dalda* (cooking oil), rice, sesame seed oil and tea) has resulted in an increase in the type of diseases.

However, people felt that the incidence of disease can be controlled due to awareness, change in source of spring water / clean water usage and improved access to medical facilities. Additionally, availability of iodized salt has reduced incidence of goiter.

5.8 Other Factors

Other indicators that suggested colder climate a decade ago include:

- Water would freeze in utensils, while being carried home
- 15 years ago, it was so cold that trees would break in winter
- Meat (used extensively in winter) was stored for winter as it was too cold to leave home in winter
- Wheat (4-5 *maunds*) was stored for winter as there was no road access in winter
- *Giri* (apricot seed) was used
- Increase in disease and weakness has affected work on the field

6. CLIMATE CHANGE INTEGRATION INTO CKNP MANAGEMENT PLAN

6.1 Rationale for Integration of Climate Change into CKNP Management Plan

Interdependence of nature and culture
While many PAs are devoid of human population, CKNP has pockets of substantial population, especially in the valleys. Over the years, the residents have developed a way of life in sync with their physical, biological and aesthetic environment. People in these areas are accustomed to varying climatic conditions and traditional land-use systems, e.g. moving livestock to higher summer pastures after snow melt. However, in recent years climate variability has increased beyond past limits. Climatic change has rapidly altered locals' lives as well the natural environment on which the community culture and livelihood is heavily dependent, such as for water, food and forest resources. Damage to these ecosystems pose risk to the services they provide to society and expose the poorest and most vulnerable communities to more severe and frequent climate related hazards.

Such ecological and anthropogenic factors signify an urgent need to gather knowledge about prevalent and projected changes, and integrate mitigation and adaptation plan in the CKNP management process. In addition to providing protection to the socio ecological environment, a sound management plan and associated actions will ensure fulfillment of international agreements, such as the United Nations Framework Convention on Climate Change (UNFCC). From a conservation perspective, considering that CKNP, more specifically Bagrote, is an ecologically important area, creating a model region can provide a successful reference point where vulnerability to climate hazards and climate change is effectively mitigated and adapted to in other areas. The challenge is less about dealing with specific projected impacts, and more about developing strategies to manage the uncertainties created by climate change. This means going beyond a static management plan and moving towards a dynamic approach that tests assumptions, monitors results and adapts management actions accordingly.

Factors outside our control
While human activity is taken to be the main explanation for the change in the climate (largely through increase in CO2 levels due to emissions from fossil fuel combustion, aerosols, land use, irrigation, animal agriculture and deforestation), several naturally occurring factors also influence the climate, such as global circulation patterns; glaciation; ocean and solar variability; plate tectonics and on the medium and large scale, by elevation, valley orientation, aspect, slope and the height and number of upwind barriers to the airflow.

Hence, as natural and anthropogenic factors influence impact of climate change in the region, all of which cannot be controlled or prevented, it is felt that anticipatory adaptation is better than waiting for climate change and then reacting to it. Not only will that be costly, but the climate change results may be irreversible, e.g. loss of biodiversity. Anticipatory measures will give benefits even in the absence of climate change; therefore it is a no-regret option.

6.2 IUCN – World Commission on Protected Areas

In order to ensure result oriented intervention, the climate change management implications of this study (discussed in later sections) need to ensure adherence to the following categories, as defined by IUCN in its work in protected areas.

- Strict protection
- Ecosystem conservation and recreation
- Conservation of natural features (monument)
- Conservation through active management (habitat / species)
- Landscape conservation and recreation
- Sustainable use of natural ecosystems

6.3 Adaptation Implications

- Management implications - building resilience and managing for uncertainty
- Socio-cultural implications - supporting preservation of local traditions and cultural heritage
- Economic implications - establishing sustainable livelihood solutions for the locals, such as through ecotourism
- Political implications - incorporating climate change mitigation and adaptation into policy and legislation, as well as district management plans
- Ecological / biological implications – mitigating the impact of climate change on the natural environment and making effort towards recovery

6.4 Sector Specific Action Plan for Adapting to Climate Change

For simplicity, the climate change related management guidelines are discussed under four headings, for each of the discussed sectors, also listed below. The four key questions are:

i. 'What **is** happening', in terms of the impact of climate change observed in the area.
ii. 'What **can** happen', in terms of projected changes that can occur due to climate change.
iii. 'What **is** being done', in terms of coping strategies currently in place - autonomous and induced (market based and public policy driven).
iv. 'What **should** be done', in terms of contextual adaptation and mitigation efforts recommended.

The sectors for which management options have been provided include:

1. Water
2. Agriculture
3. Livestock and rangeland
4. Forest
5. Wildlife
6. Livelihood
7. Other factors (influencing the sectors listed above)

6.4.1 Water Management

<u>What is happening?</u>

- The mean temperature is rising;
- The minimum temperature for winter and maximum temperature for summer is rising;
- Winter precipitation is occurring in form of rain rather than snow;
- There is less rainfall in summers;
- Snowmelt season is occurring earlier than before
- There is increased water from glacial melt, due to rapid shrinking of glaciers;

- Due to variability in frequency and intensity of precipitation and consequent reduction in glaciers, the snowpack, river runoff, and water supply reliability and quality have been adversely affected in upstream and downstream areas; and
- Cloud forests are drying. The catchment area is not getting sufficient water for sustenance; the reason is attributed to cloud formation.

What can happen?

- There may be changes in wind direction, suggesting change in general atmospheric patterns;
- There will be fewer cold nights, while heat waves will become common;
- With the increases in surface air temperature, acute shortage of water resources is expected. According to the World Bank (2006), the Western Himalayan glaciers will retreat for the next 50 years, causing increase of Indus River flows. With a reduction in the length and thickness of various glaciers and consequent increase in river flow, water availability will increase in areas dependent on glaciers outflow. However, as the glacier reservoirs disappear and snowline moves upwards, river flows will change, resulting in decrease of flows by 30-40%;
- Intense hydrological changes are expected, due to reducing mass balance of snow and receding glaciers;
- Changing precipitation patterns will affect how much water can be captured;
- Changed snowline will result in a higher direct runoff in winter and a decrease of water level in summer when it might be needed for irrigation. This translates into the same annual amount of water in the annual system, but reduced usability of the water;
- New patterns of runoff and evaporation will also affect natural ecosystems;
- There may be no buffering ground for rivers. Glaciers provide a long-term storage for precipitation, buffering the variability of annual precipitation and providing a constant input to the river system. When glaciers decrease, they will no longer provide the same buffering capacity, allowing drought years to have a stronger direct influence on water levels and thus irrigation;
- Reduced water supplies will place additional stress on people, agriculture and environment;
- Conflicts could be sparked by the additional pressures; and
- There is risk of increased number of more glacier associated intense hazards, i.e. avalanches;
- There is risk of frequent floods (especially in lowlands) and avalanches (due to rise in temperature, and more rain than snow), followed by severe droughts;
- There can be increased incidence of landslides, due to less snowfall, more winter rain and depleting forest cover;
- Altered river flow and changes to sediment, salt loads and nutrient dynamics is feared;
- 'Higher water temperatures and changes in the timing, intensity, and duration of precipitation can affect water quality'. This is because 'higher temperatures reduce dissolved oxygen levels'. 'Flooding can also affect water quality, as large volumes of water can transport contaminants into water bodies and overload storm and wastewater systems' (IPCC 2007);
- Higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution, with impacts on ecosystems, human health, water system reliability and operating costs (IPCC 2007).

What is being done?

- User rights and water distribution system:
  - In some villages, the community has installed a water supply system, in form of a storage pond, to avoid intermittent supply of water during winter

season. Water is transported to households through pipes and water channels; and
- Water rights have been established, whereby the available amount of water is distributed amongst the local residents, who take turns – each household gets a turn once in every 9 days. The payment made is Pak Re. 1 for 40 minutes of water supply used. Earlier, people paid taxes according to the amount of land they owned; now, there is no tax, but the distribution system is the same.

What should be done?

- Assess demand for water;
- Establish and implement watershed management and preservation:
  - Explore options for water availability and use;
  - Make frugal use of water;
  - Set up water storage systems – construction of pumps and village ponds;
  - Set up carefully planned, sited and maintained micro-hydel development projects, to suit hydrological as well as aesthetic requirements;
  - Adopt flood control and mitigation, such as through construction of small dams;
  - Consider slope stabilization of landslide and flash flood prone areas. Storminess, temperature, wind, slope steepness and orientation (the direction it faces), terrain, vegetation, and general snowpack conditions are all factors that influence whether and how a slope avalanches;
  - Impose restrictions on collection of sand and boulders, to control landslides;
  - Protect river bank by strengthening the embankments through rock soling;
  - Build dikes and water control structures;
  - Improve drainage by lining water channels;
  - Set up high efficiency (water conserving) irrigation systems for irrigated agriculture, such as through drip irrigation;
  - Improve / maintain water quality and safe water supply, such as through installation of water channels and water treatment plants;
  - Consider adoption of Payment for Ecosystem Services (PES), including provisioning, supporting, regulating and cultural services;
  - Formalize user rights system;
  - Form village water committees;
  - Set up advance seasonal weather forecast; and
  - Study temporal behavior of glaciers.

6.4.2 Land Use and Agricultural Management

Weather is a key factor for agricultural productivity, as well as for soil properties and natural commodities. The effect of climate on agriculture is related to variability in local climate, rather than to global climate patterns. Also, agricultural production may be mostly affected by the severity and pace of climate change, not so much by gradual trends in climate. This is because in areas that are already suffering from poor soil and climatic conditions, there will be less time for optimal natural selection and adaptation.

What is happening?

- Winter season is shorter and milder;
- The increase in mean temperature is causing an extension in the cropping period. The trend is towards an earlier sowing and harvesting time;
- With a longer summer period, there can now be two cropping seasons in one year;
- There has been an increase in the type and variety of crops grown;
- Land quality and natural productivity has reduced;
- Crops suited to cooler temperatures, such as millet and barley, are not grown as much anymore;

- There has been an increase in the number of diseases in crops and plantations;
- Early flowering time has been observed; and
- There is reduced quantity and quality of fruit in general.

What can happen?

- Crop productivity is projected to increase slightly, at mid to high latitudes, for temperature increases of 1 to 3°C, depending on the crop, and then decrease beyond (IPCC);
- CO2 concentration, temperature, rainfall and solar radiation changes will interactively affect crop productivity;
- With the increase in temperature, there can be a further increase in pressure from insects and disease vectors, especially at high altitudes;
- The increase in winter rains, combined with higher temperatures, can form fungal diseases;
- There can be weed proliferation, which may compete against crops such as corn;
- Higher CO2 levels may lead to reduced plant uptake of nitrogen, resulting in crops with lower nutritional value. Hence, reduced soil fertility, grain quality and soil moisture is feared;
- A change in frequency and intensity of soil drainage is predicted. There may be an increased incidence of sediment transport, as well as soil erosion following increased torrential rains. Increased nutrient movement into waterways is expected as a result;
- Increased biomass production and productivity may occur with enhanced CO2 in the atmosphere;
- Agricultural land, forests and ranges may move up the slopes with the warming of temperature; and
- There can be changes in land use and management - as the climate changes, farming, forestry, wildlife, water management and many other land uses are likely to change with it.

What is being done?

- Two seasons are utilized for crop production, each year;
- Planting and sowing season begins early;
- There has been a change in the type of crops grown. Traditional crops, such as barley and millet (suited to cooler temperatures), have been substituted for cash crops, such as potatoes;
- Crops are being grown for commercial purpose;
- Variety of fruit trees grown ahs increased; and
- There is increased dependence on fertilizer, to boost yield.

What should be done?

- Adopt conservation agriculture - with minimum mechanical soil disturbance and a permanent organic soil cover and crop rotation (FAO)
- Adopt organic agriculture - increase soil organic carbon, reduce mineral fertilizers use and reduce on-farm energy costs
- Adopt risk coping production systems that incorporate crop rotation and crop livestock association);
- Adopt soil and land management practices that have resilience against both excess of water and lack of water;
- Change the cropping calendar to take advantage of the wet period and avoid extreme weather events (e.g. floods, avalanches) during the growing season;
- Develop and use crop varieties adapted to changing climatic conditions, such as species resistant to pests and diseases and evapo-transpiration;
- Adopt agro-forestry (combing shrubs and trees with crops and / or livestock). Agro-forestry and 'carbon farming' forestry have the capacity to provide multiple benefits by way of shelterbelts, biodiversity, salinity control and water

quality. Trees and shrubs play a vital role in mitigating impacts of extreme events - they ensure restoration of soil fertility and conservation of biological diversity, trees and forests; provide shade to crops and animals; improve micro climate by buffering winds; and regulate water table. Thus, they contribute to sustainable agricultural production and food security. Practicing agro-forestry can also promote soil carbon sequestration, while improving agro-ecosystem function and resilience to climate extremes by enriching soil fertility and soil water retention;

- Adopt agro-biodiversity, through use of indigenous and locally adapted animals, plants and crops; multiplication of crop varieties; selection of crop and cultivars with tolerance to abiotic stresses (e.g. limited arable land, drought, flooding, high temperature, pest and disease), plant breeding (with emphasis on conserving diversity, broadening genetic base of crops, adopting varieties adaptive to diverse and marginal conditions, promoting locally adapted crops and under utilized species, and reviewing breeding strategies) – (FAO);
- Adopt organic farming, for benefit to land and human health. Such a system relies on crop rotation, organic manure, compost, biological pest control and mechanical cultivation, to maintain soil productivity and control pests. It excludes or strictly limits the use of synthetic fertilizers and synthetic pesticides, livestock feed additives and Genetically Modified Organisms (GMOs);
- Use organic soil matter, which improves and stabilizes the soil structure, so that the soil can absorb higher amounts of water without causing surface run off, which could result in soil erosion and flooding downstream. Organic soil matter also improves water absorption capacity during drought. Low tillage and maintenance of permanent soil cover can increase soil organic matter and reduce impact on flooding, drought, erosion, heavy wind and rain (FAO);
- Match fertilizer application timing and quantity to plant nutrient needs at different growth stages. This increases productivity and nutrient absorption by plants;
- Make fertilizer application timing around irrigation and rainfall events, to avoid anaerobic conditions that increase emissions;
- Place fertilizer where it is most accessible to plant roots. Excess fertilizer use where there is run-off can also impact on water quality;
- Use controlled release fertilizers and urease, to extend the time available for nutrient uptake by plants;
- Make increasing use of climate forecasting, to reduce risk to crop production;
- Protect seed sources, such as through development of seed bank;
- Undertake small-scale agriculture, to undertake diversification in crop production;
- Ensure better post-harvest management and marketing improvements;
- Work towards increased institutional support, including input credits for small farmers and intensification of research, rationalization of input and output prices;
- Make increased investment in agriculture infrastructure;
- Determine land use capabilities in the identified zones, based on biological needs of the commodities and marketing opportunities;
- Adopt land use planning approaches: identify high priority areas and areas where investments is needed most under changing climatic conditions; special attention should be given to pastoralists and local people and their relation to natural disasters;
- Inventorize global technology, to reduce irrigation and drought conditions;
- Reduce nitrous oxide emissions: they result from nitrification and de-nitrification processes in soils. Synthetic fertilizer use is the main source. Also, as plants absorb 20-80% of applied nitrogen, the excess causes Greenhouse Gas (GHG) emissions or leaching and run-off, with potential detriment to water quality and animal production of urine and faeces. Hence, fertilizer and

soil management is important. Maintaining good soil structure and continuous plant cover, retaining stubble and managing water resources helps improve soil fertility and moisture-holding capacity, while also reducing emissions. Minimum tillage, controlled traffic, moisture management, continuous vegetation cover and residue retention increases soil carbon.

- Reduce carbon emissions by reducing land clearing or conversion of forested land to agriculture, in order to preserve carbon stores that would be released if forests were cleared.

6.4.3 Livestock and Rangeland Management

What is happening?

Climate change has had a direct and indirect effect on livestock and its productivity. Some of the indicators include the following:

Husbandry challenges and practices

- Herd size per household has reduced;
- Supply of feed at rangelands has depleted, due to reduced pasture productivity from erosion and reduced precipitation, leading to lowered quantity and quality of grass (dry, less green and shorter grass);
- The indigenous shrubs are vanishing;
- The grazing activity at pasture sites has reached near or over sustainable carrying capacity;
- Some pasture sites have shifted to higher altitudes;
- There has been a change in location of winter (rain fed) pasture sites;
- Time taken to reach pastures has increased for those based at higher altitudes;
- There is an increase in the number of disease prevalent amongst livestock; and
- Dairy production gets spoilt at times, due to increased heat intensity.

What can happen?

- Climate change can affect lives of nomadic and transhumant livestock keepers, due to intensified husbandry challenges listed above. Their livelihood will be affected with reduced dependence on livestock rearing and selling of dairy products to earn a living. Likewise, as most people maintain livestock to meet their own dairy requirements, reduction in herd size and hence production will mean that the cost of living may rise, as people will have to buy dairy products for household use;
- The effects of climate change on livestock can be direct (e.g. effects of higher temperature on livestock appetite - livestock intake and livestock weight are estimated to generally decline in late summer when digestibility is lower.) or indirect (e.g. effects of changes in quantity and quality of forage from grasslands and supplies of feed). In areas where livestock rely on surface water availability, water quality could have an impact on weight gain. This would be particularly important where fewer water sources become used by greater numbers of cattle. Livestock production is also affected by changes in temperature and extreme events; and
- Pastoral ranges may move up the slopes with warming of temperature.

What is being done?

- Livestock is feeding on market (chemically produced) fodder, mainly due to shortage of natural fodder. In some households, livestock feeds on fodder grown on own agricultural land;
- Fodder production on some agricultural fields has been replaced by potato cultivation (cash crop); and
- Dependence on livestock rearing has reduced.

What should be done?

- Introduce livestock breeds adaptive to changing climatic conditions;
- Find new routes and well stocked pastures;
- Rehabilitate existing pastures and restore land by controlled grazing. Community level committees should play an active role in adopting a rotational plan to use the authorized pastures. This would mean that while one pasture is left to rejuvenate / replenish, the other is used for that duration by community members. This effort can lead to soil carbon sequestration, reduce desertification and also provide social security to the impoverished communities during extreme events, such as drought;
- Integrate animal manure waste management systems, including biogas capture and utilization, for reductions of CH4 and N2O. This can help create demand and consequent income from farmyard manure (Smith 2007);
- Graziers should adapt to stall feeding;
- Consider matching livestock stocking rates with pasture production, altering pasture rotation, modifying grazing times and forage and animal species / breeds, integrating within livestock / crop systems including the use of adapted forage crops, re-assessing fertilizer applications and the use of supplementary feeds and concentrates;
- Reduce emissions:
  - Methane emissions (largely from enteric fermentation in cattle and manure):
    - Give a natural diet and / or ruminant diet;
    - Ensure selective breeding from animals with high feed-conversion efficiency (ability to convert feed mass into body mass, such as for meat production) and fecundity (reproductive capacity – major measure of fitness);
    - Improve feed digestibility and nutrients, to increase feed-conversion efficiency; and
    - Use feed additives and vaccination.
  - Methane emissions:
    - The use of certain alternative forages has the potential to reduce methane emissions by 10-20%. The feed additive sodium monensin has also been shown to reduce methane emissions as a co-benefit to its main purpose of reducing bloat in lactating dairy cows; it achieves this by both reducing the feed intake of cows without reducing their milk production, and reducing the amount of hydrogen produced in the rumen.
- Reduce production of red meat and convert to poultry and fish production;
- Adopt alternative policy instruments, such as levy and incentive payments; and
- Revise pastoral use and management policies and plans.

6.4.4 Forest Management

What is happening?

- There is a major decline in forest cover, largely due to reduced precipitation, warmer climate, deforestation and overexploitation of resources (such as for fuelwood and construction);
- There is less natural regeneration due to decreased precipitation;
- Annual fuelwood drain is three times higher than the rate of wood replenished;
- There is drastic reduction in the variety and quantity of trees (juniper and *katal* tress are facing risk of extinction);
- Juniper, birch, *kasoonar* and deodar are used as fuelwood, in addition to dried branches and plants;
- There is increasing demand for timber ad firewood, due to increase in population and change in lifestyle (such as change in housing style – a

change from one-room houses to multiple rooms, each room with its own fireplace and hence firewood);
- Cooking and heating is usually done on separate stoves;
- Heating efficiency of locally made open stoves is 10-25% and causes indoor air pollution;
- Wild plant species have been affected by grazing and wood harvest;
- Medicinal plants fear extinction;
- There is reduced herbage quality;
- There is loss of wetlands and associated biodiversity; and
- Fruit trees blossom earlier.

What can happen?
- Forests may move upwards with the warming of temperature;
- Range of many plants may be pushed to higher elevations;
- There may be a change in phenology (life-cycle events - flowering, egg-laying, migration);
- There may be changes in metabolism in plants (photosynthesis, respiration, growth and tissue composition);
- Deforestation may damage land quality;
- There may be high risk of forest fires;
- Risk of aridity may occur;
- Ecosystems may become carbon sources, as vegetation burns or decays; and
- Species that depend on one another may become out of sync. For example, plants could bloom before their pollinating insects become active.

What is being done?
- There are government imposed restriction on cutting of trees;
- There is a community level forest management and user rights system in place, mostly through the local CBO; and
- Social forestry is practiced. Poplar, mulberry, *bair*, *beo*, willow and *shahtoot* are some of the trees grown.
- Dried branches and trees are used as fuelwood; and
- Timber is bought from market, as forests in close vicinities are mostly depleted.

What should be done?
Restore and rehabilitate forest landscape:
- Undertake changes in forest management:
  - Ensure right mix of hardwood / softwood species;
  - Review timber growth and harvesting patterns;
  - Review rotation periods;
  - Shift to species or areas more productive under new climatic conditions;
  - Plan landscapes to minimize fire and insect damage; and
  - Install fire management systems.
- Strictly implement forest protection policies;
- Formalize user rights;
- Search for fuelwood alternatives;
- Protect biological diversity (including pollination and seed distribution);
- Identify resistant genotype - some genotypes in certain populations are more resistant to climate change than others. Although the core population may become extinct because of global warming, resistant types in peripheral populations will survive and can be used to rehabilitate and restore affected ecosystems. The geographic locations of the peripheral species population usually coincide with climatic transition zones;
- Give special attention to those tree species that have poor seed dispersion, occupy ecological niches, have a small population, have a restricted range,

are peripheral species, are genetically impoverished or have important ecosystem functions;
- Work towards reforestation;
- Promote natural revegetation, such as with locally adaptable trees;
- Select suitable tree species for planting. The species should be fast growing, provide required products, protect soil, and adapt to a wide range of future temperature and moist regimes (e.g. Chir pine);
- Adjust planting dates to minimize the effect of temperature increase;
- Reduce wood use, e.g. through cooking and heating done on the same stove;
- Establish fuelwood orchards;
- Conserve cultural habitat;
- Conserve scenic beauty;
- Adopt opportunistic planting;
- Adopt community-based forest management model;
- Reduce reliance on forests for livelihood;
- Substitute NTFPs, to reduce the effect of climate change on wood availability;
- Discover and implement alternative fuel options for the local communities
- Control changes in the micro environment – the forest area needs to function as carbon sink. Plants and trees absorb CO2 as they grow, "sequestering" carbon naturally. Increasing forestlands and making changes to the way we farm can increase the amount of carbon we are storing; and
- Protect upper-catchments forests and restore wetlands, to reduce risks from climate-related floods and droughts, amongst other benefits (e.g. maintaining biological diversity, and water quality and storage).

6.4.5 Wildlife Management

What is happening?
- Species face extinction;
- There is a shift in species location – upward trend;
- Trophy hunting is practiced;
- Grazing competition is being faced; and
- There is increased incidence of disease.

What can happen?
- Ecosystems are expected to change - habitat fragmentation and destruction is feared. There will be changes in distribution and abundance of species, including insects. Some animal species will shift upwards or become more successful; others will not be able to move and may become extinct due to their inability to adapt to rapidly changing climate and habitat conditions;
- There may be a change in the distribution of insects that carry diseases, such as dengue and malaria;
- Changes in species interactions are predicted;
- Shift in species composition may occur;
- The life cycles of many wild plants and animals are closely linked to the passing of the seasons. Changes in the timings of seasonal events may lead to ecological mismatches, such as in the availability of food for wildlife. Climatic changes can also lead to interdependent pairs of species (e.g. a wild flower and its pollinating insect) losing synchronization, if, for example, one has a cycle dependent on day length and the other on temperature or precipitation. In principle, atleast, this could lead to extinctions or changes in the distribution and abundance of species;
- Extreme weather events (e.g. floods, droughts) will adversely effect species population;
- There may be disruption to stream and wetland food webs, due to reduced supply of nutrients;
- Diet of animals, birds and insects may require change;

- There may be disruption of the semi-regular cycles of expansion and contraction of cool and warm climate adapted species;
- Earlier birds breeding and spring arrival, and delayed autumn departure is expected;
- Threat to long distance migrants is feared;
- There may be loss of migratory birds dependent on streams;
- There may be a change in community ecology - changes to competitive advantages between species and the spread and impacts of invasive species and diseases are likely to lead to different communities of plants and animals than those present today;
- Drier summers could lead to more periods of drought, potentially affecting many species of animal and plant;
- There may be ascendancy of weedy or opportunistic species at the expense of scarcer species with narrower or more specialized ecological requirements (http://www.climate365.com/cliamte-change);
- Milder winters may result in trees leafing earlier, reducing the length of the window to complete their life cycle; and
- Changing rainfall patterns can increase the risk of extinction of vulnerable species.

The following list is indicative of the factors that can help to identify biodiversity susceptibility to changes in climate:

- Bounded distribution, such as mountain tops and high latitudes;
- Restricted areas;
- Poor dispersal capability relative to the projected nearest suitable 'climate space';
- Physical limits to dispersal e.g. barriers formed by mountain ranges and fragmented habitat;
- Limits imposed by species attributes, such as slow-moving, slow-growing, flightlessness in birds and insects; and
- Susceptibility to extreme temperatures, droughts, snowfall, winter temperatures, sea surface temperatures, sea level rises or floods.

Other indicators:

- Extreme habitat / niche specialization, such as a narrow tolerance to climate sensitive variables ;
- Close, co-evolved, or synchronous relations with other species; and
- Inflexible physiological responses to climatic variables.

<u>What is being done?</u>

- Trophy hunting – money from the exercise goes to local communities, thus increasing their interest in wildlife conservation.

<u>What should be done?</u>

- Work towards restoration and repopulation of species;
- Strictly implement adherence to hunting, trapping and poaching restrictions;
- Work towards prevention and mitigation of alien and invasive species;
- Explore and implement income generation alternatives for communities - review trophy hunting policy and implementation to ensure sustainability;
- Conduct training on wildlife protection and management;
- Conduct training on value of ecosystem for livelihood security. In that, share benefits of saving wildlife for the community, e.g. ecotourism benefits.
- Develop and implement a species conservation plan;
- Develop and implement a wildlife disease management programme;
- Shift protected areas to higher grounds. Though this may have implications for infrastructure surrounding human communities;
- Plan for the movement of species and keep future management options open;

- Provide natural migration corridors; and
- Create regional biological corridors.

6.4.6 Livelihood Options

What is happening?

- Construction of houses has adapted, both in terms of design and material used, to better suit the rising temperatures. Local materials (wood, stone and mud), which were used for insulation purposes are being replaced by concrete and cement. Likewise, underground single room houses for winter living, which were designed to conserve heat, are not constructed anymore. People have moved to multi storey houses with multiple rooms;
- Use of woolen carpeting and warm and multiple layers of clothing during the winter months has declined;
- Fuelwood consumption per person has reduced substantially, though consumption per household has increased, with the concept of multiple rooms as compared to one room used by all earlier;
- There is still heavy reliance on waning forests, especially for fuelwood. This is resulting in environmental degradation.
- Agriculture is almost entirely dependent on spring water, supply of which is intermittent since the last few years;
- There is less reliance on livestock as a source of livelihood;
- Anthropogenic factors (e.g. fuelwood usage, washing and waste dumping in streams) are giving rise to air and water pollution.

What can happen?

Changes in the hydrological cycle (e.g. less snow, more rain, droughts, floods) induced by climate change, can have serious impacts on agriculture based livelihoods, infrastructure and health. In the long run, climate change might also have a severe influence on culture and lifestyle, as cultural habits and traditions are often directly linked to environmental settings. Some expected changes include:

- Natural disasters are feared to cause damage to physical and socio-economic infrastructure, e.g. flooding of sewerage systems, pollutants being flushed into streams, and landslides causing damage to road infrastructure and disruptions to transport;
- There is risk of exacerbating poverty, without the funds to adapt / overcome damage;
- Health of humans and animals may deteriorate as they migrate uphill. This may also result in encroachment of human settlements / cultivation into protected areas;
- Natural resource depletion may also cause changes in resource supply for livelihoods activities, such as crafts making;
- Increase in water borne (e.g. typhoid, diarrhea), food borne (vomiting, abdominal cramps), vector-borne (e.g. malaria, dengue, ticks) and rodent borne (e.g. Leishmaniasis, Leptospirosis and jaundice) diseases / illnesses;
- Increasing illness and death may occur from heat shock / stress. heat waves, floods, droughts and fires;
- There may be a decline in cold winter related deaths;
- There may be a rise in malnutrition with increasing stress on land and its produce; and
- There can be a strain on health services, with the rise in illnesses and heat wave.

What is being done?

- Village level Conservation Committees have been constituted to deal with the issue of changing conditions with the warming of climate; and

- Dubani Trust has developed a community-based management plan.

What should be done?

- Consider community needs (improving traditional practices);
- Explore/provide alternative livelihood options - more off-farm or cash earning job opportunities;
- Establish business opportunities and employ community members for protection and monitoring of resources;
- Initiate services to compensate for loss of winter earnings / tourism;
- Create access to markets, to improve liquidity and food security;
- Promote social organization - Payment for Environmental Services – make the community aware of the environmental significance of natural resources and organize them to manage resources in a sustainable way. Farmers will in turn receive payments. Water availability and quality is expected to increase with this;
- Improve data management for updated and shared information on meteorological data;
- Promote ecotourism– highlight and protect the natural environment and cultural heritage;
- Create awareness on climate change – impacts, adaptation and mitigation (resilience);
- Provide conservation education and awareness in schools;
- Introduce micro-finance schemes;
- Introduce energy efficient and energy saving structures
- Encourage emission free energy production (such as through medium size and micro hydropower);
- Create compensation / disaster fund;
- Provide insurance / mutual insurance, social funds, safety net facilities;
- Create village self-help groups;
- Create women's groups;
- Institutionalize Village Conservation Committees;
- Develop communal water storage system;
- Devise disaster prevention, management and preparedness plan;
- Provide food aid assistance;
- Provide assets protection / recovery;
- Provide re-location / resettlement of affected towns;
- Improved technology of building houses, physical assets, infrastructure, to withstand natural calamities;
- Develop early warning systems;
- Set up weather station, climate proof technologies and infrastructure, climate forecasts;
- Improve public works;
- Conduct hazard mapping and vulnerability analysis;
- Set up ecological monitoring system;
- Provide access to key resources (e.g. land, water rights, emergency services, communication) to enhance people's adaptive capabilities;
- Ensure following services:
  - Provisioning services: food, water, fuelwood
  - Regulating services: climate, disease, flood
  - Cultural services: spiritual, recreational, tourism, aesthetic, inspirational, educational
  - Supporting services: needed for provision of above: soil formation, nutrient cycling, primary production
- Set up system for public-private sharing of costs;
- Review and implement community-based management plan;
- Ensure combined cooking and heating operations; and
- Establish / strengthen disease surveillance and monitoring system, to closely monitor the incidence and prevalence of climate sensitive diseases. This will

serve as an early warning system to inform the preparedness for preventing and dealing with climate induced major health disasters (IPCC 2007).

6.4.7 Other Factors

Acid Rain

Acid deposition primarily results from the transformation of sulphur dioxide (SO2) and nitrogen oxides into dry or moist secondary pollutants, such as sulphuric acid (H2SO4), ammonium nitrate (NH4NO3) and nitric acid (HNO3). Acid rain has been shown to have adverse impacts on forests, freshwaters and soils, killing insects and aquatic life forms, as well as causing harm to physical infrastructure and human health. Some affects have been discussed below:

Surface waters and aquatic animals

Lower pH and higher aluminum concentrations in surface water that occur as a result of acid rain can cause damage to fish and other aquatic animals – fish eggs hatching is affected and adult fish is exterminated. Furthermore, as lakes and rivers become more acidic, biodiversity is reduced.

Soils

Soil biology and chemistry can be seriously damaged by acid rain and low pHs. The enzymes of these microbes are denatured (changed in shape so they no longer function) by the acid.

Forests and other vegetation

High altitude forests are especially vulnerable, as they are often surrounded by clouds and fog which are more acidic than rain. Other plants can also be damaged by acid rain.

Human health

Scientists have suggested direct links to human health. Fine particles, a large fraction of which are formed from the same gases as acid rain (sulfur dioxide and nitrogen dioxide), have been shown to cause premature deaths and illness, such as cancer and other diseases.

6.5 Management Implications

Broad categories of mitigation and adaptation implications are listed below:

- Integrate climate change in all relevant CKNP management planning process;
- Bring conducive policy level changes – review land use plans and zoning;
- Prevent, manage, plan for and learn about change;
- Be a model for conserving other vulnerable ecosystems nationally and internationally, as a part of local and global climate change mitigation strategy;
- Adopt landscape level approach* to conservation management;
- Create effective partnerships that can elevate climate change to a socio-economic, conservation, and political priority among local, regional, and international stakeholders;
- Blend traditional and modern approaches;
- Undertake a survey in Bagrote and build an inventory of the different forms of soils, forest, water use, crop, plant and animal genetic resources, giving priority to those under threat of extinction;
- Protect genetic resources by maintaining and establishing protected areas and improving traditional farming and animal husbandry activities and establishing programmes for evaluating the potential value of the resources;
- Maintain and generate database and information systems to facilitate the integrated management and evaluation of environmental risks and natural disasters in mountain ecosystems;
- Improve and build the existing land / water ecological knowledge base regarding technologies, agricultural and conservation practices in Bagrote, with the participation of local community;

- Build the knowledge base and understanding by creating mechanisms for cooperation and information exchange among local, national and regional institutions working on fragile mountain ecosystems;
- Strengthen existing institutions or establish new ones at local level, to generate a multidisciplinary land / water ecological knowledge base on mountain ecosystems;
- Promote national policies that would provide incentives to local people for the use and transfer of environment friendly technologies and farming and conservation practices;
- Encourage policies that would provide incentives to farmers and local people to undertake conservation and regenerative measures and use environment-friendly technologies;
- Diversify mountain economies, *inter alia,* by creating and/or strengthening ecotourism, in accordance with integrated management of mountain areas;
- Integrate all forest, rangeland and wildlife activities in such a way that specific ecosystems are maintained;
- Establish and maintain meteorological, hydrological and physical monitoring analysis and capabilities that would encompass the climatic diversity as well as water distribution;
- Identify hazardous areas that are most vulnerable to erosion, floods, landslides, earthquakes, snow avalanches and other natural hazards;
- Identify localities threatened by air pollution from neighboring urban areas;
- Launch training and extension programmes in environmentally appropriate technologies and practices that would be suitable to mountain ecosystems;
- Support higher education through fellowships and research grants for environmental studies in mountains, particularly for candidates from the mountain areas (Gilgit-Baltistan);
- Undertake environmental education for farmers, in particular for women, to help the rural population better understand the ecological issues regarding the sustainable development of their surrounding ecosystems;
- Undertake measures to prevent soil erosion and promote erosion-control activities in all sectors;
- Establish watershed development committees, complementing existing institutions, to coordinate integrated services to support local initiatives in animal husbandry, forestry, horticulture and rural development at all administrative levels;
- Enhance popular participation in the management of local resources through appropriate legislation;
- Support NGOs and other private groups assisting local organizations and communities in the preparation of projects that would enhance participatory development of local people;
- Provide mechanisms to preserve threatened areas that could protect wildlife, conserve biological diversity or serve as national parks;
- Undertake income-generating activities in cottage and agro-processing industries, such as the cultivation and processing of medicinal and aromatic plants;
- Generate data on alternative livelihoods and diversified production systems at the village level on annual and tree crops, livestock, poultry, village industries, markets, transport and income-earning opportunities, taking fully into account the role of women and integrating them into the planning and implementation process;
- Consider undertaking pilot projects that combine environmental protection and development functions, with particular emphasis on some of the traditional environmental management practices or systems that have a good impact on the environment;
- Generate technologies for specific watershed and farm conditions through a participatory approach involving local men and women;
- Promote technologies of vegetative conservation measures for erosion prevention, in moisture management, improved cropping technology, fodder production and agroforestry that are low-cost, simple and easily adopted by local people;
- Promote a multidisciplinary and cross-sectoral approach in training and the dissemination of knowledge to local people on a wide range of issues, such as household production systems, conservation and utilization of arable and non-arable land, treatment of drainage lines, recharging of groundwater, livestock management, agroforestry and horticulture;
- Promote local awareness and preparedness for disaster prevention and mitigation, combined with the latest available technology for early warning and forecasting;
- Government, with the support of the relevant international and regional organizations, should develop and strengthen national centres for watershed management to encourage

a comprehensive approach to the environmental, socio-economic, technological, legislative, financial and administrative aspects and provide support to policy makers, administrators, field staff and farmers for watershed development; and

- The private sector and local communities, in cooperation with government, should promote local infrastructure development, including communication networks, mini or micro hydro development to support cottage industries, and access to markets.

* Landscape level scale management is the concept of working on a broad scale, whereby all sectors, such as health, water, sanitation, forest, wildlife, are addressed together. Multiple needs and diverse issues of concern, such as habitat conservation, sustainable energy use, and cultural preservation, can be dealt with simultaneously, resulting in cumulative effects, improved knowledge base, reduced financial and human resources and easy monitoring.

Resilience Approach

Mountain systems are vulnerable with respect to ecological and social systems, for reasons of high heterogeneity. Adaptation to ecological changes depends on resilience capacity of the environment. Resilience depends on the scale, intensity and rate of change of the climate system, as well as the inherent ability of ecosystems or communities to adjust to new circumstances. Moreover, resilience capacity is influenced by ability to cope with the real cost of adaptive measures, the existence and engagement of appropriate institutions, access to technology, and biophysical constraints, such as land and water resource availability, soil characteristics, genetic diversity for crop breeding and topography. It entails three basic components: ability to undergo and retain the same controls, capacity for self organization, and openness to learning and adapting.

As a large number of human, institutional and economic factors influence the adaptation process, an interdisciplinary approach is essential. Any development or change in one sub-sector has a chain effect on other sub-sectors. Hence, other pressures (pollution) and mechanical damage exacerbating climate change impacts will have to be controlled simultaneously.

Long-term adaptation to climate change requires anticipatory actions, which would require considerable investment of capital, labor, and time. With regard to resilience and mitigating vulnerability, flexibility issues are particularly important.

Traditional societies have always manipulated biodiversity to ensure ecosystem resilience and to cope with uncertainties in the environment. There is increasing evidence to suggest that we could learn from their traditional ecological knowledge base for coping with uncertainties associated with global change.

Wedge Approach

Researchers Stephen Pacala and Robert Socolow at Princeton University, USA have suggested an approach that they call "stabilization wedges." This means reducing GHG emissions from a variety of sources, rather than relying on an enormous change in a single area. They suggest seven wedges that could each reduce emissions, and all of them together could hold emissions at approximately current levels for the next 50 years, putting us on a potential path to stabilize around 500 ppm.

There are many possible wedges, including sustainable energy system (increases in water, wind and solar power, bio-fuels produced from crops and natural gas); conservation tillage; reduced deforestation; reforestion; afforestation; and new plantations. There is also the potential to capture the carbon dioxide emitted from fossil fuels and store it underground—a process called carbon sequestration.

Emissions Control

There are several GHGs responsible for warming and humans emit them in a variety of ways. Most come from the combustion of fossil fuels (oil, coal, natural gas). The gas responsible for the most warming is CO2. Other contributors include methane, released from land use, landfills and agriculture (especially from the digestive systems of grazing animals), and nitrous oxide from fertilizers and the loss of forests that would otherwise store CO2.

Kyoto gases
The six 'Kyoto gases' accounted for in national GHG inventories are:

1. Carbon dioxide (CO2)
2. Methane (CH4)
3. Nitrous oxide (N20)
4. Hydrofluorocarbons (HFCs)
5. Perfluorocarbons (PFCs)
6. Sulphur hexafluoride (SF6)

Approximately 25 other gases, such as chloroform and carbon monoxide, qualify as climate-changing GHGs.

Steps to control emissions
- Impose a charge on agriculture emissions created when land is converted from forestry to agriculture;
- Offset emissions for agricultural emissions by emission reductions elsewhere i.e. tree planting, biofuels etc.;
- Control GHGs and other effects arising from land use change from forestry to agriculture;
- Research into mitigation, adaptation and measurement techniques and practices for methane and nitrous oxide;
- Use of demonstration farms and financial incentives to promote adoption of mitigation technologies, e.g. nitrogen inhibitors, nutrient budgeting improved forage crops; and
- Impose a charge on nitrogen fertilizers.

Synergies and co-benefits of emission reduction
Mitigation related decisions could make the society, ecosystem and economy more resilient against the expected effects of climate change, and potentially change the vulnerability of society or ecosystems to the impacts of climate change. Examples include:

- Higher levels of insulation in houses for energy saving purposes improve resilience to summer peak temperatures and may reduce vulnerability to extreme weather events; and
- Distributed generation systems using local energy resources are likely to be more resilient against failures of power systems due to weather.

Conversely, the impacts of climate change could lead to reduction in GHGs and / or increasing carbon sinks. Examples include:

- Higher average winter temperatures would reduce winter heating demand;
- Greater snow melt and increased winter rainfall would lead to relatively greater storage levels in hydro lakes during winter, which should result in reduced inter-annual variations in CO2 emissions from supplementary thermal power generation during winter; and
- Increased risk of erosion and changes in economic agricultural viability of some regions could prompt greater rates of afforestation.

However, emissions may also be exacerbated through impacts of climate change. Examples include:

- Higher temperatures and increased risk of drought could lead to increased bio-security and fire risks to existing forest sinks;
- An increase in more drought-resistant but lower-quality pastures could lead to increased methane emissions intensity from agricultural production;
- Increased inter-annual climate variability could increase occasions when low winter hydro lake levels need to be supplemented by additional thermal power generation; and
- Expansion of forest sinks and bio-energy systems could increase vulnerability to the effects of climate change if the expansion is into areas that may become more susceptible to bio-security risks, fire and drought under a warmer and drier climate.

Renewable and non-renewable energy sources
Pakistan is witnessing a serious power crisis due to the depletion of conventional sources of energy. Global warming and deteriorating environmental conditions are adversely affecting Pakistan's water resources. The rivers are dying out at a slow but steady pace and with them, Pakistan's chances of producing cheap hydropower are diminishing as well. The need for exploring alternative, environmental-friendly, and renewable energy resources has therefore become inevitable. The most appropriate answer is exploring renewable sources of energy, such as wind and solar energy. These not only have huge power-generation potential, but are also cause minimal emissions and are successfully being used for electricity generation in various countries of the world.

Unfortunately, not much research is being carried out in Pakistan for utilizing renewable sources of energy for power production. This is despite the fact that an Alternate Energy Development Board (AEDB) exists in the country. The purpose of this Board is to raise awareness about renewable energy sources and to promote them in the country.

Government institutions need to invent products, solar or wind-solar hybrid, and provide them to people on easy instalments. There is a need to explore potential sites in Gilgit-Baltistan, where windmills could be installed. However, EIA of proposed projects need to be conducted to evaluate feasibility and impact, such as on wildlife, pollution, and cost and adaptability implications.

Similarly, biomass is another potential energy source which needs to be explored by authorities concerned, researchers, and investors, in order to provide electricity to far-flung and remote areas such as Bagrote, as well as to meet the growing demand of electricity for agriculture. Biomass is a very resourceful material and can be used to produce heat, electricity and a combination of heat and power (electricity). Using biomass as an energy source creates a 'closed carbon cycle'. As a biomass energy source grows CO2 is absorbed from the atmosphere, when it is burnt the CO2 stored by the biomass as is released, making biomass fuel carbon neutral. Most biomass fuels are clean, containing no noxious metals, chemicals or other pollutants and so will not evoke environmental issues, such as acid rain and human respiratory problems.

Fossil fuels are a form of 'ancient biomass'. Burning these fossil fuels causes a release of CO2 that for millions of years has been fixed underground and transfers it to the atmosphere creating a carbon imbalance.

In areas such as Bagrote, the biggest issue is of accessibility. Considering the location, two other options besides the one discussed above are LPG and kersosene. Though kerosene is a much available fuel used for cooking and heating and is the easiest to obtain in remote areas, it is hazardous as a household fuel, as it can cause fire and indoor air pollution. LPG on the other hand is a cleaner fuel, but is poorly distributed. LPG also causes less smoke or sulphur emissions and is convenient to stock.

International mitigation responses

Internationally acclaimed existing and contemplated policies that will contribute to emissions abatement include:

Argentina
- Improving energy efficiency by facilitating the adoption of efficient technologies;
- Replacing the use of fuel oil with natural gas in combined-cycle power stations;
- Encouraging the development of forest plantations to provide carbon sinks;
- Adopting financial support measures to promote the development of wind energy;
- Encouraging flaring of methane emissions from sanitary landfills, rather than combustion;
- Reducing emissions from the agricultural sector by improving the production system with better diets and managing an increased proportion of animals in confined conditions;
- Promoting "no till" and "low till" land-use practices to reduce fuel consumption for agricultural purposes;

- Examining potential hydroelectric power opportunities to offset or replace thermal generation; and
- Promoting the use of CNG in the transport sector.

China

- Introducing policies and measures to foster the development of new, renewable energy, including wind, small-scale hydro, biogas, solar and geothermal technologies in rural areas;
- Establishing energy-efficiency standards, labeling and certification processes and launching a national energy conservation publicity week;
- Establishing standards for energy conservation in the construction sector;
- Conserving and improving pastures and forest lands, including establishing loans for afforestation;
- Introducing administrative regulations, policies and criteria for waste management to help prevent pollution from waste treatment; and
- Implementing programmes to improve education, training and public awareness on climate change, predominantly through the education system.

India

- Establishing a Bureau of Energy Efficiency to promote energy efficiency and conservation, and setting energy-efficiency targets for motors, lighting and energy intensive activities,
- Undertaking regulatory reforms to promote competition in the electricity, petroleum and coal markets, to help enhance the technical and economic efficiency of energy use, and to encourage investment in the development of natural gas infrastructure to replace more carbon-intensive forms of energy;
- Promoting the use of renewable energy through financial support to hydroelectric developments and upgrading existing hydro stations, using solar photovoltaic power systems for a variety of decentralized applications and extending distributed solar, hydro and biomass generation to rural and remote areas
- Introducing agricultural initiatives focused on improving the energy efficiency of irrigation, improved animal feeds and digesters, and rationalization of power tariffs; and
- Introducing initiatives to maintain or enhance existing forest land for ecological reasons, including afforestation programmes by government power organisations.

Japan

- Promoting high-efficiency water heating in residential and commercial premises;
- Supporting market introduction of photovoltaic power generation, solar thermal utilization, wind power generation, waste power generation and biomass energy;
- Subsidizing the cost of converting old coal-fired power generation to natural gas generation; and
- Aiming to halve the volume of waste disposed in landfills.

6.6 Potential Barriers

Macro scale barriers

- Uncertainties in climate change science related to extent and rate of climate change impacts;
- Difficulties in ascertaining necessary time frame for adaptation;
- Institutional barriers to adaptation;
- Knowledge uncertainty, arising from our incomplete understanding of the interaction between natural and human processes;
- Lack of awareness and recognition of climate threats by policy makers;
- Relief dependency, (donors providing support to affected communities) – without addressing the root causes, this may increase the vulnerability of future disasters;
- Lack of broad powerful integrated strategies addressing issues of adaptation to climate change;
- The divergence between the priorities determined in global negotiations and local level priorities; and

- Little research work on the practical application of policy measures for adapting to climate change.

Micro scale barriers

- Compounding problems of poor / worsening local conditions e.g. land degradation;
- Lack of community resources (financial, human, social) to enhance own resilience; and
- Lack of local institutional capacity and resources to support community resilience building.

7. CONCLUSION

Discussions held with residents of Bagrote have indicted climate induced changes in the natural and social environment. As the people and their environment are potentially interdependent, any ecological changes (such as land fertility, livestock productivity, resource scarcity, forest degradation and habitat destruction) result in spontaneous adaptation by the local community, such as in terms of natural resource use and lifestyle changes. However, due to the rapidly altering climatic conditions, an ecologically sensitive mountainous area such as Bagrote, requires collaborative efforts by stakeholders, so that an interdisciplinary landscape level approach is implemented for effective mitigation and adaptation to climate change. In addition to this, it is also crucial to systematically assess the vulnerability of the local population, raise their awareness on the specific impacts that climate change may have in the area, and institute a planned adaptation response which incorporates local knowledge and experiences, as well as builds the capacity of the community to implement it, for improved transition.

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Annexure I
PROJECT INFORMATION

The HKKH Project is committed to the development of Central Karakoram National Park (CKNP) through a series of coordinated activities, including technical advice on management planning (through the development of a sound management planning framework), capacity building, baseline studies, database development, and provision of latest tools and instruments to assist in the management of natural resources.

The Project realizes that there is tremendous pressure on CKNP ecosystem, due to traditional usufruct rights of the local inhabitants, coupled with unsustainable resource use and tourism practices (causing pollution, noise, litter and waste; cutting trees for fuelwood, disrupting traditional life; and threatening cultural identity).

Project Background

The HKKH Project is a partnership initiative forming part of the Global Mountain Initiative and approved by United Nations as a Type II outcome of the World Summit on Sustainable Development. The Project also considers the recommendations identified in Agenda 21 (a global partnership initiative which offers 'policies and programmes to achieve a sustainable balance between consumption, population and the earth's life-supporting capacity. It describes some of the technologies and techniques that need to be developed to provide for human needs, while carefully managing natural resources.')

The Project is financed by the Italian Cooperation (MAE-DGCS). The implementing organization is IUCN Asia Regional Office (IUCN-ARO). The Executing Partners are ICIMOD, Ev-K2-CNR, CESVI and IUCN.

The current Project phase (2007 - 2011) is a continuation of a pilot phase (March 2004 - June 2005). Preceding that was the start-up phase in 2005-2007.

Project activities presently focus on three national parks: Sagarmatha National Park (SNP) in Nepal, CKNP in Pakistan, and Qomolangma Nature Preserve (QNP) in Tibet Autonomous Region of PR China.

HKKH Project and Climate Change

The regional HKKH Project focuses on poverty reduction and biodiversity conservation. It aims to enhance the institutional capacity, for systemic planning and management at the local, national and regional level. In all the CKNP oriented research work, climate change issues and adaptation has been marked as a cross-cutting theme.

Annexure II
FIELD VISIT PLAN

- **Target area:** Bagrote (Union Council), Gilgit District, Gilgit-Baltistan, Pakistan
- **Villages covered**: All 10 villages in Bagrote Valley

Field Visit Schedule

No.	Area	Total No. of Households	Population Sample	Distance	Group	Day
Pilot study (Hopay)		130	1 person	0 km	I & II	Tue
1	Girish	12	1 male / 1 female	10 km	I	Wed
2	Sinaker	140	2 males, 2 females	8 km	I	Wed
3	Datuchi	150	2 males, 2 females	4 km	II	Wed
4	Hopay	130	2 males, 2 females	0 km	I	Thu
5	Farfooh	210	3 males, 3 females	4 km	II	Thu
6	Chira	50	1 male, 1 female	6 km	I	Thu
7	Bulche	240	3 males, 3 females	6 km	I & II	Fri
8	Hamaran	45	1 male, 1 female	6 km	I	Sat
9	Bilchar	80	1 male, 1 female	12 km	II	Sat
10	Taisot	70	1 male, 1 female	14 km	I & II	Sat
TOTAL (34 forms)		**1127**	**17 males, 17 females**	**-**	**-**	**-**

* Distance has been measured from resident of President, Dubani Development Organization (CBO) in Hopay
Group I: Mohammad Aqib Uddin Group II: Fizza Shah

Additional key persons interviewed

1. UC members
2. Gilgit-Baltistan Forest, Wildlife and Park Department
3. District Forestry Officer
4. District Conservation Committee (DCC)
5. *Numberdar*
6. Chairman, Dubani Development Organization, Bagrote
7. Dubani Forest Committee members
8. Village notables

Annexure III
LIST OF RESPONDENTS

No.	Name	Gender	Age	Key position	Area
1	Muhammad Yousaf	M	80	• Ex NA Scouts • Village Head	Sinakar
2	Jawed Iqbal	M		Son of Mohammad Yousaf	
3	Muzzafar Ali	M	73	• Retired UC member (thrice) • Bagrote District Chairman	
4	Urbani	F	80	-	
5	Hussain Ali	M	80	-	Datuchi
6	Ghulam Sarwar	M	60	-	
7	Naib Khan	M	47	UC member (2004-09)	
8	Mahrab Khatoon	F	40	-	
9	Zubaida	F	40	-	
10	Ghulam Muhammad	M	65	-	Hopay
11	Ali Murtaza	M	50	-	
12	Akbar Khan	M	56	-	
13	Momin Shah	M	50	CBO committee member	
14	Zabul	F	60	-	
15	Maqsooma	F	105	-	
16	Ramzan Ali	M	43	Committee member	Hamaran
17	Ali Ghulam	M	60	-	
18	Arif Hussain	M	50	-	
19	Shukurdeen	M	60	-	
20	Kashmiri	M	70	-	Bilchar
21	Gul Najab Hurnisa	F	18	-	
22	Subjan	F	50	-	
23	Ali Dad	M	50	-	
24	Fida Hussain	M	50	-	
25	Wazir Shah	M	60	-	Taisot
26	Khushnoor	M	50	-	
27	Sidra	F	60	-	
28	Meherenama	F	45	-	
29	Ghulam Raza	M	70	-	Farfooh
30	Ali Sher	M	55	-	
31	Shahadat Khan	M	90	-	
32	Shahida	F	47	-	
33	Khursheed	F	52	-	
34	Abdul Wahd	M	43	-	
35	Fida Hussain	M	60	-	Bulche
36	Baraati	F	60	-	
37	Mir Zaman	M	35	-	
38	Mohammad Ibrahim	M	50	-	
39	Maqbool Hussain	M	37	-	
40	Nigar	F	60	-	
41	Mohammad Raza	M	30	-	
42	Hakeem Shah	M		-	
43	Mohammad Jan	M	35	-	
44	Hussain Ali	M	45	-	
45	Ghulam Jan	M	38	-	
46	Sultan Mir	M	54	-	

Annexure IV
SURVEY QUESTIONNAIRE

1. General Information			
1.1. Date of interview (day / month / year)			**1.2. Time of interview**
1.3. Name of village / valley			**1.4. Name of data collector** (first name / last name)
1.5. Name of respondent (first name / last name)	Gender	Age	**1.6. Key position(s) held by respondent** (if any) (e.g. village head / *numberda* / *tehsildaar* / *subedar* / district member)

2. Household Information	
2.1 Number of members in the household (specify gender)	**2.2 Family system** □ Joint □ Single
2.3 Legal ownership of assets ☐ House ☐ Agricultural land (kanal) ☐ Shop ☐ Other (specify) Specify land use (e.g. agriculture, agro forestry, pastoral)	**2.4 Occupation / means of livelihood** State all sources of income for household (e.g. farmer, shepherd, artisan) At present: Ten years ago (if different from above, state reason):

3. Information on Climate Change and its Impact		
3.1 If occupation is agriculture / farming, which crops/fruits are grown? (specify any change in diversity)	Commercial use	Domestic use
At present (e.g. wheat, tomato, potato, pulse, apple, pear, apricot, cherry)		
Ten years ago (if different from above, state reason)		

***3.2* Changes in sowing time**			
Crop 1		**Crop 2**	
At present		At present	
Ten years ago		Ten years ago	

3.3 Changes in harvesting time			
Crop 1		**Crop 2**	
At present		At present	
Ten years ago		Ten years ago	

3.4 Annual yield (maunds per kanal)	**3.5 Crop diseases / pests**
At present: Ten years ago (if different from above, state reason):	At present: Ten years ago (if different from above, state reason – e.g. fertilizer/seed variety):

3.6 Livestock / poultry owned by household

Type (e.g. cow, goat, sheep,yak)	Number 2008	Number 2007	Purpose (household/commercial use)

3.7 Has there been any change in the quantity and quality of milk / meat obtained from livestock? If yes, state reason.

3.8 Has there been any change in the quality and quantity of resources (grass) **at pastures / grazing sites?** If yes, state reason.

☐ Yes ☐ No

3.9 Has there been any change in the location and duration of stay at pastures / grazing sites during the past ten years?

☐ Yes ☐ No

If yes, state:	Duration of stay (in months)	Travel time
At present		
Ten years ago (if different from above, state reason)		

3.10 When do fruit trees flower?

This year:

Last year:

5 years ago:

3.11 Has there been any change in the quantity, quality and diversity of plantation in the area? If, yes, state reason.

(specify type and name, e.g. fruit trees - *apricot*, *mulberry*, *cheeri)*

☐ Yes ☐ No

3.12 Does the household use forest resources?

☐ Yes ☐ No

If not, state why. (e.g. less awareness, no male at home, not available)

If yes, specify:

Name of forest:

Forest resource extracted (e.g. medicinal plants/wild herbs, timber: juniper, *cheer*):

3.13 How are forest resources used?(e.g. fuelwood,construction)

At present:

Ten years ago:

3.14 Has there been any change in quantity and diversity of forest resources? If yes, state how and provide reason for change.

☐ Yes ☐ No

3.15 Has there been any change in forest cover? (high altitude) If yes, state extent.

☐ Yes ☐ No

3.16 Has there been any change in forest site accessed? (mountains: Rakaposhi, Haramosh, Diran, Dobani) If yes, state reason/location.

☐ Yes ☐ No

3.17 Forest trees grown (If yes, specify name, e.g. Poplar, Willow, Mulberry)

☐ Yes ☐ No

3.18 Have you noticed any change in the size of glaciers? (If yes, state name and condition - shape, thinning, shortening, distribution) Glaciers in area: Baska, Burche, Chogo Lungma, East Darchan, Gutumi, Hinarche, Haramosh, Ishkapal, Mani, Phuparash)

☐ Yes ☐ No

3.19 Energy usage for:

	Fuel used (firewood, gas, kerosene)	At present	Ten years ago
Cooking			
Heating			
Lighting			

3.20 Are the winters getting warmer? If yes, explain how. (e.g. no. of sweaters/blankets use, fuelwood use, construction style)

☐ Yes ☐ No

3.21 Fuelwood consumption

This year:

Ten years ago:

3.22 Rainfall pattern

This year:

Last year:

Ten years ago:

3.23 Timing of meltwater in channels

(streams: Hispar, Bagrote, Shimshal)

This year:

Last year:

Ten years ago:

3.24 Quantity of meltwater in channels

This year (if different from below, state reason):

Last year:

Ten years ago:

3.25 Month in which turbidity starts in river

This year:

Ten years ago:

3.26 Amount of snow (in feet)

This year:

Last year:

Ten years ago:

3.27 *Source of water for:	At present	Ten years ago
Agriculture (glaciers)		
Household use (spring water – direct in winter, tap in summer)		
Animal husbandry		
Other (specify)		

3.28 What adjustments have you made to adapt to the changes in water availability?

Agriculture:

House use:

Other (specify):

3.29 Has any increase in diseases been noticed in recent years? If yes, state reason.

☐ Yes ☐ No

Time	Summer (e.g. diarrhea)	Winter (e.g. pneumonia, TB, cough, goiter)
At present		
Ten years ago		

3.30 Have you noticed any usual pattern in the climate? (e.g. unusual snowfall/rainfall, change in wind pattern)

☐ Yes ☐ No

If yes, specify change:

What do you think has caused the change(s)?

3.31 Has there been any change in the incident of natural disasters?

☐ Yes ☐ No

If yes, specify change / type of disaster that occurred:

3.32 Have you noticed any change in the bird species in the region? (e.g. migratory birds, crow, wild pigeon, partridge yes,state reason.

☐ Yes ☐ No

3.33 Have you noticed any change in mammals / reptiles / amphibian species in the region? (e.g. markhor, ibex, blue sheep, urial, Marco Polo sheep, snow leopard, brown bear, wolf).

☐ Yes ☐ No **If yes, state:**

Current status (seen less, not seen at all, seen only in winters etc. – specify name of species):	Reason for observed change in status
Migratory pattern/corridors of species (specify name of specie From: To:	Reason for observed change in migratory pattern
Future predictions (change in number/location of species):	

3.34 Hunting practices

Hunters	Local hunting traditions / practices / tools
Hunted species	Hunting location Ten years ago: At present:
Current hunting scenario	Future hunting scenario

3.35 How has the change in climate affected agriculture / business, livestock and people's lives in Bagrote?
(e.g. land productivity, crop diversity, watering pattern, health, medicine, clothing, housing, dietary pattern - organic/other, mosquitoes/flies/rats infestation, trade)

3.36 How do you think the change in climate has affected or will affect:

a. Migratory pattern of local human population

b. Local tourism industry

3.37 What do you think is being done, can be done or needs to be done to deal with the changing natural conditions?
(e.g. afforestation, plantation, education, local action body, awareness, migration, storage, diversification, communal pooling, trade, seed variety/price, human/animals medicine, less polluting machines) State current efforts (communal transformation/external support)

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