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Case Studies on Local Indigenous Adaptation Practices in Mountain Areas of Pakistan

Rural Support Programmes Network (RSPN), and International Centre for Integrated Mountain Development (ICIMOD)

IMPRINT

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The authors' views expressed in this publication do not necessarily reflect the views of the Rural Support Programmes Network (RSPN), International Centre for Integrated Mountain Development (ICIMOD), and the European Union

Authors

Hamid Sarfraz and Dr. Shahid Ahmad

dev~consult

269-E, Street 13-B, E-11/4, Islamabad, Pakistan
Tel. +92 (51) 2222469 | Cell +92 (333) 5590803, +92 (345) 2004111
info@devconsult.pk | www.devconsult.pk | Skype/Twitter hsarfraz

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Acronyms and Glossary

ADB	Asian Development Bank
ADP	Annual Development Programme
AEDB	Alternate Energy Development Board
AKRSP	Aga Khan Rural Support Project
Barani	Rain-fed
BMZ	German Federal Ministry for Economic Cooperation and Development
CBO	Community Based Organization
CIDA	Canadian Agency for International Development
DDMA	District Disaster Management Authority
DDMUs	District Disaster Management Units
DFID	[UK] Department for International Development
DMCs	Disaster Management Committees
DRM	Disaster Risk Management
Ehtesab	Accountability
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization of the United Nations
FATA	Federally Administered Tribal Area
FDMA	FATA Disaster Management Authority
FOs	Farmers Organizations
FPA	Foreign Project Assistance
FRs	Frontier Regions
GBP	Great Britain Pound
GCISC	Global Change Impact Study Centre
GHG	Green House Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Society for International Cooperation)
GLOF	Glacial Lake Outburst Flood
GoKP	Government of Khyber Pakhtunkhwa
GoP	Government of Pakistan
ICIMOD	International Centre for Integrated Mountain Development
IEE	Initial Environmental Examination
IFAD	International Fund for Agricultural Development
IPPs	Independent Power Produceres
IRSA	Indus River System Authority
IUCN	International Union for Conservation of Nature

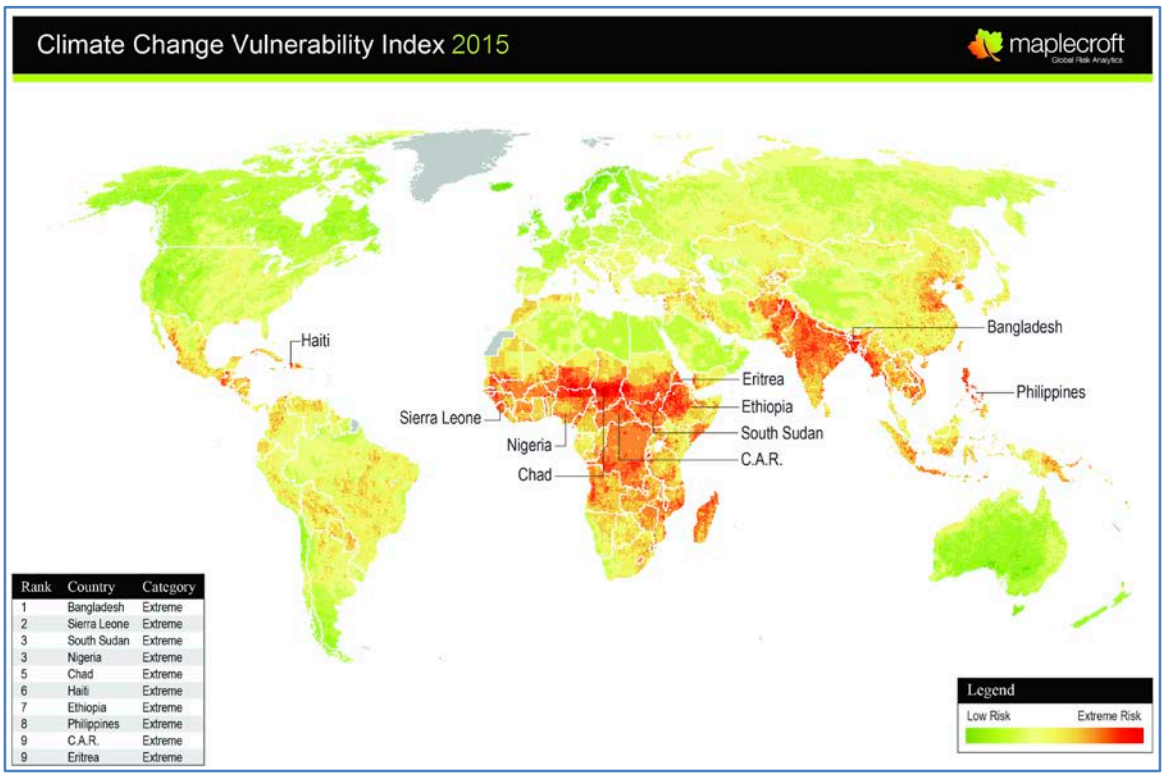
IWMI	International Water Management Institute
IWRM	Integrated Water Resource Management
JICA	Japan International Cooperation Agency
Katcha	Unpaved, made of mud
KfW	Kreditanstalt für Wiederaufbau ([German] Reconstruction Credit Institut(e)
KP	Khyber Pakhtunkhwa
kWhr	Kilo-watt-hour
LG&RDD	Local Government and Rural Development Department
lps	Litters per second
MAF	Million Acre Feet
MDTF	Multi-Donor Trust Fund
Naccas	Openings on a water channel
NADP	Northern Areas Development Programme
NDMA	National Disaster Management Authority
NDMC	National Disaster Management Commission
NDP	National Drainage Programme
NOC	No Objection Certificate
NWFP	North-Western Frontier Province
O&M	Operation and Maintenance
OECD-DAC	[UN] Organization for Economic Cooperation and Development – Development Assistance Committee
OFWM	On-Farm Water Management
P&DD	Planning and Development Department
Pacca	Bricked, lined
PARC	Pakistan Agricultural Research Council
PATA	Provincially Administered Tribal Areas
PCNA	Post Crisis Need Assessment
PDMA	Provincial Disaster Management Authority
PDWP	Provincial Development Working Party
PFI	Pakistan Forest Institute
PHED	Public Health Engineering Department
PKR	Pakistani Rupees
PPAF	Pakistan Poverty Alleviation Fund
PSDP	Public Sector Development Programme
PVC	Polyvinyl chloride [pipes]
Rod-Kohi	Mountain channel; a form of irrigation system in Pakistan
RSPN	Rural Support Programmes Network

RSPs	Rural Support Programmes
SAARC	South Asian Association for Regional Cooperation
SDC	Swiss Agency for Development and Cooperation
SDGs	Sustainable Development Goals
SDPI	Sustainable Development Policy Institute
SRSP	Sarhad Rural Support Programme
TOT	Training of Trainers
UC	Union Council
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	US Agency for International Development
VDMCs	Village Disaster Management Committees
WAPDA	Water and Power Development Authority
Warabandi	Turn-by-turn water distribution
WB	[The] World Bank
WMD-AD	Water Management Directorate of the Agriculture Department
WSP	Water and Sanitation Programme
WSSP	Water and Sanitation Services Peshawar
WUAs	Water Users Associations

1. INTRODUCTION

Pakistan is not a significant contributor to the global greenhouse gas emissions, with a contribution of 0.8% of world's total in 2008, but it is considered one of the 'most vulnerable countries'. Pakistan is ranked 5th most climate affected country in 2014 on the Global Climate Risk Index 2016 while it was ranked 8th during 1995-2014 period. In 2014 alone, Pakistan suffered 1227 deaths, and around 2220 million USD economic losses due to climate related disasters. On the other hand, a World Bank report suggested that Pakistan is among the 17 countries currently facing water shortages and is among the 36 countries with serious threat of food crisis. Various studies by the Global Change Impact Study Centre suggest that the temporal precipitation distribution patterns will change while climate change will increase the variability of monsoon rains and enhance the frequency of heavy precipitation, which would lead extreme events such as floods and droughts.

Climate Change is a posing serious environmental and developmental challenge to Pakistan, most of which have multiple dimensions in cause and effect. Besides, the Country is already experiencing climate induced phenomena such as high glacial melt, prolonged droughts, flash floods, cyclones and changes in weather patterns. These in turn are affecting Pakistan's water resources and agricultural productivity, which is the backbone of its economy. The Country's vulnerability to such impacts and changes is likely to increase considerably in the coming decades.



Rank	Country	Category
1	Bangladesh	Extreme
2	Sierra Leone	Extreme
3	South Sudan	Extreme
3	Nigeria	Extreme
5	Chad	Extreme
6	Haiti	Extreme
7	Ethiopia	Extreme
8	Philippines	Extreme
9	C.A.R.	Extreme
9	Eritrea	Extreme

Unfortunately, not much has been observed and documented on impact of climate change on urban and coastal areas of Pakistan. The report of the Planning Commission's Task Force on Climate Change (TFCC, 2010) has identified the following most important climate change threats to Pakistan:

1. Increased variability of monsoon;
2. Rapid recession of Hindu Kush-Karakoram-Himalayan (HKH) glaciers;

3. Deforestation and loss of biodiversity and risks to other vulnerable ecosystems
4. Increased risks of floods and droughts;
5. Increased siltation of major dams resulting in greater loss of reservoir capacity;
6. Severe water-stress and heat-stress in arid and semi-arid regions, leading to reduced agriculture productivity and power generation;
7. Increased upstream intrusion of saline water in the Indus delta, adversely affecting coastal agriculture, mangroves and breeding grounds of fish;
8. Threat to coastal areas including the city of Karachi due to sea level rise and increased cyclonic activity due to higher sea surface temperatures; and
9. Increased health risks.

This situation warrants thorough understanding of the climate change phenomenon and its impact on human population, especially women, children, and vulnerable groups who have high dependence on nature and natural resources. Almost half of the world population is dependent on mountain ecosystems for their water requirement, which are extremely vulnerable to climate change; still mountain communities who are custodians of these ecosystems are the most neglected stakeholders in the climate change debate. The extreme climatic events in the mountainous regions have triggered unprecedented quantum of natural disasters, including floods, avalanches, GLOFs, landslides, erosion, and extreme cold, affecting livelihood of mountain communities, pushing already vulnerable communities into chronic poverty. "Such shifts have already been observed among climate-sensitive livelihoods in high mountain environments. Yet mountain people rarely receive support for adaptation and are rarely involved in adaptation planning."[1] Still these communities offer climate smart adaptation solutions based on their traditional and indigenous wisdom, rich diversity of crops and livestock breeds already adapted to harsh conditions.

The chain of events over the last few years dictates the need for concerted action to enhance resilience of vulnerable populations, especially the mountainous communities. Adaptation to climate change and building resilience among ecosystems and people are relatively new concepts, and there is gross variation in community as well as institutional; responses to the climate change challenge. Hence, there is need for documenting and sharing of experiences and ideas across the country to learn and benefit from best practices in climate change adaptation.

In this backdrop, coupled with low options for climate change mitigation and lack of institutional and financial capacity to forewarn and cope with effects of climate change, adaptation remains the only viable strategy for communities at large, especially in mountainous areas. Hence, the effort by RSPN and ICIMOD to document best practices in climate change adaptation at community as well as institutional levels is a timely intervention, which may lead to a well-designed policy action to ameliorate the situation.

1.1. The project

ICIMOD and RSPN collaborated together for several activities, which included developing a pool of master trainers on climate change adaptation from the RSPs and government departments in each provinces/region of Pakistan. This strategic initiative has helped in developing a pool of human resource at provincial and regional level by conducting six regional trainings across Pakistan for further dissemination and replication of this concept at community level and also for individuals who are active in these communities. Ultimate goal of this initiative was to

[1] Mountain communities being devastated by extreme climate impacts. IIED (http://www.iied.org/mountain-communities-being-devastated-extreme-climate-impacts).

accelerate climate friendly planning and implementation of related Programme. RSPN is overlooking the management and implementation of the HIMALICA project, housed in its Research and Knowledge Management (RKM) Section and managed by the Specialist Monitoring & Evaluation.

Under the first phase (Nov 2013 – Jun 2014), two key staff members from RSPN participated in a regional TOT organized by ICIMOD in Nepal; the TOT participants adopted, contextualized the learning materials and approaches disseminated in the TOT and; trained a total of 85 government, non-government staffs and community leaders on adaptation to change including climate change issues in three selected districts (Abbottabad, Kotli and Gilgit) of Pakistan.

Under the current phase (Jan 2015 – Jun 2016), the following results have been achieved so far:

- Training of Master Trainer (TOT) on CCA as a four days residential event for 22 participants from ICIMOD, RSPN, AKRSP, SRSP, NRSP, WWF, NARC, BEEJ, TRDP, MARC, FOCUS, BRSP, IRM, SRSO and Central Forest Office, AJK (including 10 women).
- Training of RSP's Communication and Monitoring & Evaluation (M&E) staff on Knowledge Management for Climate Change Adaptation.
- Three-day residential Regional workshops on Climate Change Adaptation at Sukkur, Peshawar, Bahawalpur, Quetta, Muzaffarabad and Gilgit in collaboration with Sindh Rural Support Programme (SRSO) and Thardeep Rural Development Programme (TRDP), Sarhad Rural Support Programme (SRSP), National Rural Support Programme (NRSP), Balochistan Rural Support Programme (BRSP), Aga Khan Rural Support Programme (AKRSP) and FOCUS.

Through these trainings, a pool of experts of climate change has been created. Some communication material aimed at creating awareness on causes and impacts of climate change has also been produced. For example, the posters (in Urdu) were produced on what are the reasons for climate change, what are the effects of climate change, and how to prevent climate change. The effort to document the case studies on climate change adaptation is in the same suite.

1.2. Study methodology

As an approach, we believe in participatory development and management of climate change adaptation, which mainstreams inclusion of all relevant stakeholders including women and

marginalised groups, ensures thorough scientific basis for review and analysis of available information and data and beef-up with diagnostics of best and local practices in adaptation to climate change, and remains pragmatic to achieve the desired results within the given timeframe and financial resources.

The methodology for this study was qualitative in nature, including collecting and reviewing available documents, meeting the key informants, conducting in-depth interviews, and synthesising the available information and data into a well-structured report on Best Practices in Climate Change Adaptation.

To keep this assignment efficient in terms of time and resources, no primary data was collected and the information synthesised from secondary sources has been used to elaborate the best practices. This, however, has been a limitation of this study.

After a inception meeting with the RSPN staff to understand the context and obtain available documents and reports, relevant studies and reports relevant to the subject were critically evaluated for the selection of relevant and effective case studies under the this study using criteria of relevance, cost-effectivity and sustainability. The list of relevant literature was expanded through snowball approach using personal knowledge of the climate change adaptation perspectives and practices, and in-depth interviews. The draft report, following the agreed outline was shared with RSPN for review and feedback. Incorporating the comments and suggestions by RSPN, the report has been finalised.

2. CLIMATE CHANGE ADAPTATION: COMMUNITY PERCEPTION IN HIGH MOUNTAINS OF BAGROTE VALLEY, GILGIT[2]

The dialogues and discussions made by the IUCN and UCLAN, in two separate case studies, with the local communities of the Bagrote Valley, district Gilgit indicated that weather and climatic variability and climate changes in the local environments have impacted the population and their livelihood sources. As people and their environments are potentially interdependent, any ecological changes (such as water availability, soil fertility, crop and livestock productivity, resource scarcity, forest degradation and habitat destruction) result in spontaneous adaptation by the local community, such as in terms of resource use and lifestyle changes. However, due to the rapidly altering weather and climatic conditions, an ecologically sensitive mountainous area such as Bagrote valley, requires an input from the experts so that they can first learn the local adaptations and then fine tune the management plans prepared by the community. In addition to this, it is also crucial to systematically assess the current availability and use of various resources (water, vegetation, lands, human, etc.) and based on the resource budget of different resources, work with the local communities to support the cost-effective adaptations, which are sustainable on long-term basis. The question is not the awareness of the communities rather it is learning or relearning of experts through living with the local communities and contribute something within the envelop of potentials and constraints in which the local communities are living.

2.1. The context

The Central Karakoram National Park (CKNP) is situated in the Gilgit-Baltistan of Pakistan, which is the county's largest protected area, covering over 10,000 km² of the geographical area and encompassing the world's largest glacier outside the Polar Regions. It is a region characterised as fragile environment, largely due to altitudinal variations ranging from 2,000 m to over 8,000 m, including the world's second highest peak of K2. The region is already experiencing extreme climatic variability even before the climate change, which in turn affects the environment and subsequently the lives of the local population.

A case study was carried out by the International Union for Conservation of Nature (IUCN) in the Bagrote valley, to document community perceptions on the impacts of climatic and weather variability and climate change, and local adaptations introduced by the communities. Weather and climatic variability is included because it is not easy for the local people to separate the variability from the climate change. The study illustrated weather and climatic variability and climate change, therefore effort was made to present the perceptions of the communities in the

[2] This section has benefitted from:

- IUCN. 2011. Community Perceptions on Climate Change in Bagrote Valley of Pakistan. Islamabad: IUCN.
- Khan, Athar Ali. 2014. "Local Solutions to Global Problems; Local Perceptions and Adaptations to Climate Change: A Study from Bagrote Valley in Central Karakoram." Thesis, University of Central Lancashire, UK.
- Ahmad, S. 2008. Water shortage and future agriculture in Pakistan – Challenges and opportunities. Paper presented in the National Conference on "Water Shortage and Future Agriculture – Challenges and Opportunities", Agriculture Foundation of Pakistan. August 26-27, 2008, Islamabad, Pakistan.
- Ahmad, S. 2009. Global warming impacts on agriculture and adaptations. Paper presented in Workshop on Climate Change Impacts and Adaptations in Agriculture of Pakistan. Agriculture Foundation of Pakistan and University of Arid Agriculture, Rawalpindi.

right perspective. There are many contradiction i.e. rise in temperature and reduction in snow and glacier-melt.

Figure 1: Bagrote valley of Gilgit

IUCN conducted a survey in villages of the Bagrote valley to address key parameters, including (Figure 1): (a) changes in local climate - precipitation and temperature; (b) fuelwood use; (c) flowering time of fruits and crops; (d) pasture location and unusual weather patterns; (e) water resources (glaciers and meltwater); f) livelihoods; g) agriculture (crops, cropping calendar, yield and pests/diseases), livestock, biodiversity (animals, birds and natural environment); and h) lifestyle pattern (construction style, clothing and diseases). Consultative meetings and group dialogues were undertaken with the local community based organizations (CBO).

The community members indicated, that they perceive, the climate of Bagrote valley has changed in the past few years; they also feel that the changing climate has affected the natural environment and the lifestyle of the local population, but this is a perception based on short term experiences and may be due to climatic variability. The major impact is on the availability of water resources; as the respondents reported a severe decline in winter and summer precipitation, which may be due to the climatic variability already in place. A reduction in the length and thickness of various glaciers was also observed by the local communities. 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. However, it is difficult to justify that with the increase in temperature how come there is reduction in snow- and glacier-melt. 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, which is largely weather phenomenon. 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 forage, and the shifting of some pasture sites to higher

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.

The local communities have long experience of coping with climatic variability, 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 fuel wood use.

2.2. Community perceptions on sectoral impacts and local adaptations

2.2.1. Water management

2.2.1.1. Community perception of impacts on water management

The impacts as perceived by the local communities of Bagrote valley are (Figure 2):

- The minimum temperature for winter and maximum temperature for summer is rising;
- Winter precipitation is occurring in the form of rain as well as snow – meaning reduction in snowfall;
- There is less rainfall in summers;
- Snowmelt season starts earlier than before
- There is increased water from glacial melt;
- 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; and
- Cloud forests are drying. The catchment area is not getting sufficient water for sustenance; the reason is attributed to cloud formation.

Figure 2: Bagrote water channel

2.2.1.2. Community based indigenous and local adaptations

The indigenous and local adaptations as implemented by the local communities of Bagrote valley are:

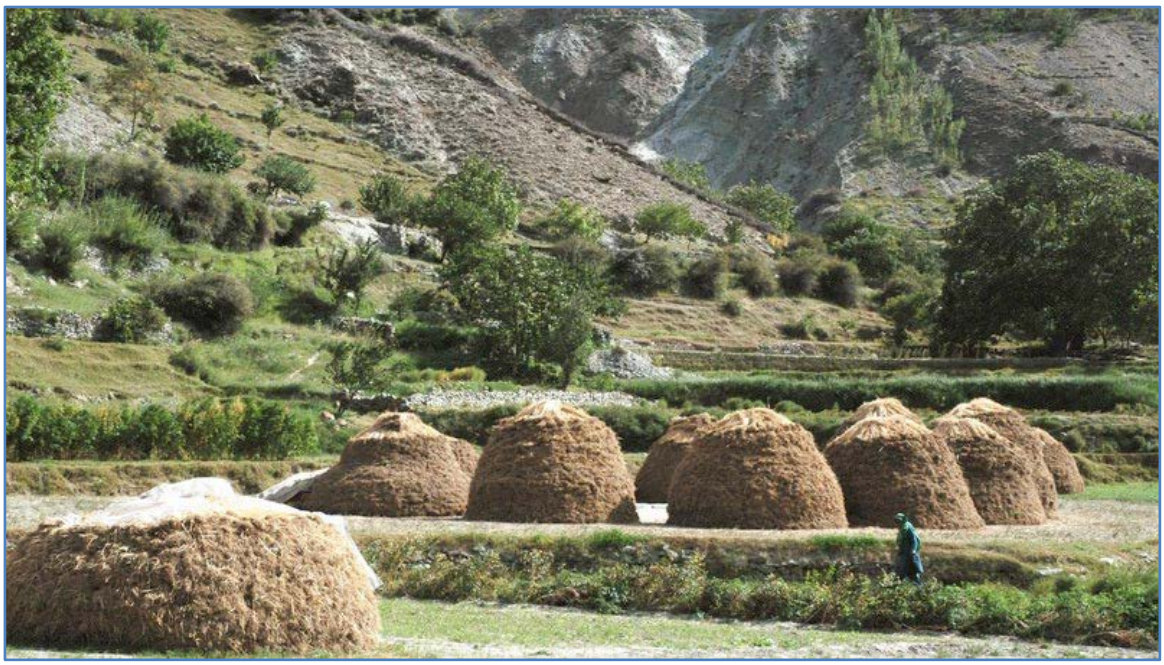
- The water users' rights and water distribution system has been well developed and flexible enough to adjust the weather and climatic variability and changes to meet the domestic and irrigation needs:
- In some villages, the community has installed a water supply system, in form of a storage pond, for adaptation to intermittent supply of water during winter season. Water is transported to households through pipeline and/or water channels to meet the domestic water needs; and
- Water rights have been established, whereby the available amount of water is distributed amongst the local residents, using a concept of Warabandi (rotational schedule of water distribution) and a fixed rotation of number of days e.g., in Bagrote it is 9 days. There is a fixed water charge in different channels based on the allocation of time.

2.2.2. Land use and agricultural management

Weather is a key factor for selection of crops, cropping pattern, planting and harvesting dates and productivity, as well as availability of water and management of soils. The effect of climate on agriculture is related to variability in local weather and climatic conditions, rather than to global climate changes. Agricultural production is also affected by the weather and climatic

variability, which affects the productivity in temporal terms. The valley is already suffering from coarse textured soils and climatic variability, thus there is less time for natural selection and adaptations (Figure 3).

Figure 3: Land use system of Bagrote Valley



2.2.2.1. Community perception of impacts

The impacts as perceived by the local communities of Bagrote valley are:

- Winter season is shorter and milder;
- The increase in temperature is causing a reduction in growing season length and changes in terms of sowing and harvesting dates;
- With a longer summer period, there is an opportunity to move from one cropping season to two cropping systems in cooler regions;
- There have been some changes in the type and variety of crops grown;
- Reduced cropping season length has resulted in reduced productivity;
- Shifts in crops from millet and barley to sorghum and wheat;
- Increased infestation of diseases and insect pests in crops, vegetables and fruit plants;
- Early flowering of crops and plants due to temperature changes; and
- Reduced productivity and quality of fruits in general, which may not be only due to climatic variability or changes and impacts of overall management is also there in terms of balance use of composts and fertilizers.

2.2.2.2. Community based indigenous and local adaptations

The indigenous and local adaptations as implemented by the local communities of Bagrote valley are:

- Farmers in cooler regions due to rise in temperature have started growing winter season crops of shorter duration;

- Adjustments in planting and sowing season in line with temperature changes, as farmers can adjust to these changes easily. Rather the farmers of cooler regions are happy that they are now in a position to grow two crops per annum;
- Shift in crops due to climatic variability and change in cooler regions where farmers have replaced barley and millets with potatoes;
- Crops are being grown for commercial purposes and thus there is a shift towards cash crops like fruits and vegetables, as they fetch better prices;
- Increased dependence on fertilizer to enhance crop productivity and at the same time there is a trend to move towards organic farming due to premium prices.

2.2.3. Livestock and rangelands management

2.2.3.1. Community perception of impacts

The impacts on livestock and its productivity as perceived by the local communities of Bagrote valley are (Figure 4):

- 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 fe(d) 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.

Figure 4: Livestock managed by gender in Bagrote

2.2.3.2. Community based indigenous and local adaptations

The indigenous and local adaptations as implemented by the local communities of Bagrote valley are (Figure 5):

- Livestock is being fed on fodders, mainly due to shortage of pastures and forages. In some households, stall feeding of livestock is common using fodders and concentrates;
- Area under fodder production is reducing due to the introduction of potatoes; and
- Dependence on livestock rearing has reduced.

Figure 5: Community based indigenous and local adaptations

2.2.4. Forest management

2.2.4.1. Community perception of impacts

The impacts on forest management as perceived by the local communities of Bagrote valley are (Figure 6):

- 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 and fuelwood, 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 firewoo(d);
- 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.

Figure 6: Forest management by community

2.2.4.2. Community based indigenous and local adaptations

The indigenous and local adaptations as implemented by the local communities of Bagrote valley are:

- There are government imposed restriction on cutting of trees, which has positive impacts on managing the forests and rural communities are also contributing in managing the forests;
- There is a community level forest management and users' rights system in place, mostly through the local CBOs;
- Social forestry is practiced in agriculture as the concept of integrated land use is centuries old. Poplar, mulberry, bair, beo, willow and shahtoot are some of the trees grown at the farm level and around the houses.
- Dried branches and trees are used as fuel wood; and
- Timber is bought from market, as forests in close vicinities are mostly depleted and now community is aware of the benefits of managing the forests.

2.2.5. Wildlife management

2.2.5.1. Community perception of impacts

The impacts on wildlife management as perceived by the local communities of Bagrote valley are:

- Species face extinction;

- There is a shift in species location – upward trend;
- Grazing competition is being faced; and
- There is increased incidence of diseases.

2.2.5.2. Community based indigenous and local adaptations

The local communities of Bagrote valley are actively engaged in Trophy hunting. The money received from this activity goes to the local communities, thus increasing their interest in the conservation of wildlife. This is the most important local adaptation of moving from individual hunting to trophy hunting, which will ultimately have positive impacts on the wildlife conservation and management (Figure 7).

Figure 7: Community based hunting programme of Markhor

Photo courtesy: Babar Khan/WWF Pakistan

2.2.6. Livelihood options

2.2.6.1. Community perception of impacts

The impacts on livelihood as perceived by the local communities of Bagrote valley are:

- Construction of houses has adapted, both in terms of design and material used, to better suit the rising temperatures. Local materials (wood, stone and mu(d), 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 woollen 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.

2.2.6.2. Community based indigenous and local adaptations

The indigenous and local adaptations as implemented by the local communities of Bagrote valley are:

- Village level Conservation Committees have been constituted by the local population to deal with the issues of changing conditions with the warming of climate; and
- Local institution, the Dubani Trust has supported the community to develop management plan.

2.3. Local perceptions of local adaptations – case study of Bagrote Valley

2.3.1. The context

The University of Central Lancashire, United Kingdom (UCLAN) undertaken a study on local perceptions and adaptations in the Bagrote valley of Gilgit-Baltistan. The rationale of the study is based on an observation that most of researches and interventions in the Bagrote valley of the central mountain ranges in Pakistan have been concentrated on physical aspects of environment and climate. Whereas, indigenous societies have elaborated coping strategies to deal with unstable environments, and in some cases, are already actively adapting to early climate change impacts. Therefore, it was required to bridge the gap between scientific research and local perceptions and adaptations to climate change. This research thus documented and evaluated the local perceptions and adaptations on local knowledge that can lead formulation and implementation of policies and projects on climate change.

The research was aimed to explore, document and evaluate local perceptions and adaptations in the light of current debates, research and development on climate change. This research revolved around the three key questions:

a. How do people know that climate change is occurring?
b. What they know about adapting to climate change? And
c. What they know about how to adapt?

The research hypothesis was that local perceptions and adaptations are responsive to local climatic variability and climate changes and are best fit to the local environment.

2.3.2. Local perceptions of local adaptations

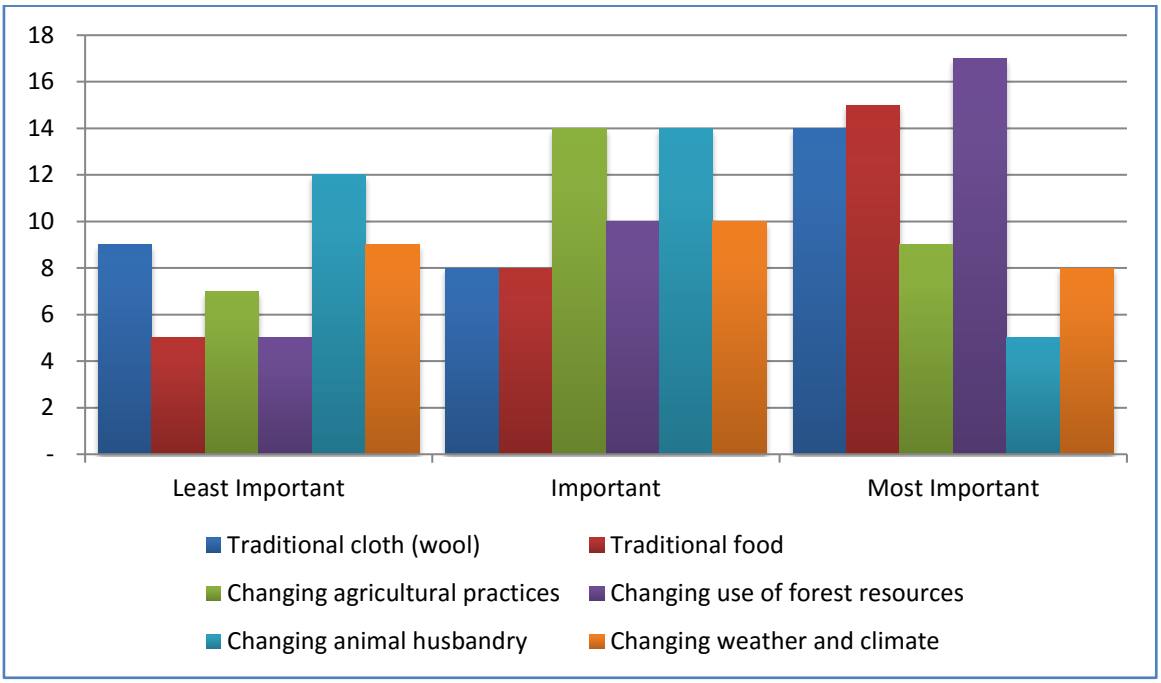
Adaptation is a response to existing or expected change for adjustments in a social, ecological, or an economic system or their impacts and effects. The local perception of adjustment in the local social, ecological, and economic system was studied by getting their response under five major categories (Table 1).

Table 1: Importance of adaptation required to survive in local climate (by responses)

Type of Adaptation	Degree of Importance					
	Not Essential	1	2	3	4	5
Traditional cloth (wool)	5	4	1	7	3	11
Traditional food	3	2	5	3	8	7
Changing agricultural practices	3	4	7	7	7	2
Changing use of forest resources	1	4	3	7	11	6
Changing animal husbandry	2	10	7	7	4	1
Changing weather and climate	8	1	4	6	7	1

The responses under each closely related category were grouped under three classes: (a) least important; (b) important; and (c) most important for better interpretation and understanding. The type of adaptations required to survive under local climate is presented in Figure 8.

Figure 8: Type of adaptations required to survive in local climate



According to local communities the changing use of forest resources is the most important to adapt to the local climatic conditions. This shows their close association and dependency on forest resources for wood and timber. This is followed by adaptation to traditional food, which is mainly wheat, potatoes, maize and meat. Besides, the local considers that local clothes are also

important to survive in the harsh climatic conditions. The changing agriculture practices and changing animal husbandry was ranked mainly as important since the community members can earn their means by finding employment in the nearest town.

The case study conducted by the UCLAN indicated that the valley of Bagrote has been experiencing an accelerated frequency of natural hazards for the last 15 years causing heavy losses to the pastures; forests and agriculture lands. Since flood is a major disaster, thus substantial losses to lives and sources of livelihoods, but the historical events recorded by communities indicated that few casualties of human lives were observed. Therefore, it is evident that the community has been able to avoid it by establishing settlements on such areas which were safe from floods and by avoiding visiting pastures and forests during expected floods, avalanche or landslides, though it is hard to predict timing, location and magnitude of hazards; but the community of Bagrote valley was able to predict the timings of floods and avalanches.

The community of Bagrote have been monitoring the weather since long and have adapted to these climate changes using available resources at the local level. They have constructed the kind of houses with built-in insulation with the kind of materials which were available locally. The traditional homes also ensured their wellbeing by reduced workload on those who were transporting wood for space heating. Besides, the traditional homes were easy to repair in case of damages due to any event of hazards including earthquake.

The traditional institutions (Zaitu/Jirg(a) and sole authority to impose fines and punishments in case of offences related to natural resources and internal conflicts in community. Though there were a number of organizations formed by the NGOs for socio-economic development, the traditional intuition is still functional, which indicates that community still believes on their traditional institutions which play key role in conflict resolutions and management of natural resources.

The forest resources in the valley are shrinking at an alarming rate, part of this problem could be the frequent floods and landslides, but the fact is that the land under agriculture and settlements has increased, which indicates population growth and increase in pressure on natural resources. This was reflected by community during discussion in workshop that the vigour of pasture has been badly affected in the last decade. The warming trend in the area might have played a role coupled with increase in biotic pressure on pastures.

Overall, the local perception and adaptation is still the only source of early warning system for the community to rely on, as it saved them and their livelihoods since long. Since there is no central authority to do weather forecast or prediction about disasters, all individuals in the community are bound to learn it from elders and verify the knowledge through their own experiences. However, this may not last for long as under GLOF an early warning system will be established and local people will be trained in DRM.

The community in the Bagrote valley can effectively predict weather based on the weather patterns of the previous season and stories of previous generations. However, with the unpredictability of the weather conditions due to climate change would be proving them wrong. Based on the evidence collected, analysed and results drawn, the research validates that the local perception and adaptations in Bagrote valley are greatly influenced by their local conditions and climate changes and tailor their activities based on their interpretation of climate. Based on the results, the hypotheses on, the local perceptions and adaptations are influenced by local climatic changes and are best fit to their local climatic conditions is acceptable.

Based on the findings of the research undertaken by UCLAN, indicate that there is ample knowledge and local practices available in the Bagrote valley for adaptations to climate change. This knowledge and local practices of adaptations to climate change must be further analysed in the light of scientific knowledge for the formulation of adaptation strategies, plans and policies on climate change mitigation. Furthermore, there is a continued need to modernize the local practices and knowledge so that these are valid with fast changes in living conditions e.g. housing, electricity, education, etc.

3. MOUNTAIN IRRIGATION – INDIGENOUS AND LOCAL ADAPTATIONS IN IRRIGATION MANAGEMENT[3]

In Gilgit-Baltistan, water management for traditional open channel systems is largely done by the water users and their institutions. There are variations in managing the open channel irrigation systems by the community. Similarly, the irrigation practices and cropping patterns also vary from location to location. Hardly any technical support is provided to the water users to improve their capacity and skills in managing irrigation system and efficient use of water for enhancing water productivity. The enlightened communities have developed a system of local service provider named as 'Ditch Rider', who is responsible in managing the irrigation system network and providing services as 'Irrigation Specialist' for managing the start and end of the water turn and in irrigating fields for the farmers on payment basis. Every farmer contributes monthly fee for managing the irrigation system network and providing services to the farmers. A system of penalty is also imposed where the defaulters have to pay double of the water fee, as a penalty in addition to the routine fee. The water users' organization also provides 50% of the penalty to the Ditch Riders as a bonus of governing the water system along an open channel. The local and indigenous adaptations are in place to manage water availability within the context of climatic variability and the local communities are capable of having adjustments to the impacts of climate change on the availability of water.

3.1. The context

3.1.1. Sources of water and water delivery channels

Water from streams originated from snow- and glacial-melt (surface water) or springs (groundwater) is diverted into earthen channels (locally named as 'Kuhls') carrying water over km of length in rugged mountainous terrain and from higher elevation to a lower elevation. This is a marvellous work of mountainous engineering, which was accomplished by the local population centuries ago, when the formal education in engineering was not available in Gilgit-Baltistan. These main channels may branch out into smaller secondary channels ('Rill') to irrigate the farms. Despite the fact that in many instances water is diverted at headwork into filter basins, normally low gradient channels and high turbidity of water result in siltation of sediments, which the community members have to desilt almost at the start of every crop season.

Agriculture in Gilgit-Baltistan is the largest sub-sector of water use. Most of the region receives too little precipitation in the lower valley altitudes to hardly allow any form of rainfed agriculture, as total rainfed area is 2,285 ha, constituting 3% of total cultivated area. Most dependable channels are those derived from glacier-melt but these often carry amounts of silt, which has implications (positive and negativ(e) for the farmers. Water channels derived from springs have relatively constant flows but they are free of silt. The most variability in flow is shown by channels derived from snowmelt where severe shortages of irrigation water occur every 5 years along with annual temporal variations. The largest irrigated area is under surface water channels constituting 66% of total irrigated area followed by groundwater oasis out through springs. Tubewell is an insignificant source of pumping water for irrigation.

[3] This section has benefitted from

- Ahmad, S. 2008. *Water resources of Gilgit-Baltistan*. Water Background Paper for the Gilgit-Baltistan Economic Report. World Bank, ADB and Government of Gilgit-Baltistan.

Water diverted in channels from small rivers experience temporal variability because of fluctuations in river flows. These channels may get inundated in May or June due to increased river discharge but later in the season the flow may reduce so much that these may have to be moved further upstream to sustain irrigated agriculture.

In Gilgit-Baltistan, most of agricultural lands are situated on alluvial fans, river terraces and scree slopes formed by erosion of mountain sides. The lower portion of alluvial fans with finer sediments and better developed soils of older river terraces are more intensively cultivated. On the scree-slopes, the upper portions with finer sediments tend to be cultivated first.

In the rugged mountains, two-third area under irrigation is through open channels, usually constructed and maintained through participatory efforts of farmers. PWD, LGRDD and AKRSP are also involved in supporting the construction or rehabilitation of water channels. Most of the open channels carry water directed through a 'crude intake structure' from mountain streams fed by snow-, glacial-melt and/or springs for distribution through watercourses to small farms. The water conveyance losses are huge in these open channels passing through a difficult terrain and coarse textured soils. The GB-PWD is involved in lining of irrigation schemes in Gilgit town to reduce seepage to control waterlogging of surrounding lands. They are of the opinion that pipe network is cost-effective for constructing future irrigation systems in the GB.

How extensive is irrigated agriculture in the GB? What, collectively, is the command area of irrigation systems in this region? What are the water conveyance losses in an open channel system? The answer to these questions would seem to be anyone's best estimate, considering the fact that formal surveys of open channel systems have never been arranged. Irrigation in Pakistan is dominated by canal irrigation systems in IBIS. WAPDA provides detailed data for IBIS, but relatively less data for the region outside the IBIS. The most comprehensive review of irrigated agriculture in Pakistan during early 80s; the Revised Action Plan for Irrigated Agriculture makes no mention of open channel irrigation systems in the GB. The Population Census 1998 indicated that the cultivated area in GB was 73,905 ha.

3.1.2. Local water rights and allocation rules

In the GB, communities usually claim a right to the usage of water flowing through their village. A neighboring village cannot use it without the consent of those who own water. In the past, traditional water rights were established but recently it becomes an important issue due to the introduction of piped water supply schemes for domestic use. The water rights and allocation procedures would further be affected due to growth in population and expansion of multiple water uses.

The traditional open channels have been managed by the water users on a justifiable manner, knowing that equitable distribution of water is essential for their survival. Where water is scarcer, strict water allocation rules and regulations are applied and adhered to. Here water rights form the basis for allocation and distribution of water inside the village. For example, in villages close to Gilgit town water use rights are given only to those who own officially registered "settled land" which is agricultural land for which Land Revenue ('Malia') was paid before 1970s. Other farmers cannot claim water for land but can only use excess water. For example, people of Jutial and Khomer have joint right to the use of Jutial Nullah. In time of scarcity (October-November and March-May), this right is strictly enforced. Irrigation water to a part of Zulfiqar colony is stopped as this settlement does not have traditional user rights. Therefore, this colony relies on a river lift scheme for drinking purposes during this period. Nonetheless, over time water rights have been modified through mutual agreements between old and new settlers in the GB.

In some villages water allocation and distribution systems are enforced in every season except summer when water supplies are abundant. In other villages, enforcement is only during March-May when farmers need more water for wheat and barley crops and snow- and glacier-melts are limited. Distribution patterns often reflect village settlement patterns. Early settlers enjoy slightly better distribution but over time agreements are reached to accommodate newcomers and population growth.

3.1.3. Managing water distribution – Warabandi schedule

The practice of water distribution schedule, taken according to an established roster, is used in Gojal systems, as it is elsewhere in the Gilgit District, to equitably allocate water and ensure distribution schedules in periods of water scarcity during March and May. When the period of water scarcity is over, or where water scarcity is not a problem, water distribution generally follows a relatively informal system based on the need. Field observations confirmed that the Warabandi generally remains a durable, not easily changed irrigation management practice in Gilgit.

Under the Warabandi system, each water user in the open channel command takes its irrigation turn on a specific day, at a specified and equal period of time. Between farmers whose turns are closely proximate to one another, there may be frequent, informal trading or exchange of turns. Generally, food crops are given first priority in water use, followed by fodders and trees. Thus, where night irrigation is practiced, it is usually for trees because food and fodder crops are commonly irrigated during the day. Amongst food crops, vegetables typically take priority over food grains; even to the point where an operating Warabandi can be interrupted out of turn should a farmer plead the necessity of water for a vegetable plot. It is hard to understand that why the water users of GB are not using water during nighttime, whereas it is a common practice in the Indus basin irrigation system, where Warabandi is based on 24 hours of roaster.

3.1.4. Managing O&M of open channel systems

The O&M of open channel systems reflects their common property origins and a continuing collective management basis. Traditionally, the principle followed for maintenance of the open channel system was an annual in kind contribution from all the water users or in cash in lieu of labour. Normally, annual maintenance is done in spring at the beginning of the crop season and when water flows are either low or non-existent. On channels, where silt loads are heavy, farmers may also participate in mid-season desilting operation. Maintenance of field channels is the responsibility of individual water user and these are hardly maintained.

Some villages employ a Ditch Rider (Chowkidar) during the irrigation season to patrol the open channel to adjust and clear debris from the intake, to plug leaks, repair small breaches, and otherwise monitor the flows. In systems where Ditch Riders are not employed, farmers will take regular turns patrolling and maintaining the channel, usually at the time of their irrigation turn. Whenever a major breach or other maintenance emergency occurs, all the water users of the channel will participate in its repair.

3.1.5. Other Physical Infrastructures

The other physical infrastructures used in open channel systems are generally straightforward and not elaborate. Sets of flat stones are often used as control structures. Rudimentary, but functional, turnouts generally are constructed from selected rocks; occasionally carefully fitted wooden turnout "gates" or small pine outlets are encountered along channels. Sedimentation tanks or stilling basins have been built at the head of the channel to reduce inflow of heavy silt loads carried by the glacier-melt. The tanks on open channels are meant to trap rock debris

carried in the glacier-melt as well, and they must be desilted from time to time during the irrigation season - a task done collectively by the water users. Several water users have dug shallow stills close to their fields. The deposited silts are removed and mixed with animal manure and spread in the fields to improve soil fertility and water retention.

In two older channels (i.e. in Soust and the Nazimabad areas), overnight storage tanks have been built. These tanks permit the augmentation of channel flows during daytime irrigation. However, such infrastructure is not as widespread among Hunza channels as might be anticipated, perhaps because inexpensive construction of tanks that will not leak, and at the same time be of sufficient size for irrigation, is difficult. The Consultant while visiting the Gilgit and Diamer districts observed that farmers are now constructing water storage tanks although of smaller size or widening of their older tanks to store night waters especially during winter when snow- and glacier melts are reduced.

The unique experience, Consultant had during his visit to Gilgit and Hunza, motivated him to document the indigenous and local concept of Ditch Rider practiced by the local communities and this adaptation already have provided them mechanism of how to have further adaptations to manage the impacts of climate change on the availability of water.

3.2. Case study of indigenous adaptations in irrigation management – The ditch rider

The ditch rider (Chowkidar) is quite common in the open channel systems of GB. With experience, he develops knowledge of the open channel system. He is also accountable to the water users and they are willing to pay him because he provides an essential service. Therefore, he may be taken as a service provider in the context of local open channel irrigation system and irrigated agriculture. In case he fails the delivery of services to the users, they are likely to replace him immediately. In the three Gojal villages (Soust, Morkhon, and Passu) land not adjacent to the developed command area is supplied water through lengthy new channels. None of the three villages yet has a ditch rider for their channels, although water users of the Soust channel say they plan to hire a ditch rider. Some of the older systems (i.e. Morkhon or Passu) also do not have ditch riders.

In a new channel in Khaiber, variation in the ditch rider system has emerged in conjunction with another innovation: Village Organization's decision to collectively develop the command area for at least the first five years of operation. The new Khaiber channel command located 2-3 km from the village. Because new land remains in collective ownership, there are no specific individual responsibilities for irrigation, and this situation required Khaiber farmers to devise a new approach to manage irrigation of the new command. Of the two obvious possible solutions, irrigation by smaller groups of water users on rotational basis or modification in the traditional O&M responsibilities of ditch riders, Khaiber farmers chose the latter. At a monthly salary somewhat equal to the local wage labour rate, three men were hired for the four months' agricultural season to do daily activities in the new command area. These "ditch riders" also continue to perform other tasks traditionally associated with them.

The Consultant studied the system of ditch rider being practiced in the Gilgit District at Manawar, Sakwar and Nomal areas. There are variations in the responsibilities of the ditch rider at various commands. But at most of the locations, it was found that ditch rider provides an essential service and communities do regard their services and pay them regularly.

The case of ditch rider in Turmai area is somewhat unique because community is very advanced in terms of managing water efficiently, as they have installed Polyethylene pipe for the

conveyance of water from source to the command area with the technical assistance from the Water Management Directorate of GB, therefore, they have hired permanent ditch riders to provide O&M and irrigation services to the farmers.

3.3. Case of ditch riders in Turmai pipe-channel system

The water users of the Turmai Command have established a system of water conveyance using pipeline of 1250 m and open channel of 427 m to the head of the command area. The rest of the channel and farmers' field channels are also open channels. The community initially invested PKR 200,000 to pipe around 610 m using low quality pipes. Later rest of the 427 m length of the channel was piped using PE High Pressure High Quality pipe of 150 mm diameter during 2004-05 at a total cost of PKR 351,000 under the support of Water Management Directorate of GB. In the second Phase another 215 m were piped using PE High Pressure Pipe at a total cost of PKR 387,500 and replacement of some of the damaged sections installed by the farmers. This makes the system unique in terms of a combined system consisting of pipeline and open channel. As the community performed extremely well in modernizing the water conveyance system, they are also performing well in managing the Warabandi system, where two ditch riders are performing their duties. One is responsible for the overall watch and ward and monitoring of the system, whereas the other works as Irrigation Specialist.

Mr. Ali Gohar is the ditch rider who provides support to the water users in managing the Warabandi schedule as per agreed water rights and allocations. Mr. Gohar assists farmers in irrigating their lands and also monitors the schedule of Warabandi (Figure 9). His decision regarding irrigation completion at farm and field level is final. The system followed in command is that Mr. Gohar accompanies the water user who has the turn. Water user irrigates his fields and Mr. Gohar gives the verdict whether irrigation in the field is completed or not. When all the fields of a farmer are irrigated, the ditch rider asks the next water user to take over the turn.

Figure 9: Ditch rider as irrigation specialist (above), and for supervision of the channel (below)

Penalty is also imposed on defaulters if they do not follow the decision of the ditch rider. Every water user pays PKR 25 or more based on the size of land holdings. In case of penalty water user has to pay double the amount. Out of the amount of penalty, 50% is paid to the Water Users' Association's account and rest 50% is paid to the ditch rider as a bonus. This creates a balance in enforcing the water regulation by the Water Users' Association.

The ditch rider also works as service provider to the water users in case of emergency when a water user is unable to irrigate his fields.

The most important question comes to mind is that who provides capacity building support to the ditch rider. The answer is none. If the capacity of ditch rider is continuously upgraded, he can perform his duties better. Similarly, his capacity and capability has to be enhanced regarding irrigation priority and irrigation scheduling so that over-irrigation might not result in loss of nutrients and yield. The public-sector institutions and NGOs have to take the lead to identify the enlightened communities and ditch riders to build their capacity in irrigation management and efficient water use at the farm level. Without this intervention the goal of enhancing land and water productivity can't be accomplished.

It is important to note that Turmai command never had VO formed by the AKRSP or any other NGO, as their own Committee was so strong that even after conducting joint work with the Water Management Directorate of GB, they used the representatives of the same Committee as representatives of the registered Water Users' Association. Participatory approaches in irrigation are indigenous to the area and these have to be further strengthened instead of introducing any new concept. It was there before the inception of the AKRSP or even before the creation of Pakistan. It is in fact centuries or millenniums old. It is a general belief that the Water Users of Pakistan can be organized around water, as it is a community issue and value of water is very high due to arid environment because nothing will grow without water. Major conflicts among the rural communities are emerged on water. Thus, the community organization has to the institution of water users dealing with all the public sectors and all the NGOs.

3.3.1. Irrigation priority and scheduling

Individual farms have an allocated share of water and it is conveyed through farm channels. The priority for allocation of water is from head to the tail of the channel. In other systems, priority also moves with the pre-set priority assigned to various groups or individuals i.e. in Hunza area. The first priority is given to cereal crops on irrigated terraces, then potatoes, vegetables, fodders and finally fruit trees. This sequence is relaxed only when sufficient water is available in the channels. At this time, the first watering of orchards is allowed. The current organizational aspects of water management are based on the village communities who manage water through mutual consent and have laid down an elaborate system of water allocation and channel supervision.

4. MOUNTAIN FRUIT FARMING – CASE OF LOCAL PRACTICES AND LINKAGES WITH PRIVATE SECTOR ENTREPRENEUR FOR VALUE ADDITION IN HUNZA[4]

In the Gilgit-Baltistan, in the Hunza valley, integrated farming system has been developed since centuries to make adjustments with climatic variability and disasters in terms of extreme events of floods and droughts. The integrated farming system in the Hunza valley is comprised of crops, fodders, fruits, vegetables, and fuel wood/timber plants. The purpose is to have sustainable farming system, which suits with the winter and summer seasons and extreme variability in the access to water during both the seasons. The other benefit is that this system provides optimal surface cover in the farming areas, so that in case of heavy precipitation the runoff or floods do not cause severe soil erosion or landslides. The local communities have been trying best to grow the deciduous fruits including nuts, especially the apricot is a major fruit comprising of two-third of the total fruits produced in Hunza. The community have also developed mechanisms for value addition and by-products for apricot and other fruits. In the recent past, the Mountain Farming Company after privatization developed the Fairtrade Fruit Production Associations as contact growers to provide the produce to the company and fetch the premium price for the fresh and dry fruits. The buyback arrangement between the producers' associations and the fruit company also provides a stable business to the small producers of fruit. The local communities have survived in climatically variable environments and they are fully cognizant with the expected climate change.

4.1. The context

The deep valleys cut by the Gilgit and Hunza rivers and their tributaries, as they drain the Karakorum Mountains, are the locus of permanent settlements in Gilgit District, in villages perched precariously on river terraces or the sides of alluvial fans. The climate is dry continental, characterised by a large range of temperatures and meagre annual precipitation. The annual variability is high in the region that is largely in the rain-shadows of the largest concentration of mountains of > 6,000 m in altitude. Only at higher altitudes (>3,000 m) precipitation falls in the form of snow.

Agriculture depends upon surface water derived primarily from snow- or glacial-melt. Less frequently, the open channels are fed by perennial springs, the scarcest but most reliable water source, or by small rivers. The snow- and glacier-fed open channel systems generally have the least temporal variability in flows, but these carries large quantities of suspended silt much of which is subsequently deposited in the farmers' fields as a mixed blessing. During the period of germination and emergence, there is a risk that seeds will become buried too deeply to achieve an optimal germination rate or that the seedlings will become coated with silt, inhibiting normal metabolism. On the other hand, silt is often important in the soil-building process, especially for improving soil structure besides it also provides a natural source of potash and other nutrients.

[4] This section has benefitted from

- Ahmad, S. 2008. *Water resources of Gilgit-Baltistan*. Water Background Paper for the Gilgit-Baltistan Economic Report. World Bank, ADB and Government of Gilgit-Baltistan.
- Production and handling of Apricot in Gilgit-Baltistan. AgriHunt (http://agrihunt.com/articles/horti-industry/production-and-handling-of-apricot-in-gilgit-baltistan/).
- Mountain Fruit Company (http://www.mfc-fairtrade.com/).

Harnessing water for irrigation is a major part of the task of developing and sustaining agriculture in the GB. Equally, perhaps even more arduous, is the longer process of land development on steep slope gravelly soils for surface irrigation. In bringing land under surface irrigation, soils have been drastically modified for land forming on steep slopes. Irrigated crops are largely confined to three major landforms and associated soil types. In the valleys of Rivers and its tributaries, river terraces and alluvial fans have the highest agricultural potential. The deeper and better-developed soils found on old river terraces are more important than those on terraces of relatively young origin. The lower portions of alluvial fans, formed by small streams and hill torrents, are more intensively cultivated than the upper areas, because of the small proportion of coarse soil materials. In either instance, better soils are commonly the focus of grain and vegetable crops as well as orchards. Less developed soils tend to be used for raising fodders and fuel wood.

Another focus of irrigated agriculture is the cone-shaped scree slopes produced by mass wasting of surrounding barren cliffs and hills at elevation of <2,000 m. Because of inherent instability of these slopes, their agricultural development presents special problems and tends to be both more recent and slower. The upper portions where finer materials are concentrated are cultivated first, usually with slope-stabilizing trees, shrubs, and fodders. Stability of steep slope agriculture on newly formed open channels is a serious issue because soils are extremely of coarse texture and gravelly.

The best innovation traditionally made by the local communities is the integrated land use where they are growing crops, vegetables, fruit trees and forest/timber plants, in addition to livestock and rural poultry. Apricot has a central place in the farming system along with other fruits like cherry, apples and peaches. Nuts are available in the forest area – walnuts and chalghoza. They also grow walnuts at the farm level and also use nuts from apricot. The communities have been involved since centuries in drying of apricot and extracting oil from apricot kernels. Both the oil and dry apricots are part of their diet.

The local communities in the last decade have also started learning value addition in the traditional drying and oil extraction. They started using more hygienic ways of drying apricots and better extraction of oil from apricot kernels to have higher rates of recovery. They have also started semi-level processing using grading, sulphur treatment and packing of dry fruits. They also gone a step further in processing cherry and other nuts. Recently, the rural communities also developed a system of buyback arrangement with the local Mountain Fruit Company and now getting fair price of their premium produce including the organic products.

4.2. Case study of Hunza integrated farming – indigenous and local adaptations

The integrated land use and farming system developed by the population of Hunza and the type of food they have eaten for centuries are responsible for the remarkable vigour, long life and less diseases enjoyed by this unique race. Their integrated farming system is empirical and not based on scientific principles, which they have been following without any deviation for centuries and millenniums. The local communities since centuries back have developed level bench terraces in the steep mountainous lands, so that they can apply surface irrigation. Even today if someone walk in to these bench terraces must get a remarkable view of marvellous earthwork done using primitive tools and without any engineering tools of levelling. Sometimes these bench terraces reach nearly to the timberline. It is astounding to think of the number of man-hours required for the earth and stonework to construct the remarkable bench farming system.

Water is an essential input for irrigated farming because nothing can be grown without irrigation. The bunded fields are small to medium in size must be irrigated throughout the season for the production of two crops. The Hunza farmers are fortunate enough in having a regular supply of irrigation water from snow and glacier melts. The today's farmers must owe to their former generations, who developed most of these steep-slope farming systems. The current population have rehabilitated and improved these over time. See the integrated farming system in Figure 10, which is engineering masterpiece in irrigating such topography.

Figure 10: Integrated land use in Hunza slopes

The mountain water is rich in nutrients and the silt is also carried to the fields with every irrigation and that's why even the organic farming is possible because the silt is a source of continuous addition of nutrients in to depleted soils. Because of the importance of water in the Hunza economy, disputes about water comprise the greater part of the court docket the council of elders rules upon. Early in the spring and again before second crop is planted, canal gates (large flat stones or wooden gates) are opened and all the terraces are irrigated. After the infiltration of the irrigation water in the soil, leaving the silt deposit on the surface, the bench terraces are ploughed and fertilized using composts and fertilizers. Women are equally involved in farming operations except irrigation. They are involved in planting, cultural operations, harvesting, drying, grading, storage, and value addition (Figure 11).

Figure 11: Integrated land use and involvement of gender

In the integrated farming system of Hunza, soil must be replenished regularly by means other than silt from the mountain waters; indeed, the Hunza soil is almost a newly developed soil every year. Every solitary thing that can serve as food for vegetables, field crops and fruit trees is diligently collected, stored and distributed in rationed equality over every terraced field. Sunken compost pits are conveniently located, and into them go ashes from cooking and heating fires, inedible parts of vegetables, pulverized animal bones, dead leaves, rotten wood and the collected manure of animals.

The Hunza farmers' idea of returning to the soil everything that comes from the soil is actually comparable to nature's law as applied in the impenetrable jungle. There is no intrusion of non-living matter in the jungle. Plants, animals, birds, reptiles and insects come into being, live their life span, die and return as life-giving elements to the incredibly fertile jungle soil. It is simply a cycle of life-death-life. Nothing is ever lost; nothing wasted. A scenic view of fruits at blossom is presented in Figure 12.

Figure 12: Fruit trees blossom in Hunza

The regions not blessed with sufficient arable land to feed their population are forced to adopt an integrated farming system that is matching to gardening. It is the principle illustrated in the above paragraph, that every organic thing is returned to the soil, e.g. wastes of vegetables, livestock, crops, food, wood, and ash that is produced in the soil. It is astounding that how many different food products are grown in the small agricultural area of Hunza valley, which is limited by high mountains to an area of about 100 km long and 2 to 6 km wide.

- Grains include wheat, barley, buckwheat, corn, millet, alfalfa and rye.
- Seven fruits offer ample diversity to the diet: apricots, peaches, apples, cherries, mulberries, watermelons, and grapes.
- Vegetable requirements are satisfied by potatoes, tomatoes, carrots, onions, garlic, peas, beans, and food legumes (pulses).
- Nuts are restricted almost entirely to walnuts, almonds, and kernels of apricot.
- Milk, mostly from goats, provides butter and cheese.
- Meat is scarce (mostly mutton, beef and sheep).

Chickens are viewed with suspicion because they scratch up precious seeds and crops. Apricots are one of the staples of the native diet, but the trees are not like the modern orchards. They are allowed to grow for at least 50 years before the tops are cut off about 6.1 m from the ground; then growth continues for another 50 years.

The Hunza soils are rich in nutrients, as the trunks of these trees match the circumference of forest trees, and production of fruit is exceptional. The importance of the apricot in the Hunza economy is suggested by the fact that the trees are regarded as valuable property which, on the death of the owner, is willed to a favourite son or other relative. To own an apricot tree is an indication of richness, and the local maidens cast covetous eyes on swains fortunate enough to boast ownership of such a prize.

The apricot kernels are eaten as nuts and sold in the market. These are also used to extract apricot oil and it is used in food preparation in place of edible oils. The apricot oil is like olive oil and used for deep-frying bread, meat and other foods. On festival nights, women use apricot oil to shine their hair. It makes a good rubbing compound for body bruises and also used for shining silverware.

Apricots and mulberries are sun-dried to serve as dry fruit when the fresh fruit is not in the season. Enough of this harvest is use in the fall and winter months. Nothing is unpalatable about the apricot fruit in Hunza. Hunza people soak the dried fruit in water overnight, and then in the morning it resumes its original size and sweet and delicious like the fresh apricots. These apricots, cooked with stone-ground oatmeal and milk, and served hot, are the main dish at many a meal. Hunza fruits are rich in natural sweetness, therefore sugar is not used.

The chappati is made of wheat or millet, baked or deep-fried, and served with accompanying food. These are very tasty, especially in their fancier forms, and their nourishing qualities far outshine any other bread in the country because the natural goodness is not lost in milling. Chappaties can be made of other grains than wheat and millet, and dried vegetables (peas, beans, etc.) are often ground up and used with grains in making special breads. The important thing about the use of grain in the diet of Hunza people is that all the goodness and health-giving properties of the grain are utilized.

Vegetables in season are eaten raw by the Hunza people. They also prefer the food in its raw state. They get the full nourishment of the plant, because it is altered very little in the transfer from soil to table. Even corn on the cob is eaten raw in the milk stage. They soak beans and peas in water for one or two days, and then spread the seeds out on wet cloth in the sun. They are eaten raw when they begin to sprout.

Vegetables are cooked by boiling in covered pots method comparable to steaming. Very little water is used and this is replenished in small quantities as required. The water in which the vegetables are cooked is drunk at the time the food is eaten, or saved for future consumption. This, again, is a wise custom, because much of the food value of the vegetables is concentrated in the water in which they are cooked.

Vegetables, whether eaten raw or cooked, are not scrubbed so thoroughly or deep fried; consequently, the vital health-giving skins are eaten advantageously. About twenty per cent of the food eaten in Hunza is cooked; the balance is eaten in its natural state.

Livestock production in Hunza is severely limited because grass is almost non-existent, and it is not possible to fatten animals adequately. The pastures are available high in the mountains. Sheep and goats can subsist on less fodder than cattle, and the available supply of leaves and straw produces more milk when fed to these animals. When an occasional animal is slaughtered, usually in the festival season in winter, every morsel of meat is consumed. Even the vital organs are cooked and devoured. Bones are ground for fertilizer, and the gut is dried for a variety of uses such as thread and instrument strings. Of course, the skins are cured and used as leather.

Meat dishes are predominantly stews, which simmer until tender in large kettles with such whole grains as millet, wheat, barley and corn. During the latter part of the cooking, fresh vegetables are added to make a mutton stew, a real treat for the Hunza people.

4.3. Case study of apricot production and processing

4.3.1. The origin of apricots

One of the most precious gifts of nature is the blessing of apricot, which is the major fruit among the variety of fruits in Gilgit-Baltistan, which is the largest apricot producing region in the country. The apricot has a long and interesting history. It is generally believed that the origins of apricot are in China, where the fruit has been cultivated for food as well as for its therapeutic properties for more than 4,000 years. The apricot tree has also been grown in neighbouring India and Tibet since times immemorial. According to ancient records, the Hunzas, who inhabited the Himalayan mountains in the northern regions of Pakistan and were acknowledged for their vigour and long life span, cultivated and treasured apricot for its aptitude to foster health for more than 1500 years.

Apricots not only taste good rather they are also packed with good nutrients. Some of the nutrients found in apricots are: vitamin A, vitamin C, fibre and potassium, which can help to protect eyes and heart as well as digestive system. Dried apricots are an excellent source of iron.

4.3.2. Apricot as a major fruit in Gilgit-Baltistan

In Gilgit-Baltistan, apricots along with other deciduous fruits are primarily produced as cash crop where majority of families grow apricot. The practice of planting seeds from the best trees over an extended period of time has resulted in an incredible amount of variation. Many years ago, the farmers did learn to graft so now hence, in each village in addition to seedling trees, one would find many favourite local cultivars.

Fruits have mainly been produced to meet annual family needs for dry fruit particularly during severe winter. Majority of people ranked apricot as their most preferred fruit. Because apricot would meet most of their subsistence needs. Dried apricot and kernels are main dry fruits for winter. Most fuelwood is obtained from apricot trees. Oil from kernels is obtained for various domestic uses. Cracked kernel shells are also used as fuel.

According to the survey conducted by FAO in 2003, Gilgit-Baltistan produce about 0.171 million tons of fruit per annum and apricot alone contributes 0.108 tons, meaning that apricot contributes around 63% of total fruit production. There are around 180 different cultivars in several villages of Gilgit-Baltistan. The average household in the villages, covering 40% of the rural households, earn PKR 20,000 to 25,000 from apricots and its by-products in Gilgit-Baltistan.

Most apricot cultivars blossom in early March. The blossoming time is about a fortnight and may be prolonged or shortened by the presence or absence of cold spell. Considerable variation is also shown by different cultivars in their blossoming habits. The incidence of frost during March is common and considerable damage to apricot crop is annually experienced.

4.3.3. Drying of apricot – traditional methods

Traditionally, the local communities sun-dry the apricot in open environment. Therefore, the dry fruit accumulate some dust due to the wind. Further this drying process is also prone to insects. Improvements have been made with passage of time. Initially the community dry the apricots on the roofs of their houses. Later on they started using containers made of mulberry sticks in round shape. Recently, they started using the soft wood because of ease of construction and reduced labour cost (Figure 13).

Figure 13: Improved and traditional method of sun-drying of Hunza golden apricots

4.4. Case of grafting local production practices with value addition – Case of Mountain Fruit Company

Mountain Fruit Company Private Limited is the first processor and exporter of fairtrade and organic certified dry fruits, nuts and edible oils in Pakistan. The Company was conceived by the Founder Director, Mr. Sher Ghazi, in the year 2000, as a project of Aga Khan Rural Support Program (AKRSP). The project was registered as a private limited company in 2004. Since November 2007, the company is owned by Mr. Sher Ghazi, Mr. Adam Brett, Ms. Kate Sebang and Mr. Richard Friend, after the auction of the Company by AKRSP.

The Mission of the Mountain Fruit Company is to support small farmers through fairtrade system and value addition through training in horticulture management, organic farming, training of small farmers in improved techniques of fruit drying and subsequent value addition to the product so that the marginalized people in the mountain valleys of Gilgit-Baltistan have the benefits of fair price from the Company.

4.4.1. Fairtrade farming community

Mountain Fruit Company is working with Fairtrade farmers' groups under contract production in the three districts of Gilgit-Baltistan. The company has 2474 Fairtrade contact producers consisting of 2039 males and 436 female farmers organized in 63 males and 10 female Fairtrade Producers' Groups. These communities are organized into six valley based Fairtrade Associations which are governed by the producers Executive Body, registered as Mountain Area Fruit Farmers' Association. This producer's representative organization is capable of handling Fairtrade premium distribution among the producers' organizations. This organization in collaboration with the Company staff prepares and implements Fairtrade Organizational Development Plan to make the community capable of sustainable production (Figures 14 and 15).

Figure 14: Community participating in a fair trade meeting and community representatives are receiving cheques for repair of an irrigation channel

Figure 15: Women producers' groups receiving Fairtrade premium cheque for an ECD school and farmer picking fresh organic apricot for drying in Hunza valley

More than 50% of farmers are organic certified by Control Union and they are committed to move for more environmentally friendly sustainable production system. Mountain Fruit Company's Farmers' Groups dry cherry in clean environment of Karakorum Mountains. These organic dried cherries are marketed in Fairtrade's markets in Europe since 2010.

Fresh cherry being delicate to transport to 600 km away, the nearest market at Islamabad, Pakistan (Figure 16) therefore communities prefer to preserve them by sun drying (Figure 17). Mountain Fruit Company processes the fruits at international standards and pack for bulk shipment in 15 kg vacuum packs to export. Year 2015 is the year of cherry, with high production so buyers are invited to buy organic cherry from Mountain Fruits Company.

Figure 16: Fresh cherry of Hunza

Photo courtesy: http://www.mfc-fairtrade.com/fairtrade-farming-community/.

Figure 17: Solar drying of cherry in Hunza

Photo courtesy: http://www.mfc-fairtrade.com/fairtrade-farming-community/.

4.4.2. Organic and inorganic products

The detailed list of products being offered for local sale and export is presented in Figure 18. There is a choice for the certified organic and non-organic products by the company.

4.4.3. Certification

International level ethical and quality certification is the strength of the company. Mountain Fruits Company has been certified as a Fairtrade and organic production company in the year of 2005. Since then the company is being updating organic and Fairtrade certificates successfully. Recently, the company has HACCP certified one of its processing units at Damass where almonds, apricot kernels, and walnuts are being processed. The company has applied for NOP and Bio-Swiss certification in 2014 for almonds, walnuts, and their by-products.

Figure 18: Non-organic and organic fruit products (nuts, oil and dry fruits) by Mountain Fruit Company

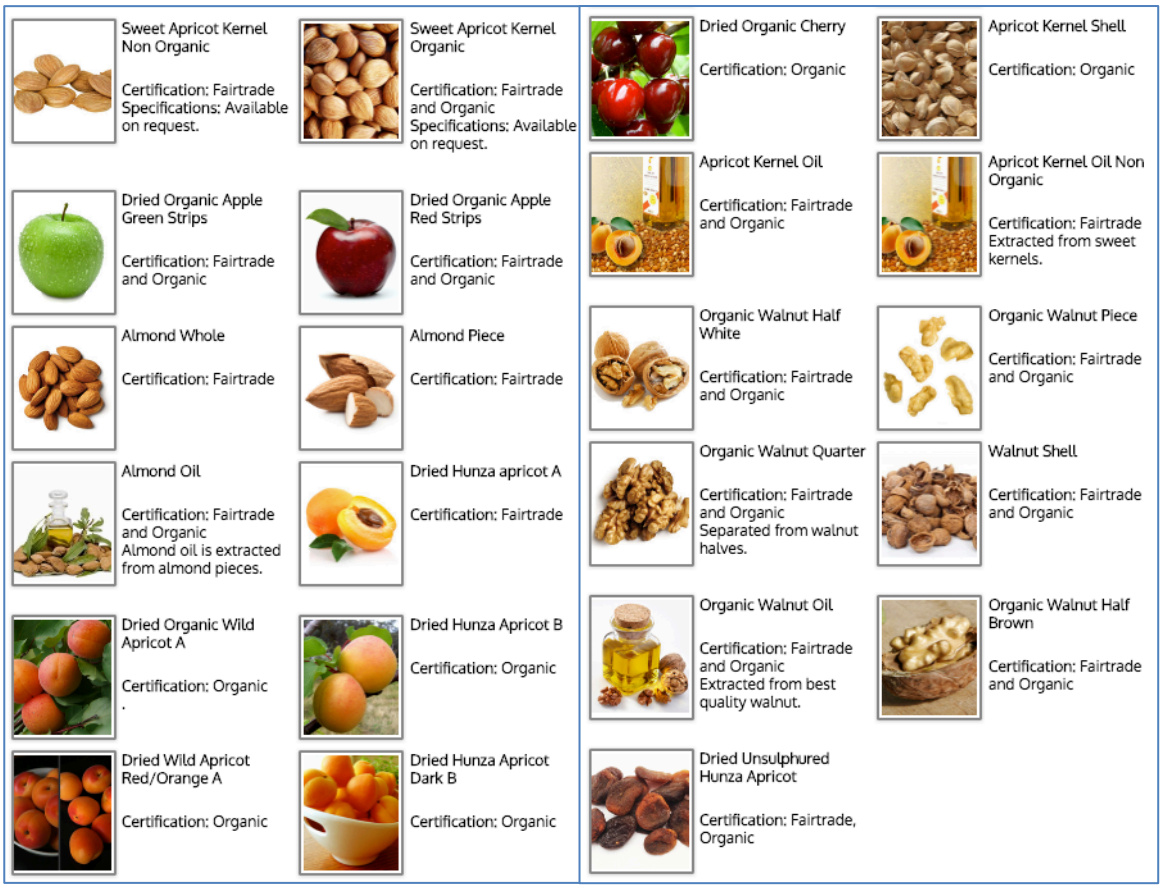


Photo courtesy: http://www.mfc-fairtrade.com/products/.

5. MOUNTAIN HOUSING – REFINEMENT OF LOCAL HOUSING PRACTICES FOR CLIMATE AND EARTHQUAKE RESPONSIVENESS: 2005 POST-EARTHQUAKE SCENARIO IN AJK AND KP[5]

5.1. The context

On 8 October 2005, an earthquake of 7.6 magnitude struck the northern Pakistan and Azad Jammu and Kashmir (AJK). The earthquake epicentre was located around 19 km north northeast of Muzaffarabad, the capital of AJK. The Pakistani government's official death toll stood at 100,000. Around 138,000 were injured and over 3.5 million rendered homeless. Around 19,000 children died, most of them in widespread collapses of school buildings. It affected over 500,000 families. In addition, 250,000 farm animals died due to collapse of stone barns, and more than 500,000 large animals required immediate shelter from the harsh winter. Over 780,000 buildings were either destroyed or damaged beyond repair, and many more were rendered unusable for extended periods of time. Out of these, 17,000 school buildings and most major hospitals close to the epicentre were destroyed or severely damaged. Lifelines were adversely affected, especially the numerous vital roads and highways that were closed by landslides and bridge failures. Several areas remained cut off via land routes even three months after the main event. Power, water supply, and telecommunication services were down for varying lengths of time, although in most areas services were restored within a few weeks. Most of the houses were demolished because these were constructed with stone or brick masonry and due to rigid structure and absence of earthquake codes, while designing these structures was the main cause.

Massive land sliding was a particular feature of this event. A very dense, high frequency band of landslides was triggered along the fault rupture trace in the mid-slopes; however, it quickly dissipated with distance away from the fault rupture zone. Almost all landslides were shallow, disaggregated slides, with two of them larger than 0.1 km^2. Due to the generally arid landscape, liquefaction was not observed (Figure 19).

5.1.1. Landslides

Landslide concentrations along the rupture zone were very high, but quickly dissipated within as little as 2 km of the surface projection of the fault. During the aerial reconnaissance of the affected area, landslide damage appeared to be most severe on the hanging wall, with relatively low concentrations on the footwall side. A very high concentration of large and small landslides

[5] This section has benefited from:

- NDMA. 2006. *Learning from Earthquakes - The Kashmir Earthquake of October 8, 2005: Impacts in Pakistan — EERI Special Earthquake Report*. Islamabad: NDMA, GoP.
- Zaufishan. 2011. "Micro-financed straw houses for Pakistan are quake-proof." The Ecomuslim (//www.greenprophet.com/2011/10/straw-houses-pakistan/#sthash.YpMs4VX6.dpu(f), 31 Oct 2011.
- Tareq Emtairah's practical eco-house in Aqaba, Jordan. Sustainable architecture in straw-bale house organic computer design (f).
- PAKSBAB - Pakistan straw bale and appropriate building - A project of builders without borders (http://www.strawbaleconference.com/Final%20PDFs%20of%20Presentations/ Donovan_PAKSBAB_ISBC.pd(f).
- PAKSBAB (www.paksbab.org).

was observed in the mid-slope area along the surface projection of the fault. The number of slope failures also increased significantly along slopes.

The largest concentration of destroyed or damaged buildings was in Muzaffarabad and Balakot. Other cities such as Bagh and Rawlakot also had significant damage. It is estimated that in Muzaffarabad, 30-50% of the buildings were either destroyed or badly damaged in the main event. Major damage concentrations in Muzaffarabad were in areas of deeper alluvial deposits along the Neelum and Jhelum rivers. Damage in Balakot was directly related to fault rupture. In Abbotabad, damage was due to local site response in the Cantonment area that was reportedly developed on former marshland. Several other towns located along the rupture zone (Bagh to Batagram) also suffered significant damage to their building stock. The widely photographed collapse of the high-rise Margala Towers in Islamabad, located over 80 km from the epicentre, may have been due to construction-related issues. A helicopter survey revealed that a large number of buildings in the more rural, mountainous areas— perhaps as much as 50% in areas proximate to the fault rupture— were destroyed or severely damaged. These were mostly farmhouses belonging to migratory and non-migratory mountain slope farmers. The government of Pakistan estimates that more than 80% of the total destroyed buildings were located in rural regions.

Figure 19: Massive landslide in the background, completely collapsed structures in the foreground with only roofs intact

5.1.2. Buildings

Most of the buildings in the affected area are of non-engineered un-reinforced masonry (URM) wall construction. The typical structure consists of one or two stories of unreinforced stone,

solid brick or solid concrete block masonry-bearing walls with reinforced concrete floors. Roof structures are flat or pitched. Flat roofs in smaller towns and villages consist of wood (non-machine(d) beams and straw-reinforced mud slabs and occasionally lightly reinforced concrete slabs ("Tayyar Chath") or GI (galvanized iron) sheets. Larger towns have buildings built of reinforced concrete slab roofs. Pitched roof construction, gabled, with or without hips, is framed with wood or light steel trusses with corrugated sheet metal roofing. Tiled roofs can also be found in this region. The smaller villages also contain adobe structures that, as expected, performed poorly in the earthquake. Foundations are constructed mostly of stones or bricks bearing on native soils about 0.6 to 0.9 m below grade and 18 to 0.6 m wide. The only steel reinforcing found in most of the bearing wall construction is in lintels (window or door headers), and normally consists of four #4 bars in a 9 x 9 concrete beam with stirrups or ties at 230-300 mm spacing. Typically, no bond beams are part of the wall and no positive ties exist between the walls and the floors/roofs. The performance of the URM wall buildings in the earthquake was varied and seems to have depended on factors such as redundancy in structural walls and quality of materials and construction (Figure 20).

Figure 20: Man in front of his sister's house in Muzaffarabad that collapsed and killed her

5.1.3. Transportation

Road closures completely cut off land access to the Jhelum, Neelum, and Kaghan valleys. Landslides were the pre-dominant cause of the closures. The problem of slope failures along road cuts was exacerbated by a road-building process that uses ex-plosives in weak structures and cuts into toes of pre-existing land-slides. Many road closures were due to shallow disaggregated slide sand rock falls that rarely caused the complete loss of the roadway bench.

However, the unstable nature of the debris and the presence of disrupted rock masses along the slopes above the roadway created ongoing challenges in clearing and opening the roads.

The problem of road closures was so significant that the army dedicated 12 engineer battalions to open roads. Due to the army's extensive experience with road building, and the availability of skilled builders in the mountain communities after many years of building the Karakoram Highway, the opening and reconstruction of roads was handled efficiently. At the time of the reconnaissance, the Jhelum Valley road, the Kaghan Valley road, and the Karakorum highway had been cleared and opened. The Neelum Valley road, the only other major road in the affected area. While most major roads have been reopened, there is a vast network of tertiary roads serving the mountain community in the higher elevations. Many of these roads remain closed, cutting off populations that did not even experience the direct effects of the earthquake and hampering relief efforts.

5.1.4. Bridges

Several bridges were damaged, especially within the Jhelum Valley and in Balakot. However, a number of bridges did not suffer much damage and were open to traffic. Within the earthquake-affected zone, the most prevalent bridge type was either suspension bridges or reinforced concrete multiple span bridges. The former consist of a wood deck supported on steel girders suspended by steel cables on either side of the deck. The cables are supported by a tower at each end and anchored in a concrete anchor block. In addition, the deck is prevented against sway by cables attached to a longitudinal cable on each side below the deck elevation and anchored in concrete anchor blocks. The suspension bridges are typically for pedestrian use, with some allowing vehicular traffic. Damage to suspension bridges ranged from shearing of the tower foundation to complete collapse of the towers (Figure 21).

Figure 21: Collapsed suspension bridge, Jhelum Valley

5.2. Earthquake proof houses in Pakistan – A case of post-earthquake refinement of local adaptations by PAKSBAB in Khyber Pakhtunkhwa

After the 2005 earthquake, Pakistan Straw Bale and Appropriate Building (PAKSBAB) was set up to protect people's homes against extreme weather conditions. More recently with the catastrophic earthquake in Turkey, reminded us the value of homes and family.

PAKSBAB invests in creative micro financing, giving the local community innovative design solutions to semi-independently construct energy efficient houses. A training period enables families directly affected by the earthquake to build their own houses using refined natural materials, and locals are recruited to participate in developing the community.

Since 2006, PAKSBAB has trained fifty people and constructed twenty-six straw bale buildings in Pakistan's Khyber Pakhtunkhwa province. Construction expertise is passed forward as disadvantaged Pakistani families are educated in the necessary steps to build their own straw bale homes (Figure 22). The Community Development Program (CDP) in 2007 did just that, providing all the necessary materials, training and financing to the poorest socio-economic group in the region.

Figure 22: Twice as energy efficient as a conventional house, straw bale makes for environmentally friendly earthquake-proof homes

Photo courtesy: http://www.greenprophet.com/2011/10/straw-houses-pakistan/.

By providing this life-changing opportunity, PAKSBAB hopes to improve the health and living conditions of Pakistani people, particularly the victims of flooding and earthquakes. Empowering

the most vulnerable with environmental awareness and reconstruction skills creates social and economic stability. Such low-cost building solutions for the developing world are earthquake resistant and about two times more energy efficient than typical construction methods, according to PAKSBAB (Figure 23).

Figure 23: Clay-plaster reinforced, a fabricated straw bale house costs half the expenses of modern building for every square foot

Photo courtesy: http://i0.wp.com/www.greenprophet.com/wp-content/uploads/2011/10/pakistan-environment-house.png

5.2.1. Low-cost investing for long-term profit

The project offered alternative building methods that are more environmental friendly than modern standard construction. While similar tools and building materials are utilized, the straw bale project is significantly less expensive, taking advantage of willing manual labour and local available materials.

An average straw bale house amounts to USD 54-65/m^2 in material and labour cost, in comparison to conventional developers' costs of around USD 129/m^2 for low-cost housing. The average construction of PAKSBAB's typical 54 m^2 is under USD 3,000 per house.

5.2.2. Earthquake proof design

In March, 2009, PAKSBAB performed the first impressive shake table simulations of a straw bale house, which provided convincing evidence that the construction system is very earthquake resistant (Figure 24). The tests were conducted at the Network for Earthquake Engineering Simulation facility at the University of Nevada, Reno, with support from the Earthquake Engineering Research Institute. The house was subjected to a series of eight earthquakes of

increasing intensity. It withstood accelerations of 0.8 g, larger than 0.3-0.6 g estimates of the Kashmir Earthquake accelerations.

Figure 24: House survived 8 increasing levels of earthquakes / 0.8g acceleration - larger than 0.3-0.6g estimates of the 2005 Earthquake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Typical straw bale construction uses straw, an agricultural by product after the harvest season, which is tied into bales and forms “building blocks” for walls. Both foundation and walls are built to withstand intense pressure, similar to a brick built house (Figure 25)

5.2.3. Why not bricks and mortar?

- Contrary to the three little pigs’ bedtime story, a reinforced straw house is more durable than imagined.
- Energy efficiency is built-in as the walls are ready prepared with draft proof insulation, keeping out the blasting winds during Pakistan’s winter season.
- Use of natural materials – light straw clay and woven wooden supports – means each house is organic in the sense that only non-toxic products are made use of.
- Sourcing locally available materials means families who are already under the standard of living quality are not forced to buy expensive materials and rely on builders for construction to begin.
- Once constructed, straw houses are resistant to damp, earthquakes and pests.

Figure 25: Tightly packed walls and a gravel weighted foundation creates better weather-proofing

5.2.4. How to build a straw house

Green design is a key element of PAKSBAB's quakeproof houses. The construction is executed in such a way that the house can take greater weight (Figure 26). Each family contributes about 1200 hours of labour. The current building material costs for the homes are PKR 200,000 or about USD 2,000.

A system for manufacturing straw bales has been developed from manually operated farm jacks and locally fabricated compression moulds. To establish independent local enterprises, PAKSBAB supported a straw bale fabrication operation in Khaki town, a rice-growing region near Mansehra. The team produced an average of 15 bales per man each day, costing a mere PKR 53, with room for reduction with mass-scale production.

Pakistani families are trained to construct cost-effective locally sourced materials for insulation. About 300 fabricated straw bales are tied tightly and packed between wooden beams and finished with clay plaster. This supports the roof load, reduces the foundation pressure as well as resisting wind.

Other ingenious design features include a foundation of gravel bags for weighting, upon which is poured a soil cement mixture. The whole surface is shrink-wrapped with nylon fishing net, providing plaster reinforcement and seismic resistance.

The standard Community Development Program home is 7.3 m x 7.3 m (53.3 m^2), comprised of two rooms and a veranda, with an optional kitchen.

Environmental building methods are part and parcel of PAKSBAB, whose straw houses use passive solar design, whereby the roof and walls store and effectively distribute solar energy (heat). Each house is designed with appropriate space for high-efficiency cooking, rainwater catchment techniques, and compost toilets.

Figure 26: Construction steps of straw bale house for earthquake proof (Courtesy: Green Prophet)

6. MOUNTAIN ENERGY: ADAPTATIONS OF INDIGENOUS WATER MILLS TO HYBRID WATER MILLING AND HYDROPOWER PLANT - CASE OF LOCAL SOLUTIONS[6]

The mountainous regions of Pakistan covering the Gilgit-Baltistan, northern Punjab and Khyber Pakhtunkhwa and Azad Jammu and Kashmir (AJK) are endowed with perennial streams and rivers, where water mills have been developed since centuries for the milling of grains – wheat, maize and chickpea. These water mills operate at very slow speed and therefore the process of making flour is not efficient being time-consuming. Some of the water millers shifted to electric or diesel operated flourmills. However, large number of water millers in Gilgit-Baltistan, AJK, Chitral and other northern parts of Khyber Pakhtunkhwa and northern Punjab are still operating these mills. Some of the innovative and visionary water millers in these regions started developing hybrid systems by adding the hydropower plants using some of the power being produced by the water mills to convert mechanical energy in to electrical energy. These visionary millers not only made these adaptations they also started providing electricity to the village households at very low prices because there is no or little O&M cost of the hydropower generators. They have demonstrated the ability not to maintain the centuries old water mills rather changed these to hybrid systems – water mills and hydropower generators. These systems still not that efficient and some technical knowledge, skill enhancement through trainings and micro-finance support can lead towards a massive revival of some of the abandoned water mills and generation of power for the rural communities.

6.1. The context

6.1.1. Indigenous water mills for grinding the grains in Kalasha Valleys

The current era is a cyber world – the world, which has been changed tremendously with the introduction of modern machines, and instruments, which are now extensively used in daily life of people in rural Pakistan. These machines have made our lives easier compared to our ancestors. But, in this cyber era, there is a community, living in northern Pakistan, in the range of Hindu Kush named as Kalasha Valley, and it is still maintaining their indigenous and traditional living style. They have maintained their indigenous culture and way of life since last many centuries. They have also maintained the barter system within their community. Even today, the Kalasha people grind whole of the grains with stone grinding mills installed on the banks of

[6] This section has benefited from:

- The Old-dates Method of Grinding the Grains in Kalasha Valleys. Kalasha: The Sole Pagan Tribe of Pakistan (http://kalashapeople.blogspot.com/2010/07/old-dates-method-of-grinding-grains-in.html).
- Are watermills in Kashmir a solution to Pakistan's energy crises. Express Tribune (http://tribune.com.pk/story/895659/are-watermills-in-kashmir-a-solution-to-pakistans-energy-crisis/), 2015.
- Khaliq, Fazal. "The art and science of grinding flour in a water mill without fuel or electricity in Shinkat." The Express Tribune, 20 Apr 2012.
- Dying tradition water mills disappearing due to fast pace of life. The Express Tribune (http://tribune.com.pk/story/367184/dying-tradition-water-mills-disappearing-due-to-fast-pace-of-life/).
- Mohmand, Mureeb. "Case of local solution: Converting indigenous watermill in to power generation in Miandam." The Express Tribune, 29 Jun 2015.
- Case of watermills in Azad Jammu and Kashmir. The Dawn (http://www.dawn.com/news/1185506), 1 Jun 2015.

streams using the hydropower. The history illustrated that water mills are being used since the Neolithic era.

6.1.2. Dying tradition: Water mills disappearing due to fast pace of life

Faced with an onslaught of modernity, centuries-old traditional water mills are now disappearing fast. Indigenous water mills have been in use since time immemorial. They are powered by fast-flowing water, channelled from a stream, which turns the heavy grindstone producing flour. The Swat valley is blessed with a myriad streams and channels, thousands of traditional water mills are scattered across the valley, milling flour for locals, practically free of cost.

But with the introduction of technology of modern grinding mills, which are very fast, water mills are rapidly disappearing from the countryside and with them, an ancient symbol of local culture. The local people still believes that the taste and standard of the flour ground by water mills is far superior to flour ground in flour mills and that is why people from far-flung areas bring their grains to water mills. They also believe that the flour ground in a water mill is natural and does not spoil for years. Traditional water mills do not pollute the environment, nor do they require electricity or fuel. Certainly, these water mills are environment friendly. Despite the fact that there are mechanised flourmills in the Shinkat village of Swat and its suburbs, more than 10,000 people living in villages prefer to grind their grains in a very famous water mill known as Druz Garai (Figure 27).

Figure 27: Channel constructed for transferring water to stone mill for grinding of wheat and corn in Kalasha Valley, Chitral

The people are of the opinion that flour ground in traditional water mills remains safe from insects and other pests for a period of over one year. This is why you can see loads and loads of sacks filled with grains waiting for their turn. While there is a long list of benefits attached to flour ground in water mills, the one disadvantage is that it is time-consuming. It takes several hours to grind a single kg of wheat. People travel long distances to get their grains ground from the water mills.

The water mill of Shinkat is owned by four brothers. The brothers take a small quantity of grain as payment, which is ten times less than what flourmills charge. They have been operating this mill since childhood but have been charging much less than mechanised flourmills. They are charging 50 kg flour as labour for grinding 2000 kg. They also arrange food and tea for the customers as well. This mill has been in their family for generations.

Traditional water mills are environment-friendly and do not consume energy. There is a need to convert these local water mills to a hybrid system combining an efficient and high-speed grain milling system and hydro-power generation.

Case of local solution: Hybrid system combining indigenous watermill and hydropower generation in Miandam

Working on a water shaft and wheel, Hazrat Hussain and Hazratullah are not in any hurry to complete the job before they lose power. Outages are common elsewhere in the province but these two know they have their own power supply to rely on (Figure 28).

Figure 28: Water mill converted to hybrid system – water mill and hydropower plant in Miandam

Two brothers from Miandam have used a two-centuries-old watermill made by their forefathers to cater to their entire community's electricity needs in Miandam Union Council in Khwazakhela, Swat. They produce power from a hydropower generator and provide to the households for a fixed tariff of PKR 200 per house, per month for nearly uninterrupted supply. The community does get power from the national grid, but few rely on it.

The hydropower plant was set up four years ago and since then power outages are a rarity for the 50 households in the area. Even if load shedding happens, it is just once in a year – that too because of a fault or floods. The households have added fans and even irons run on hydropower supplied by the hybrid system – water mill and hydropower.

Just like other consumers, those who use this plant sometimes default on their monthly dues of PKR 200 but they do not have surcharges on late bills like the government. The owner spent PKR 400,000 to construct the power generation plant where he uses a 15 KW power generation unit to produce 11 kWhr of power that is supplied to houses from early evening till early morning. There is little demand for power during the day as it is bright and few fans are used as the area is cold but if someone requires the owner of the powerhouse provides the electricity.

6.1.3. From flour to electricity

Once upon a time, locals would use this watermill to grind maize and wheat but now it is mostly used to generate power for domestic and, sometimes, commercial purposes. The owner indicated that they still sell maize and wheat flour grinded at the mill and the flour has a special

quality – the taste does not change even if it is stored for a year. It is unlike flour produced at power mills, which deteriorates in quality after a month. They also own a tailoring shop, which runs on the mill's power supply.

6.1.4. A happy community

The village Swato Khwar, in Miandam Union Council has WAPDA electric poles installed since the last 15 years. Over 200 people have applied for the meters but they are still waiting for installation of meters. The people who are using hydropower indicated that they are relieved to have the option of being connected to the local hydropower plant. Moreover, they are happy to get electricity for only PKR 200 per month throughout the year, even in Ramadan. The power supplied by the hydropower plant is much cheaper than WAPDA, as WAPDA charges in thousands of rupees every month along with load-shedding at peak demand when electricity is needed. With the hydropower plant, there is no worry about surcharges in case we pay the bills after the due date. The only issue is the quality of power, because sometime the voltage drops with the drop of water level – winter and summer seasonality (Figure 29).

Figure 29: Water mill converted to hybrid system – water mill and hydropower plant in Miandam

When a convenient option is possible then, why does the government not install cheap power generation plants on community basis, the hydropower plants which locals can maintain on

their own? This is a question, which everyone in the locality is asking. The hydropower plants do not require large financial resources and do not take long to build.

6.2. Case of watermills in Azad Jammu and Kashmir - mall project big benefits

The owner of the hydropower plant thinks that he has an answer to address the issue of power shortage in Pakistan. For a few hours a day, a few days a month, the villager in Kohori Tarari near Muzaffarabad, the capital of AJK, the owner grinds maize and wheat with a watermill. But he sees untapped potential in his century-old mud-and-stone mill. He also wants to use it to generate free and clean electricity. The owner of mill in Muzaffarabad, is one of hundreds of millers who make a living using watermills, locally named as *jandar* built along streams by his elders.

Some millers have taken it upon themselves to harness the potential of their water mills. Two years ago, Maskeen Qureshi, who lives in the Kohori Tarari hamlet near Muzaffarabad, installed a homemade turbine and a small transferring motor along the side of water mill. Maskeen's son helped him make and install the turbine, while a neighbouring village leader gave him a small-capacity motor. The generator is connected to lights by copper wiring recycled from telephone cables. The cost of developing the hybrid system was only PKR 50,000. The hydropower is used for lights in the water mill and power to half-dozen houses. The turbine uses one-fourth of the water required to run the watermill, and generates enough to light our homes and charge our cell phones (Figure 30).

Figure 30: Water mill converted to hybrid system – water mill and hydropower plant in AJK by Mr. Maskeen Qureshi, of Kohori Tarari hamlet near Muzaffarabad

He estimates that with another PKR 10,0,000 (USD 1000) he could fix the turbine to a concrete base and install a higher capacity motor to create a permanent installation that would provide electricity to all 18 houses in the village, day and night.

If government can help the millers, they can shift to the hybrid systems. The agencies involved in the installation of small hydropower projects on streams and tributaries in AJK could also provide assistance to the water millers to develop hybrid systems, which are environment friendly.

The development of hybrid system would not only reduce the load on the national grid, but at the same time it would help to reduce the over exploitation of local forests. Electricity generation through watermills and small projects will ultimately reduce pressure on the forests, which are being cut down for fuel wood.

If each of these mills were connected to a small-scale turbine, the owner believes, that the villages could become energy self-reliant, helping bring an end to the long power outages that have sparked violent protests across Pakistan and the region of AJK over the past few summers. Water channelled for watermills can be used to produce electricity for the village after visiting the nearby hydroelectric power station that operates on massive turbines. Any surplus energy generated could be sold to the government to feed into the national grid.

Mureeb Mohmand, from Express Tribune stated that by the time of May every year, the country is facing an energy shortfall of 5,000 MW with the hot weather starting to bake its plains. AJK also regularly suffers from crippling power shortages, despite producing more energy than it consumes, as energy generated in AJK is fed to the national grid, making AJK vulnerable to national load shedding plans (Figure 31).

Figure 31: Load shedding and business is closed in AJK

He further stated that the requirement of AJK is 300 MW of electricity, while production is 1,133 MW. The present government has assured that the electricity crisis will be resolved by 2018,

when it hopes to have completed a series of energy mega-projects that could add several thousand MW to the national grid. But instead of focusing on large power projects, governments and NGOs can help millers to install small hydropower plants along the side of the mills. It would require a maximum investment of PKR 500,000 (USD 5,000) on turbine, motor and pipeline.

7. MOUNTAIN DISASTERS – CASE OF DRR, DRM AND CBDRM IN KHYBER PAKHTUNKHWA AND GILGIT-BALTISTAN[7]

People of Mansehra, Battagram and Gilgit-Baltistan in Pakistan have developed social, functional and sequential coping mechanisms to face impacts of recurring disasters, particularly landslides. These mechanisms depend on the capacities of the people. Therefore, the local population have benefitted from the indigenous and local practices of DRM to better deal with the adverse events. There is a need to understand the communities' perceptions and strengthen the existing coping mechanisms so that disaster impacts can be reduced. In addition, there are indigenous cases of local knowledge and practices for DRR, which have been in use in Gilgit-Baltistan and Chitral. The people who are living in the fragile environments have the first-hand information, knowledge, and practices, which have been used for centuries. Indigenous knowledge provides important mechanisms to DRR, and is especially valuable for community level DRM. Policy makers may consider preserving such effective, traditional coping mechanisms and improve on them to ensure that development does not increase vulnerability to natural hazards. Indigenous coping mechanisms alone are not sufficient to manage disasters effectively. While this knowledge helps reduce risk, it is sometimes inadequate to cope with new disasters in the community. For example, the experience of the 2005 earthquake shows that the technique in preventing water seepage has resulted in more houses being damaged because of the heavy load of soil on rooftops. Traditional coping mechanisms may not always work as coping strategies and are always subject to internal and external environment changes.

7.1. The context

The districts of Mansehra and Battagram in the Khyber Pakhtunkhwa of Pakistan (Figure 32) are highly vulnerable to hazards because of environmental, climatic, geographical, and social conditions. Vulnerabilities include: (a) physical vulnerability from high altitude, harsh weather, mountainous terrain and non-fertile land for agriculture; (b) architectural vulnerability manifest in poor buildings and infrastructure; (c) economic vulnerability pertaining to poverty, unemployment and a decline in agricultural production; (d) demographic vulnerability due to increasing population and health problems; and (e) political and administrative vulnerabilities since there is neither a disaster management structure, nor a political will to implement disaster management in these areas. For centuries, these districts face many recurring disasters including landslides, flash floods, earthquakes, and extreme weather events such as heavy rains, storms, severe snow, and hailstorms. Because of the frequency of these disasters, local people have developed a belief that disasters are part of their lives, which can't be avoided and may be a form of punishment from God.

The impacts of disasters are severely felt by rural communities because of their long-term effects on livelihood. Several other characteristics distinguish this region. The climate varies

[7] This section has benefited from:

- Komino, Takeshi. 2008. *Indigenous knowledge for DRR: Good practices and lessons learned from experiences in the Asia-Pacific region. Indigenous coping mechanisms for DRM in Mansehra and Battagram Districts, Khyber Pakhtunkhwa, Pakistan*. Bangkok: UN International Strategy for Disaster Reduction.
- Chitral Times (http://www.chitraltimes.com/english15/chitral-news-3574.htm), 16 Nov 2015.
- Op Ed by Sher Wali. Pamir Times. 19 Nov 2013.
- Ali, Muhammad Kashif. 2015. "Flooding in Rumbur Valley (Chitral-Pakistan) as I have seen." Kalasha: The Sole Pagan Tribe of Pakistan (http://kalashapeople.blogspot.com/), 18 Nov 2015.

throughout the year, where December, January and February are the coldest months, and June and July are the hottest months. Rainfall and snowfall are common in these areas. The village topography is mountainous. There is hardly any plain except for small agricultural lands, which have been levelled for farming. Small-scale agriculture, shop keeping and (e.g. school teachers and bank employees) are the main sources of income for the people of Mansehra and Battagram districts. The population is separated into several different clans and lineages including gujjar, sayed, swati, tanuli and pashtun. On religious grounds, family planning is not observed, as a consequence, boys and girls marry at a very young age, 18-25 and 15-22, respectively, contributing to a rapid increase in population. Unemployment and poverty are widespread. Male migration to big economic hubs of the country is also very common.

Figure 32: Landslide common in Mansehra and Batagram

Communities have a strong social and organizational system. Along with local community based groups, four main social institutions exist: kinship, hasshar, jirga and village hood. First, kinship allows for the extension of support for a given problem or emergency. For instance, kin members help relatives in housing reconstruction through labour, food and material aid. Second, Hasshar is reciprocal labour arranged to solve problems and during emergencies wherein help is called in from relatives and other villagers. Third, Jirga is usually conducted to resolve local quarrels and find solutions to communal problems. Finally, village hood allows people to obtain things on credit from village shops. Landslides are common in the area. Indigenous knowledge story/event landslides are a common phenomenon.

There was no government disaster management plan in place in Mansehra and Battagram when the disaster of February 14th 2004 earthquake occurred. Instead, the people used indigenous

coping strategies passed on from generation to generation to cope with the impacts of the disaster.

The existing indigenous knowledge can be divided into three different categories: social, functional, and sequential coping mechanisms. Each of these categories is used by the communities in Mansehra and Battagram at several levels of society (individual, domestic and community levels) to manage disasters.

7.2. Indigenous coping mechanisms for disaster management in Mansehra and Battagram districts, Khyber Pakhtunkhwa, Pakistan

7.2.1. Social Coping Mechanisms

There exists a variety of formal and non-formal structures and relationships that mobilize resources and help solve problems at the local level. These include internal or external structures such as social units, religious institutions, political organizations, and economic systems. The Committee Brae-Tahaffuze–Jangalat, for instance, takes part in disaster management by coordinating with the forest department in deforestation issues to avoid floods, land erosion, and losses from heavy rain. Furthermore, community groups often monitor the level of water during heavy rains. In case of danger, people residing in vulnerable houses are informed by shouts and knocks on their doors. When water level reaches a critical level, concerned households start moving things to relatives' or other villagers' houses. Family members, especially women, children and the disabled, withdraw to a safe location, preferably in the house of a relative or neighbour. In the village of Paras, this duty is rotated among community members throughout the duration of the rainy season.

During recovery, strong social ties help poor affected families by allowing them to borrow money and food items from relatives, friends, villagers, and village shopkeepers. In some villages, performance of rituals like "khatam," or the recitation of the Holy Quran, and offering of prayers take place after big disasters.

7.2.2. Functional coping mechanisms

To minimise risks from landslides, the communities have adopted several infrastructure techniques, which have developed over centuries. Houses in many villages are constructed with a distance of 0.6 to 0.9 m apart. Houses built adjacent to each other were found to be the most badly damaged from disasters and caused more deaths when rocks fall from the mountains. Furthermore, in the village of Gantar, wooden strips are used in stonewall construction to build resistance. Construction of a 0.5x0.75 m wall of stones produces cohesion and causes less damage to infrastructure. People belonging to the upper class, especially in the village of Paras, have increased the number of wooden pillars and beams in their houses for further support. In addition, roofs 0.3 to 0.6 m wide are constructed with certain precautionary measures. They are first developed with wooden pillars for support. Thereafter, heavy load of soil is spread on the rooftops to stop water seepage (Figure 33). Some people spread plastic sheets, jute or nylon under the soil to further secure the roofs from seepage.

Figure 33: Roof technique to prevent seepage

Before the monsoon season, naturally growing grass is usually weeded off from the roofs because grass roots contribute to water seepage. The centre of the roof is made slightly higher, while all sides are diagonal from the edges to facilitate the flow of water. Half of a long metal strip is placed under the soil in edges for easy flow of water from the roof. Similarly, roof edges are also extended to prevent water penetration from the roof to the wall. Furthermore, stones are sometimes used in edges to keep roofs from being damaged. The roof and area along the walls are then hammered to prevent water penetration and secure the foundation of the house.

Due to recurring disasters, people are careful in selecting land for their houses. They choose to build houses on a plain, far from a water source, close to the road and on white soil, which according to local belief is good because it is more solid. To cope with the vulnerability of the land, they plant walnut, sherol and kikar trees around their houses. The roots of these trees extend far distances, thereby contributing to the firmness of the soil. Some people also construct stone foundations up to 0.6 m deep, especially under the walls of houses. For mud houses, people use traditional materials mixed in mud for stability of roofs and walls, which include cow dung, cotton, wheat chaff, goat hair, pine leaves, grinded jute sacks, sand and sawdust. For those who can afford them, GI sheets are used for the roof in order to save on labour, time and maintenance (Figure 34).

Figure 34: Corrugated galvanized iron sheets used for roof

Sometimes, heavy stones are scattered on the GI sheet roofs to save them from being blown away during a storm. In the pre-earthquake architecture of mud houses, no joints were used between pillar and batar, or wooden strips in Figure 34. The GI sheets used as roof require much less maintenance and avoid seepage. The government's Public Works Department visits the area often during the rainy season to monitor the risk of landslides. The department also constructs retaining walls along roadsides, which are at risk from landslides.

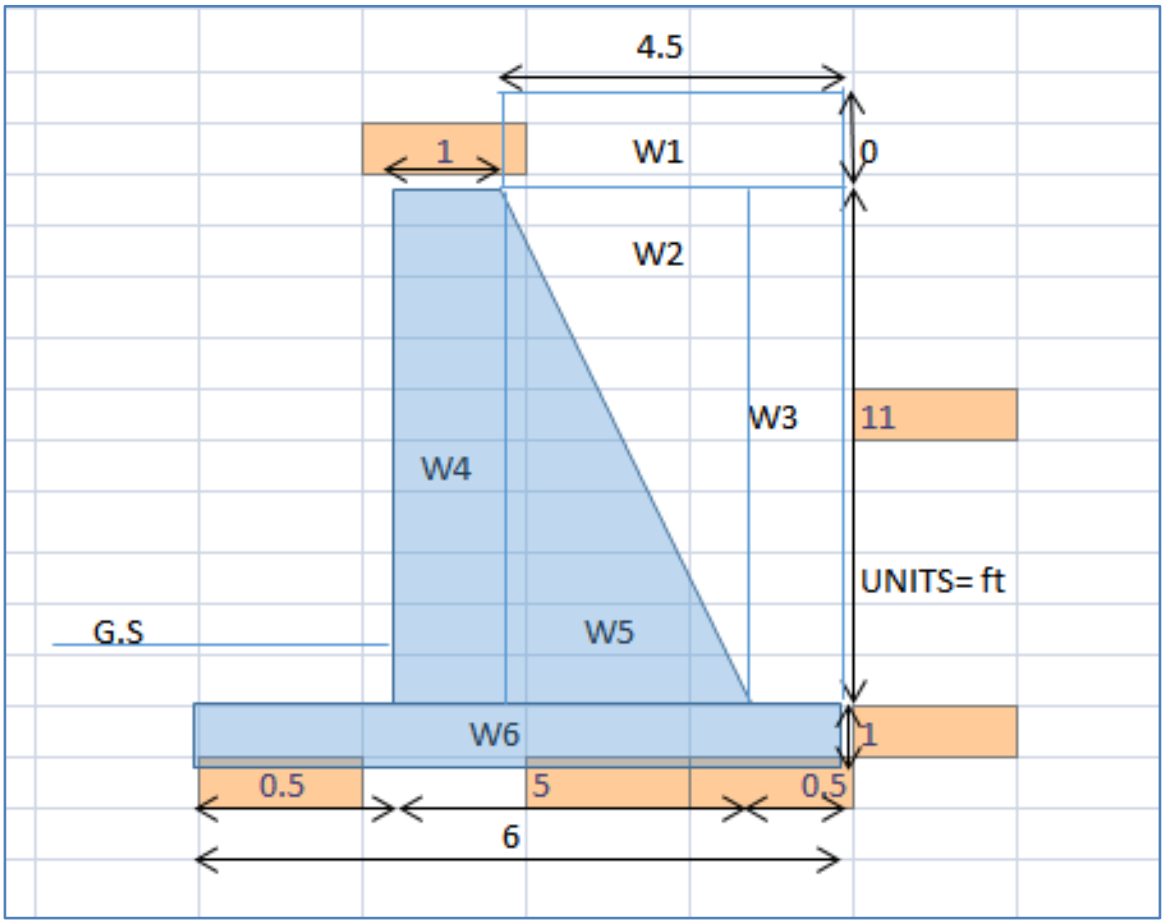
7.2.3. Sequential coping mechanisms

During disasters, communities mobilize diverse resources following a sequence based on vulnerabilities and capacities. Since the primary concern is livelihood, they first adopt a strategy to secure livelihoods. Some dietary changes are made especially by the poor. Temporary migration to other villages has been observed in cases of severe disasters, especially when the affected family has not been offered help or prefers not to stay in houses of neighbours, relatives, or friends. Sometimes young boys are sent to the nearest urban centres and big cities for labour. When disaster impact is extensive, the poor families, as a last resort, sell their assets (e.g. animals, jewellery, and lan(d).

As the community members themselves develop knowledge in these three categories through various experiences, they become imbedded in their culture and familiar and easy to implement. The knowledge evolves in situ and is dynamic and creative, constantly growing and adapting to meet new conditions. It is entrenched in a dynamic system in which spirituality, kinship, local politics and other factors are both connected and influence one another. There is no formal system rooted in the community to disseminate this indigenous knowledge. However, this

knowledge has been transferred informally from generation to generation through individuals in the community. No importance was given to the use of these coping strategies before the 2004 disaster, as there was no formal government structure working on disaster management at that time, Now NDMA and PDMAs are active at the federal and provincial levels. The DDMAs are active at the district level. The community alone disseminates and employs indigenous knowledge techniques in different ways to cope with disaster e.g. the design of the retaining walls (Figure 35).

Figure 35: Specifications of retaining Walls



7.3. Lessons learned

- Indigenous knowledge provides important mechanisms for CBDRM. Policy makers should consider preserving such effective, traditional coping mechanisms and improve on them to ensure that development does not increase vulnerability to natural hazards. Further, encouraging community involvement through the use of traditional practices provides a more realistic and local-specific strategy since the community understands the situation due to past disasters' experiences.
- Indigenous coping mechanisms alone are not adequate to manage disasters effectively. While this knowledge helps reduce risk, it is sometimes inadequate to cope with new disasters in the community. For example, the experience of 2004 earthquake shows that technique in preventing water seepage has resulted in more houses being damaged because of the heavy load of soil on roof tops. Traditional coping mechanisms may not always work as coping strategies and are always subject to internal and external

environment changes. For example, changing social, political and economic conditions in the area will affect the mechanisms and their effectiveness. There is a growing need to improve these coping mechanisms in a way that they would not impact negatively on communities.

- Coping mechanisms in Mansehra and Battagram mainly depend on the capacities of affected communities. While self-reliance and solidarity of households and communities are invaluable in the face of disasters, capacity for social support is an unquantifiable factor; nonetheless, a strong support system constitutes the backbone of coping mechanisms. The aim of DRM should be to increase people's capacities to deal with adverse events. Development and disaster management programs should promote activities that mobilize and strengthen local resources and capacities at household and community levels. This can be achieved by understanding people's perceptions and strengthening existing coping mechanisms in a way that reduces the impact of disasters.
- Limited resources and people's perception of hazards often influence the acceptance of a particular coping mechanism. Assessment and understanding of current practices, perceptions, and constraints are important for improving coping strategies. For instance, an understanding of indigenous livelihood systems is important for development initiatives not to result in the loss of self-reliance, the destabilization of cultural values and the undermining of traditional livelihood systems.
- A community based approach, which aims to understand the way communities deal with different disasters, their level of understanding of disaster, and their capacity to manage it in an effective and sustainable manner, would be the best way to implement disaster management programs – e.g. the CBDRM must be designed by the community with the assistance of the DRM experts instead of following the generic approaches.

7.3.1. Community participation

Community participation should not be viewed only as a consultation process but also as an effective empowering process to address the root causes of vulnerability. It would be helpful to develop a system to monitor the impact of disasters at community and national levels. Improved risk and vulnerability mapping, disaster awareness and early warning systems at community level would also be useful. Above all, socio-economic analysis and a community-based livelihood approach should be integrated in DRM planning and programs in affected communities.

7.4. Case of indigenous knowledge in DRR

Indigenous knowledge term encompasses a combination of traditional practices, beliefs and other cultural parameters. These sets of parameters become an integral part of a society's function over a period of existence. However, with the passage of time the indigenous knowledge loses its strength and utility when there is a competition between the new and old technologies in a society, and when the old and new generation develops gaps.

In the traditional societies there was a lack of technology and scientific tools and, thus, indigenous knowledge played a pivotal role in anticipating natural events. The indigenous practices lost their relevance, or were looked down at, with the advent of more sophisticated devices and process, with greater impact and accuracy, especially with regard to anticipation of natural risks.

However, these days the social and natural scientists, both, are convinced that in many cases there is a need of integrating indigenous knowledge into the innovative approaches, to anticipate natural hazards more effectively. Therefore, in the fast growing risks of natural disasters worldwide, the mechanism of DRM is studied by many experts, and has come to the

conclusion that indigenous knowledge is one of the key parameters for developing early warning systems for DRM.

Risk is calculated by the multiplication of a given hazard and degree of its vulnerability. The more community is vulnerable to any hazard the more they are at risk. The term vulnerability in DRM domain is a state of being exposed to a hazard which is natural or man-made. The basic parameters of vulnerability are manifold however lack of awareness and knowledge regarding to hazards and risks, lack of resources and opportunities, poverty and social inequality and lack of access to primary and tertiary services are the primary indicators. Natural hazards are true but as far vulnerability to the hazards is concern, then there is an equal role of human approaches which contribute to increase the risks. Thus, a wise and innovative approach to reduce the impact of a potential hazard is a pre-requisite.

Disaster is managed in various ways, but the early information and alert is crucial to avoid any major impact. Therefore, in the ancient times communities used indigenous knowledge to forecast the probability of a disaster or any natural hazard through, traditional practices. So we can say that indigenous knowledge is pivotal in risk anticipation and early warning. In the recent times indigenous knowledge is considered as an important indicator to incorporate with innovative approaches to develop an effective early warning mechanism.

The indigenous knowledge suggests that in the earlier periods though there was a lack of technology, no print and electronic media was available for early warning of a disaster; the indigenous people used their traditional skills and practices to anticipate the weather systems, rain and snowfall. Based on the so-called practices they prepared emergency food storage and herbal medicines to cope up any natural event. Beside this, there were such beliefs which are used for anticipation of natural hazards e.g. when there was a flood the rural people particularly women present milk or milky product and goes to the flood sites as this could reduce the magnitude of flood.

Indigenous knowledge is a strong tool for early warning for such hazards. In the earlier periods accessibility to remote mountainous areas was very difficult and people used such traditional mechanism to communicate the downstream people to aware them any emergency. For instances, if there is a flood from a remote valley people used to burn bushes to flame the smoke higher on a high mountain sides, this signalled downstream people that something might happened upstream and they prepared for evacuation to safer locations. Such cases have been reported during 1905 Karumber valley glacier outburst Flood which had caused a widespread damage along the Ishkoman valley and reached up to Gilgit City by traveling 150 km. Similarly, the same method was used in Shimshal GLOF in Hunza valley. There were such myths or beliefs which are used for prediction of rains, floods, drought and diseases. For instances if yaks are coming down areas from the upper-pastures zones during summer or spring it was an indication of rainfall or clouds and thus people collect their crops from fields to save them. When there is an extensive rainfall people slaughtered an animal. This is a cultural practice which usually observed during the summer times when there was crop in fields and extensive rainfall can damage the crop, because in the ancient times people were only dependent upon their local wheat production.

It is usually observed that the Mosques & Jamat Khana at such locations which are at high risk of different localized or remote hazards, these are being constructed based on the beliefs that the hazard cannot divert its way towards these secret buildings and thus they feel themselves secure from the impact of such hazards.

The appearance and sounds of some animals and birds are also used as early warning mechanism in earlier times. “Ishqorno” is a Boroshaski name of a brown colour bird, which usually appears during winter in snowfall time, when this bird appears the indication is that there is more snowfall. Similarly, another bird is called “Chitrang” these birds are flying in a flock in the sky when these birds flying in flock in the sky after a long lasting rainfall the indication is that the sky is now clear and no more rainfall will be happening. By using this indigenous knowledge, the locals run their routine activities. Now that the information technology is advance we have TV, newspaper where we can get daily updates of weather forecast and so this indigenous knowledge does not consider so important. But there is still need of such indigenous knowledge to be documented. Because the indigenous knowledge is created from the local indigenous people but by the time when these indigenous people are getting older and passing away, and if the knowledge is not transferred to the next generation the likelihood is that we will lost all our precious knowledge. Therefore, the United Nation has decided to celebrate the day of Indigenous People every year on 9th August. The UNEP is implementing many projects to document indigenous knowledge and making it a tool for DRM. It is equally important to document indigenous knowledge in the mountainous region of Pakistan and use it for developing effective early warning systems for managing the natural hazards.

7.5. Case study of deforestation and flooding in Rumbur valley, Chitral Pakistan

The flooding phenomenon is not newer for the Kalasha valleys of Hindukush range of Chitral, Pakistan, but intensity and chaos in ecological system is a big question. Mr. Kashif, a Lecturer at the University of Gujrat, have visited the three Kalasha valleys (Bumboret, Rumbur & Birir) for the conduct of post-graduate academic research in the domain of cultural history of the region. There were floods in the valleys before 2010 but not severe and intense floods with least harm to valleys and dwellers (Figure 36).

Figure 36: Deforestation and flooding in Rumbur river of Rumbur valley Kalash-Chitral

Photo Credit: Muhammad Kashif Ali, 2015.

People of three Kalasha valleys have been under pressure of higher flows of water in rivers in the last five years. Mr. Kashif stayed in Rumbur valley for data collection for a month during July and August 2015. He left his home with family for Chitral on July 13, 2015 and the same day first wave of the flood hit Chitral & adjacent valleys. From July 13 to August 4th 2015, with the help of friends he counted around 40 waves of floods in Rumbur Valley caused heavy damage to the infrastructure (Figure 37).

Figure 37: Fetching water from muddy springs

Photo Credit: Muhammad Kashif Ali, 2015.

Figure 38: Flood struck homes (Palarog Village, Rumbor Valley)

Photo Credit: Muhammad Kashif Ali, 2015.

The floods in Rumbur valley flow downstream from the high pastures located at: Bahuk, Ostuee, Chimiksunn and Gangalwaat. These high pastures are habitat of Pine, Cedar, Juniper and Oak largely. The local population is of the opinion that for the last four to five decades, the timber mafia has exploited the forest area indiscriminately and the slopes of meadows are now lost the forest cover and vulnerable to extreme events of floods.

Figure 39: Flood struck orchard (Rumbur Valley)

Photo Credit: Muhammad Kashif Ali, 2015.

Due to continuous flooding in an isolated and disconnected Rumbur valley from the Chitral town, the few shops got abandoned in couple of weeks and the valley was on the brink to hunger when a chopper of Pakistan Army landed in valley to distribute relief ration provided by the National Disaster Management Authority (NDMA). The family of Mr. Kashif also collected the ration from the relief packages for their survival.

During the stay of Mr. Kashif in the valley the Army chopper visited the valley just twice but it was not going to fulfil the basic needs of the valley, the people were in miserable situation, the watermills had been damaged and people had to fetch ration from relief or nearby shopping place Ayun. They were adopting mountain top route on foot about 25 to 30 km, one side. And when we had to leave valley for our survival, my kids also had to adopt the same route and the lady was also not familiar with such unfriendly trekking (Figure 40).

Figure 40: Jeep track of Rumbur Valley is washed away

Photo Credit: Muhammad Kashif Ali, 2015.

Figure 41: Local community repairs water channel by themselves

Photo Credit: Muhammad Kashif Ali, 2015.

The flash flood badly affected the tourist season in the valley. A bounty number of tourists visit Kalasha valleys during summer and especially during Eid vacations. The local and international tourists mark the Kalasha valleys as their fascinating destination for their culture and natural beauty. The shopkeepers, guides, guesthouse owners in valleys were looking towards tourists but flood abruptly shattered their plans and dreams. The Rumbur River engulfed number of fields with crops and definitely damaged their source of livelihood and food security for local people and livestock.

The community in the Rumbur valley although affected badly due to the flash flood during 2015 and they were at the mercy of relief efforts from the Pakistan Army and NDMA. However, the community has ample strengths and local knowledge to better prepared for such disasters in the future. Changes in current land use are also needed so that watershed areas are maintained with desired surface cover – the only way to manage the floods by reducing the flood peaks and extend the duration of the flow. The community also demonstrated quickly to repair the water supply and irrigation channels to restore their livelihood and survival. The work done by these communities in a period of one month was remarkable. All this was done based on their capacity and indigenous knowledge and practices, which they learn from their elders. This is a clear indication that the communities are having capacity to re-build their life saving systems in the post-disaster period but their capacity for early warning is limited.

Figure 42: Tourist leaving valley via mountain top route on foot (est. 30 km)

Photo Credit: Muhammad Kashif Ali, 2015.

8. PLANTING GLACIERS – LOCAL RESPONSE TO WATER SCARCITY IN GILGIT-BALTISTAN: AN INDIGENOUS AND INNOVATIVE APPROACH[8]

The people of Gilgit-Baltistan have been involved in planting of glaciers since centuries. They are motivated due to the issue of water scarcity and undertook this activity to have assured source of water supply. Sometimes, it is also an issue of prestige and status, as they plant glaciers because there is no glacier in the drainage basin they are living. Water scarcity is often felt during the autumn season when most of the snow-melt has ceased due to decrease in temperature. Several people who have tried it are of the opinion that it works to plant glaciers. The locations selected in planting of glaciers are located in a terrain that is conducive to the accumulation of snow by avalanching and snow slips. Furthermore, the presence of permafrost at these locations is likely to contribute to ice accumulation within the talus as melted snow refreezes. The presence of rock glaciers is also considered a positive point for the success of the glacier planting. Thus, glacier planting is already being conducted at locations which are prone to ice accumulation. The perception that glacier planting is a feasible option for the development of a glacierized basin is rooted in the way local people perceives glaciers as being gendered - female and male glaciers and glacier planting is dependent upon coming together of two glaciers of each sex – glaciers as animate. This implies that humans can influence on the lives of glaciers, just as glaciers can influence on the lives of people. This means people can act both to increase glaciers by performing the practice of glacier planting, and to diminish glaciers by exposing them to impurities. Glaciers influence on the people of the Gilgit-Baltistan by providing them water, but can also bring havoc by damming up rivers or advancing over farming areas. Stories of glaciers and glacier planting in Gilgit-Baltistan reflect the coexistence of people and glaciers, where glaciers are used as reminiscent symbols that invoke deep sentiments among the people of Gilgit-Baltistan. AKRSP is using a technical approach to glacier planting, and have explored its potential with an objective to relieve local population from the issue of water scarcity. Yet, glacier planting is a practice deeply ingrained in cultural patterns of the local society and their area, even if glacier planting is stated by its practitioners as applied to relieve water scarcity, the aesthetic values of glacier planting could not be under-emphasised.

[8] This section has benefitted from:

- Ahmad, S. 2008. *Water resources of Gilgit-Baltistan*. Water Background Paper for the Gilgit-Baltistan Economic Report. World Bank, ADB and Government of Gilgit-Baltistan.
- AKRSP. 2005. *Grafting of glaciers*. Skardu: Mountain Infrastructure & Engineering Services (MIES) and Resource Development (RD) Section, AKRSP.
- Tveiten, I. N. 2007. *Glacier Growing - A Local Response to Water Scarcity in Baltistan and Gilgit, Pakistan*. Master Thesis, Department of International Environment and Development Studies, Norwegian University of Life Sciences.
- Khan, R. 2001. “Glaciers, snow-melt water and water availability.” News International, 26 Nov 2001.
- Khan, R. 2002a. “Glaciers of Northern Areas.” Pakistan Observer, 2 Jan 2002.
- Khan, R. 2002b. “Case for scientific glacier – planting in Northern Areas.” Dawn, 8 Feb 2002.
- Evans and Cox. 1974 in Benn, D. I. & Evans, D. J. A. 1998. *Glaciers and glaciation*. London, Arnold. VII, 734 s.p.

8.1. The context

The local people of Gilgit-Baltistan living along the glaciers have enormous historical indigenous knowledge of glaciers in terms of their growth and movement. They are of the opinion that the phenomenon is cyclic because glaciers grow and move forward for a return period (10 to 12 years) and then shrink and retreat backward for the same return period. The rural communities have also characterized the glaciers into three types: (a) male glacier is a moving glacier when it carries boulders and soil on it; (b) female glacier is described as moving glacier having no boulders and soil on it (white in colour); and (c) infertile or barren glaciers neither grow nor moves rather stagnant, it is kind of permafrost in the sub-soil.

History of planting glaciers in the Gilgit-Baltistan is not known, but it is as old as the history of the region. Almost everyone in rural Gilgit-Baltistan is aware of planting of glaciers and population of water scarce villages in the region still believe that planting of glaciers is a viable option to ensure water security in rural areas of the region. A number of people in Gilgit-Baltistan have attempted to plant glaciers in environments where ecology is in line with the glaciated zone. The Consultant had a detailed meeting with the Chairperson of Purbat Social Welfare Association of Diamer district who is well known NGO in the Gilgit-Baltistan in relation to planting of glaciers. They have planted 10 glaciers and out of those they think 7 are successful. But they are discouraged because someone used their information and have taken credit of their work. The Chairperson also identified that the Team of the Ministry of Science and Technology has also monitored these locations and in their opinion all the 10 sites are successful.

Khan (2001; 2002) in a series of articles described in detail the planting and harvesting of glaciers and indicated that it is a viable option if attempt of planting is made at altitudes of >3500 m and ecology similar to the glaciated zone. The site should not have direct impact of sunlight so that planted glacier does not melt and snowfall results into process of ice packing. He further illustrated that “in the light of indigenous knowledge and wisdom of the ages, there is a need to carry out serious scientific research on what is called glacier harvesting or glacier planting”. The concept of integrating harvesting of glacier with planting is appropriate for the rural communities because beginning can be made by focusing on local issues. The goal of planting glacier is to enhance harvesting of water from glacier-melt.

AKRSP (2005) published a comprehensive report on “Glacier Grafting” including the progress of research in 15 villages for grafting of glaciers in the Gilgit-Baltistan. This report was reviewed and formed the basis of the following Sections.

8.1.1. Planting of glaciers – past experiences

The AKRSP (2005) identified the following sites where experiments on planting of glaciers were made in the near past.

8.1.1.1. Hanouchal Haramosh

The glacier was planted by the local people at six locations during 1940s, but it was successful at Hanouchal Haramosh. The rural people are of the opinion that inflow of water has increased since planting of the glacier and it resulted in increased command area.

8.1.1.2. Batkoor Chamogadh

The glacier was successfully planted by local communities above the village of Batkoor Chamogardh in district Gilgit with increased water supplies.

8.1.1.3. Minawar and Sakwar

The glaciers were successfully planted by the local people above the villages of Minawar and Sakwar in Gilgit district. The Consultant in his visit to both the villages on 2nd June 2008 also confirmed from the farmers regarding planting of glacier. Haji Mohammad Anwar Khan indicated that his father Haji Ahmad Khan planted the glacier where they brought the material from Buglote. He also feels that glacier has limited growth due to the site specificities.

8.1.1.4. Chunda

The planting of glaciers is reported above Chunda valley, which can also be viewed from Skardu town. The people believe that the Maqpoon Rajas of Skardu (around 16th century) had arranged the planting of these glaciers to meet their water requirement.

8.1.1.5. Kondus

Some of the local inhabitants of Khaplu are of the opinion that the current Kondus glacier was planted by a religious person to inhibit the intrusion of invaders from Kashgar and Tibet.

8.1.2. Planting of glaciers in 21st century

The history of planting of glaciers in the Gilgit-Baltistan is not documented. AKRSP (2005) indicated that in the village of Hanouchal Haramosh the individuals involved in planting of glacier are still alive having practical exposure of the planting of glaciers. Based on their experiences, the important steps for planting of glaciers are: (a) altitude and ecology of the selected site; (b) availability of barren glacier on the selected site; (c) sun direction at the selected site; (d) availability of moisture upstream of the planting site; (e) potential of gentle avalanche slip; (f) availability of land with adequate downstream slope; and (g) proximity of the selected site.

The AKRSP initiated the planting of glaciers during 2000 using the local expertise available from the village of Hanouchal Haramosh. Initially, the leading local expert (Mr. Ghulam Rasool, 75 years of age) from village Hanouchal participated in planting of glaciers in 5 villages of Baltistan. Later in 2001, another local expert (Mr. Ghulam Nabi, 78 years of age) from the same village joined Mr. Ghulam Rasool to jointly plant glaciers in additional 5 villages. During 2002 Mr. Ghulam Rasool further planted glaciers in 5 villages of Baltistan. Thus total number of glaciers planted was 15.

After the selection of sites, the glacier materials (male and femal(e) were transported to the relevant sites during September and October. The glaciers planting activity was completed at all the sites by the end of October.

The monitoring of planted glaciers indicated positive results. The villagers of Pari, Tarkati, Gwadi, Hussainabad and Balghar have reported increase in volume of water in the past two years. The local glacier-planting expert (Mr. Ghulam Rasool) has visited the planted sites in Pari, Takati and Hussainabad in September 2004. The expert was of the opinion that in villages of Pari and Hussainabad, there is 100% success and further monitoring of planted glacier is needed in village Tarkati. The AKRSP has planned to monitor the research sites in future, both through scientific and indigenous means with a priority to sites declared successful by the local experts. The monitoring will include: (a) discharge measurements; and (b) growth and movement of glaciers. The AKRSP further recommended continuation of glacier planting research with adequate funding.

8.2. Case study on planting glaciers by Purbat Social Welfare Association of Diamer and AKRSP

The case study of methodology of planting of glaciers and monitoring was conducted through having personal meeting with the Chairperson of the Purbat Social Welfare Association and reviewing the report of AKRSP (2005), the findings are presented as under:

8.2.1. Stepwise methodology for planting glaciers

AKRSP published a paper on grafting of glaciers in Gilgit-Baltistan and provided detailed methodology. Similarly, the personal communications with the Chairperson of Purbat Social Welfare Association also provided another version of methodology. These versions are synthesized and reproduced with some more elaborated scientific explanations. The step-wise methodology of plating glaciers is as under:

8.2.1.1. Selection of site for planting glacier

The 1st step is the selection of site, which is a key component in the success of planting of glaciers. The main features to be considered in the selection of site are: (a) availability of moisture; (b) possibility of gentle avalanche sliding; (c) deposition of snow on the site during winters; (d) minimum exposure to the sun; and (e) availability of considerable space for the glacier movement. Furthermore, availability of barren glacier is also considered as one of the most important components of selection of site. If in-situ barren glacier is not available on site, the site selection is not considered feasible for the planting of glacier. In the process of planting of glacier, an appropriate cave is selected in the middle of boulders having barren glacier round the year or digging is made to the level of indigenous barren glacier below the ground surface. In case of digging, it will be like a grave, however the bottom line is to find a suitable place having barren glacier and is prepared to plant the parent glaciers along with other ingredients.

8.2.1.2. Selection of the parent glaciers

The rural communities are of the opinion that the male and female glaciers originate from different locations and meet at a point and then start movement. The glacier material is picked up in sizeable lumps from the parent glaciers and transported to selected site. Minimum of 300 kg of glacier material (male and female assuming 12 man loads) is considered sufficient for a planting site but more material ensures higher chances of success.

8.2.1.3. Indus river water

It is a local myth that after the month of September the glacier-melt mostly contributes to the river flows. The Indus River water from an appropriate point, preferably downstream to the point where Shigar River joins the Indus is filled up in water cans or bottles and transported to the site.

8.2.1.4. Other ingredients

Wheat husk or saw wood, burnt wood or coal, and salt are the other ingredients placed along with the planting of glaciers at the selected site.

8.2.1.5. Time of planting glacier

The most feasible time for planting of glaciers is during September and October and preferably the whole activity has to be completed by the end of October.

8.2.1.6. Transportation of materials to selected site

Sizeable quantity of glacier (more than 300 kg of 12 men loa(d), Indus river water (more than 120 kg in 12 pots) and other ingredients (saw dust or wheat husk, coal and salt) of appropriate quantity are transported to the site selected above the snow level.

8.2.1.7. Method of planting glacier

After transportation of the ingredients, the Indus water is placed in the middle in an earthen pitcher and transported glacier is laid along the sides. The other ingredients (saw dust or wheat husk, coal and salt) are thoroughly spread over the glacier lumps and the trench or mouth of the cave is closed. The planted glacier is not disturbed at least 3-4 years. After the 4th year the planted glacier is inspected to evaluate the success of planting.

8.2.1.8. Indicators for success of planted glacier

It is believed that the process of movement of glacier starts after 3-4 years of planting. The evidence of success is observed as changes in physical appearance of the site and movement of soil. After 3-4 years' glacier could be seen on the surface of the soil. Although the size of the glacier does not increase abruptly, because it is a slow process, but as an evidence of success the increase in quantity of water flowing downstream or increase in flow of springs adjacent to the planted glacier.

8.2.2. Myths and realities in planting glaciers

The local people have established certain myths what they believe are realities. Some of the myths reported by AKRSP and Purbat Social Welfare Association were analysed to evaluate whether there is some scientific evidence of these myths or not. The analysed information is given as under:

8.2.2.1. Twelve man loads of glacier material and Indus water

There is a myth in the indigenous glacier planting stories that twelve person loads of glacier and twelve-person load of Indus water should be transported to the planting site. The reality behind this myth may be to encourage transportation of enough quantity of glacier material and water to the planting site.

8.2.2.2. Myths during transportation of the glacier and water

While transporting the materials to the selected site, it is a myth that the persons carrying the materials must not talk with each other and do not rest longer (rest only by standing still with carrying the load on their back). During the transportation, if the load is exchanged between two persons, it should be in a standing position. If the rest is unavoidable and persons carrying the loads want to sit, in such case the materials should be hanged on a branch of a tree or on a support. The reality behind these myths may be to ensure transportation of glacier material in frozen form and Indus water at cooler temperatures. Indus water has relatively higher level of sediments originated from glacier-melt and there might be some relevance of these sediments in the planting of glacier, otherwise spring water may be allowed for this purpose but it does not have any sediments. Also keep in mind that spring water is basically a groundwater.

8.2.2.3. Villager to announce to sacrifice his life for the success of the planted glacier

In this myth, one villager has to announce immediate after the planting of glacier that he will be the person to sacrifice his life for the success of the planted glacier. It seems a religious believe

originated from people practicing Bonism, Buddhism and Hinduism, where sacrifice of human beings for the happiness of gods and goddesses was in practice.

8.2.2.4. Person who will see the grafted glacier before 3 years will die

The reality behind this myth may be to protect the planted glacier site from damage and intrusion, while it is in the process of growing. Otherwise, the curious people will dig it to see what is going on there and in some cases they may damage the planted material, before it gets to the roots of success.

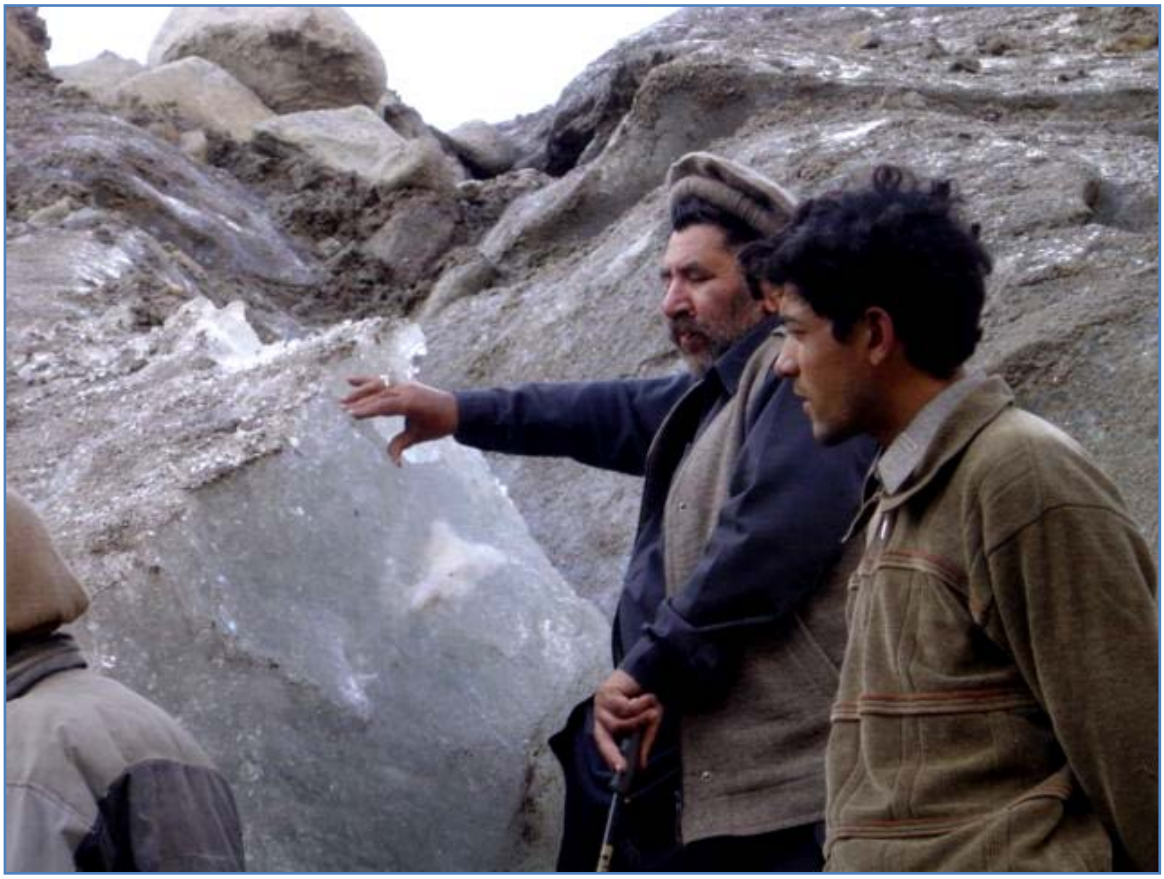
8.2.2.5. Snowfall during transportation of glaciers - a sign of success

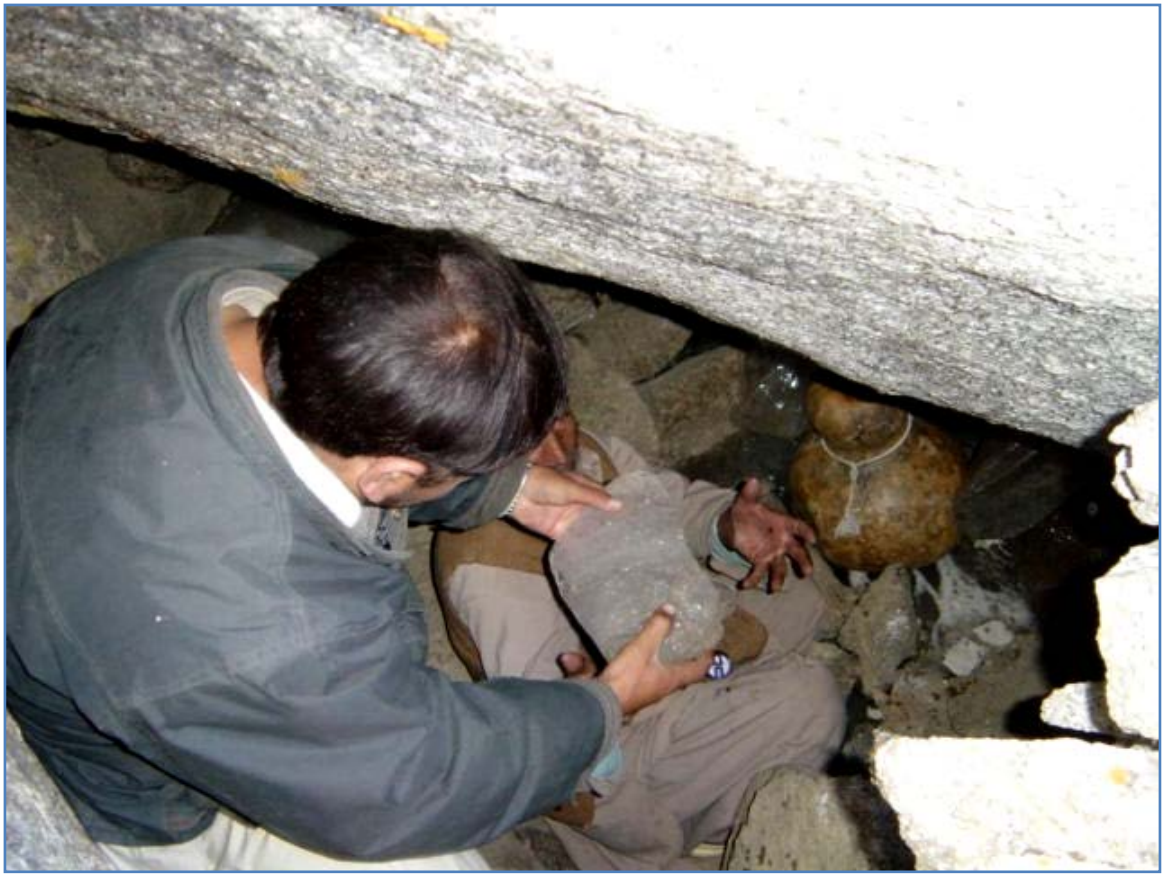
There is a myth that on the day of transportation of materials to the selected site, if snowfall occurs and seriously disrupts the transportation process until glacier is planted, it is gauged as an indicator of success of planting of glacier. This myth in fact illustrates two things which support the planting process: (a) temperature during the transportation and planting period is lower than freezing temperature which restricts the melting of glacier materials; (b) the snowfall ensures that after the planting of glacier the site might be under the heavy load of snow if the snow continued longer. Similarly, it will be easy to maintain the temperature of transported Indus water, which may be closer to the freezing temperatures.

8.2.3. Gauging the growth of planted glacier

The scientific explanations given in AKRSP (2005) need further elaboration. The only scientific evidence is that the planted material in altitudes of more than 4,000 m would help to create an environment where the snowfall materials would start converting into ice-packs and localized gentle avalanches might support the mix of debris to provide an ideal environment to initiate the process of glacierisation. Of course the concept of mass accumulation would work at the planted site having the appropriate conditions, such as moisture, in-situ glacier, possibility of gentle avalanche slips, minimum sun exposure, etc. The increase in mass balance every year further improves the condition of site and it may expedite the process gradually, thus the phenomenon may work. The trick is the selection of appropriate ecology and the site, where snowfall is reasonably high. Thus, equilibrium of the mass balance for the formation of the glacier is necessary and a little addition to the existing position may enhance the process for the formation of the glacier on an appropriate site (Figure 43).

Figure 43: From above to below: (a) selection of glacier materials; (b) transportation of glacier materials; (c) laying of glacier materials while planting the glacier; and (d) monitoring of the planted glacier to judge the success





It is important to note that there is no growth of the glacier per say rather it is the mass balance approach, where the incident precipitation and ice-pack resulted into process of glacierisation over a land mass.

8.3. Planting glacier to address water scarcity - Case of graduate research by Norwegian University of Life Sciences, Department of International Environment and Development Studies

8.3.1. Finding a place to plant the glacier

Tveiten (2007) in his Master Thesis research indicated that selecting an appropriate place for the glacier planting is of utmost concern for the glacier planters of Gilgit-Baltistan, and they all gave particular reasons for why a glacier should be planted in one place and not another. Scouting for a suitable place was done in combination with hunting trips, or shepherding of animals at the summer pastures. These scouting trips are not planned by a particular social group, but rather happen by the individual community members. Some of the factors they take into consideration when selecting a proper site are: aspect, relief, shadowing, altitude, and presence of permafrost. The following quote from one of the glacier planter in 'Kwardo' is an example of the importance given to proper shadowing:

"His glacier was about 500 m further up, and benefits only 3 villages, while the old glacier benefits all. His glacier is in a bad place, because the sun is hitting it all the time. The old glacier is only hit during two months in summer (for two hours a day) the rest of the year it is in total shadow." "His glacier" refers to a glacier growing of recent date made by a person from a neighbouring village. While the "old glacier" is a glacier they grew in 'Kwardo'. Clearly there is

some level of antagonism and rivalry implied in this statement, which illustrates that glacier growing is also a matter of social prestige. The fact that glacier growing is usually initiated by individuals who scout a suitable place and subsequently lead the planning and organizing of the endeavour, indicates that it is a practice by which one can acquire some amount of social status. Glacier growers were indeed often referred to as “brave men” or “hard working men”.

Returning to the issue of placement of the glacier-planting site, Tveiten (2007) found many similarities between the different villages in how they chose to place their ice. The information regarding the planted glaciers is systematically presented in Table 2. The coloured sites were observed by Tvieten (2007) and the sites accounted for by interviewing the people is presented in colourless portion of the Table 2.

‘Talus’ is a sloping mass of rock debris at the base of a cliff. The rocks have been dislodged from the mountainside by weathering processes. Table 2 indicates that all of the glacier planting sites have been put in a talus slope, and one is placed in an area of boulder sized rocks; that is, rocks of a diameter more than 26 cm. The reason for putting the ice in such an area is twofold: (a) rocks provide cover against solar radiation; and (b) in rock masses like these one can find interstitial ice which has survived the summer. Regarding the first reason, all of the glacier growers had dug out a cave from the talus inside which they had placed the ice and the rest of the ingredients. The glacier planters recognized that this would protect the ice against solar radiation, and those in ‘Kwardo’ had evidently learned from mistakes made by their ancestors:

“Our forefathers tried to grow a glacier up in these mountains a long time ago, but they had no rocks, only greenery. Altitude was very low and the area was very open with much sun coming in. This glacier melted very rapidly and is gone now.” This indicates that consideration is given to altitude, which in most of the cases exceeded 4,000 m, with the exception of Minawar. In addition to rock-cover and altitude, aspect is a factor that greatly influences the survival of snow during the summer months. In the northern hemisphere north-facing mountainsides receive less sunshine during the year than south-facing sides. As north was the predominant direction faced by most of the glacier growing sites it seems that glacier planters take this into consideration when selecting a site.

Table 2: Locations of planted glaciers in Gilgit-Baltistan

Village	Year of making	Altitude (m a.s.l.)	Location	Aspect	Surrounding relief	Grain size	In situ ice
Hussainabad 1	2000	4720	Talus slope	North-northwest	Cirque[4] with steep cliffs	Cobble (6-26 cm)	Yes
Hussainabad 2	2005	4520	Talus slope	North-northwest	Cirque with steep cliffs	Boulders (.5-7 m)	Yes
Tasso Gol	2000	4660	Talus slope	North-northeast	Cirque with steep cliffs	Boulders (.5-7 m)	Yes
Balghar 1	2000	4800	Talus slope	East-northeast	Cirque with steep cliffs	Boulders (.1-15 m)	Yes
Minawar	1950's	3770	Talus slope	North-northeast	Cirque with steep cliffs	Boulders (.5-7 m)	Yes
Balghar 2	1966	4750	Talus slope	East-northeast	Cirque with steep cliffs	Boulders (1-15 m)	No
Kwardo	1980	>4000	Talus slope	Northwest	Cirque with steep cliffs	Boulders	No
Harikon	1980	4500	Talus slope	North	Cirque with steep cliffs	Boulders	Yes
Ghwari	2000	>5000	Talus slope	Northwest.	Underneath steep cliffs	Boulders	Yes
Diamel	2000	>4500	Talus slope	West	Cirque with steep cliffs	Boulders	Yes
Hanuchal	1940's	4700	Talus slope	Southwest	Underneath steep cliffs	Boulders (3 -4 m)	Yes
Surongo	1961	Ca.5800	Talus slope	Unknown	Cirque with steep cliffs	Boulders	Yes

Source: Tvieten, 2007.

The predominance of locating the glacier in a cirque is another factor that could greatly reduce ice melting during summer, as cirques are bounded by a horseshoe of mountain walls upstream, and thus provide a pronounced shadowing effect. Figure 44 is a picture of the glacier-growing site I visited in the nallah of Balghar village. It is located in a cirque surrounded by a steep headwall, and the glacier-growing site is marked by a giant boulder measuring 15 m.

Figure 44: Glacier planting site in Balghar village

The glacier at Balghar Nullah was planted in year 2,000, Tvieten visited this site in 2007 along with the glacier planter, they observed one-meter thick ice accumulation under the entire length of the boulder. A stonewall has been built at the entrance of the cave to shield it from sunlight.

In 'Harikon' they applied the same method as in 'Balghar', here described by one man who participated in that glacier-planting, "There was already a glacier on that place. They broke the ice and took some more ice from there and put it under some big boulders. It's a safe place from the sun. There was no sun there."

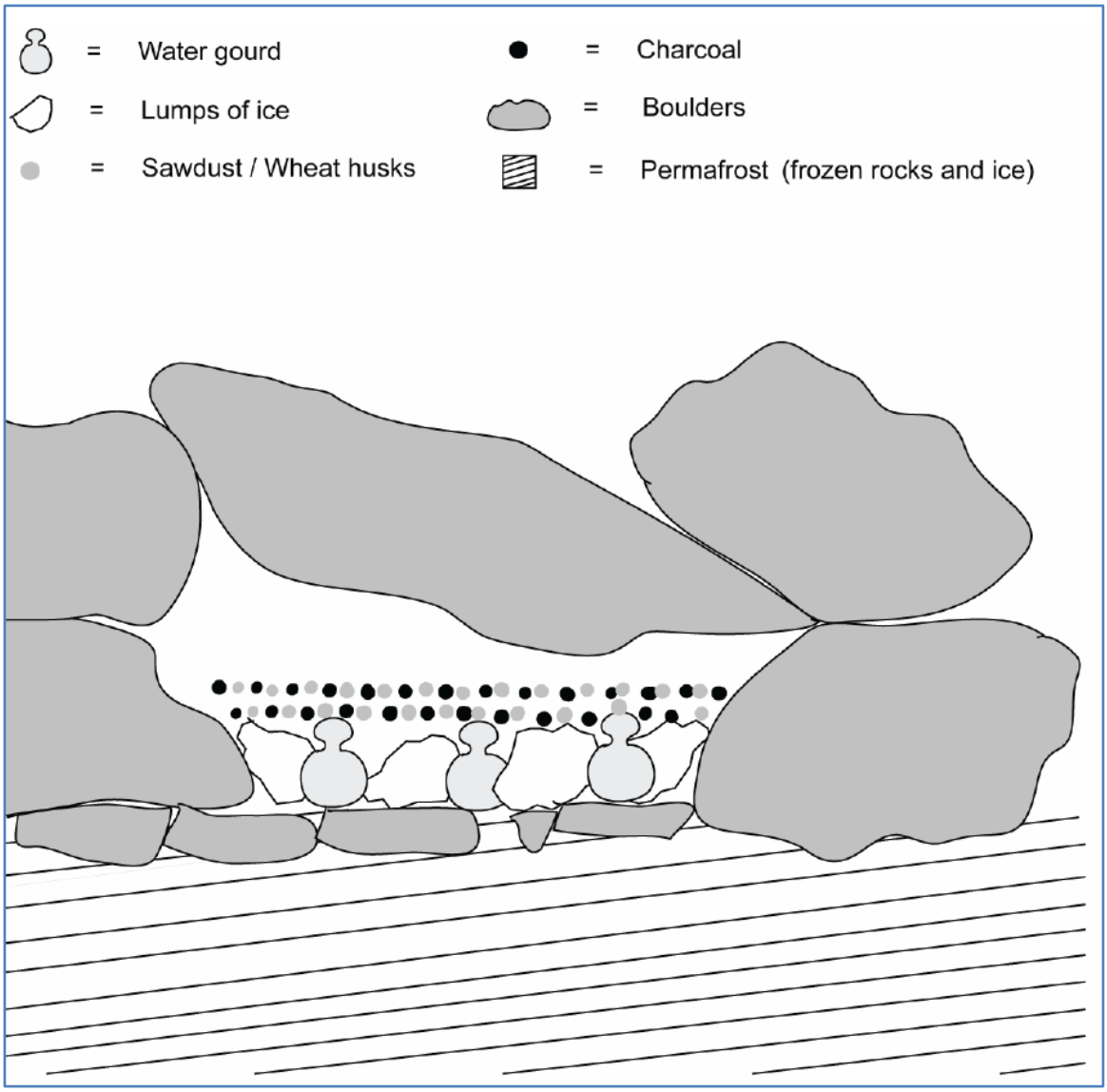
Part of the practice of glacier planting is thus to find a suitable place in a talus slope where to put the collected ice and water. They found that the ingredients were usually put underneath one or several large boulders, and then walled in by smaller rocks. Common to all of the glacier planters except the ones in 'Balghar' and 'Kwardo', was a preference for in situ ice. The previous statement from 'Harikon' tells us how they brought the ice and mixed with ice found at the site. This can either be ice found in the permafrost underground, or interstitial layers of ice found between the boulders. Such ice is preserved among the boulders due to the cooling effect of permafrost present in the ground, and the insulation provided by the boulders. In Hanuchal they deemed in situ ice as a necessity when selecting a site for the glacier planting, and would dig into the ground to find an ice patch to plant their glacier on "We found a place where water was coming out. This was a sign that there was ice under the soil. We dug down 2.14 m and found a layer of ice there. It was male ice. We chose to grow the glacier there. Now it has become big and is breaking up the rocks and moving them."

The glacier grower planters behind this statement recalled that they had participated in four previous attempts to grow glaciers where they did not choose a site with in situ ice. All of these had failed, and they presumed that this was caused by the lack of ice in the ground. Table 2 shown that 10 out of the 12 recorded glacier-planting sites were placed on in situ ice. Permafrost denotes "perennially frozen ground with a temperature colder than 0 °C for two or

more years". The upper layer of permafrost is called: "the active layer" and is a layer of varying thickness that thaws during the summer season.

Figure 45 is a schematic of a glacier planting site. In the diagram water is contained in gourds. There were, however, different ways of storing water at glacier growing sites; for example, in clay pots, tin cans, or in sacks of goatskin. In Hanuchal, where gourd was used, the glacier planter explained that as the water in the gourd froze to ice the shell cracked, and so the ice became part of the planting glacier.

Figure 45: Schematic of planting glaciers in Gilgit-Baltistan



The amount of ice was typically around 200-400 kg. Sometimes, however, the glacier planters would collect remnants of ice and snow avalanches in the vicinity, and add it to the pile making it considerably bigger. In the village of 'Kwardo' people went back to the site each summer, in order to shuffle more snow and ice to the pile.

8.3.2. Findings of Tvieten thesis

In his thesis, Tvieten explored the phenomenon of 'glacier planting' as it is practiced and conceived in Gilgit-Baltistan. The role played by this practice in the management of water has

also been examined. Glacier growing is carried out by people, who don't have a glacier in the drainage basin where they get their water. In these villages water scarcity is often felt during the autumn when most of the snowmelt has finished. Formation of a glacier is the desired outcome of this practice, and several of the people who have tried it are of the opinion that it works to produce glaciers.

Nevertheless, observations and accounts of the locations where glacier planting is typically performed have revealed that they are placed in a terrain that is conducive to the accumulation of snow by avalanching and snow slips. The presence of permafrost at these locations is likely to contribute to ice accumulating within the talus as melted snow refreezes. At one of the places Tvieten observed a rock glacier at the glacier growing site, and oral accounts from several of the other glacier planting locations also indicates the presence of rock glaciers. Thus, glacier planting is conducted at locations, which are already very prone to ice accumulation, and may explain why glacier planting is perceived to work.

The perception that glacier planting is a feasible strategy for the development of a glacierized basin is rooted in the way people of the study area perceives of glaciers as being gendered. 'Female' and 'male' are seen as intrinsic categories to glaciers, and glacier growth is dependent upon the 'coming together' of two glaciers of each sex. This entails a view on glaciers as animate, and Tvieten interpreted it as a vital condition for how people see it as a feasible action to attempt making glaciers.

The view of glaciers as animate implies that humans can influence on the lives of glaciers, just as glaciers can influence on the lives of people. Tvieten has highlighted that people can act both to increase glaciers by performing the practice of glacier planting, and to diminish glaciers by exposing them to impurities. Glaciers influence on the people of the Gilgit-Baltistan by providing them with water, but can also bring havoc by damming up rivers or advancing over cultivated land. Stories of glaciers and glacier planting in Gilgit-Baltistan reflect the coexistence of people and glaciers, where glaciers are used as evocative symbols that invoke deep sentiments among people of Gilgit-Baltistan.

Glacier planting in Gilgit-Baltistan is viewed by Tvieten as a possible method to apply in the management of water, and the AKRSP has provided technical and financial support to the village organisations who wants to try it out. As an organisation with a stated aim to increase the income generation of people in Gilgit-Baltistan, they exhibited a technical approach to glacier planting, and have explored its potential to relieve water scarcity. Yet, glacier planting is a practice deeply ingrained in cultural patterns of this area, and function and form is not easily separated from one and another. Even if glacier planting is stated by its practitioners as applied in order to relieve water scarcity, the aesthetic values of glacier planting should not be under-emphasised.

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+92 (51) 2222469
+92 (333) 5590803
+92 (345) 2004111
info@devconsult.pk
www.devconsult.pk