

TECHNICAL REPORT:
**CLIMATE CHANGE ADAPTATION NEEDS OF
PEOPLE OF THE HINDU KUSH HIMALAYAS**



Technical Report: Climate Change
Adaptation Needs of People of
the Hindu Kush Himalayas

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EXECUTIVE SUMMARY

The Hindu Kush Himalayas (HKH) region has witnessed spectacular impacts of climate changes as indicated by rapid temperature rise, shifting precipitation characteristics, black carbon emission and uncertainties on climate change projections. The impacts are already pervasive in the 8 HKH consisting of Afghanistan, Bangladesh, Bhutan, China, Myanmar, Nepal, India and Pakistan in full or parts of their territories. The HKH region is warming at higher rates (0.03-0.07°C per year) mainly in the central Himalayas and the Tibetan Plateau. In HKH regions, precipitations changes are remarkable but no clear trends of decrease or increase are observed. Receding glaciers and shrinking snow covers are the widely experienced impact of temperature rise and changes in precipitations. The consecutive impacts of these changes are already observed on water resources including seasonal flow of rivers and streams, quality of ecosystem services, biodiversity, population dynamics, agriculture, and human health.

In response to added uncertainties, stresses and risks due to climate change, people in the HKH region have made efforts to adapt with the new situations with their existing capacity and resources. Autonomous adaptation is often shaped by multiple factors such as social, economic, political and institutional environment. People respond to stress in various ways and autonomously. How planned adaptation measures are interfaced with the responses by individuals and households can suggest useful point of entry for adaptation. Migration, livelihood diversifications and behavioural changes to respond disaster risks are some common examples of autonomous adaptations being practiced in the HKH region.

Though data, information and knowledge gaps remain major constraints to employ long term adaptation measures, inadequate support systems and learning platforms for sharing knowledge and good practices are identified also as the major hindrances to disseminate knowledge and implementation. An online survey conducted for this study insisted on 'capacity building' and 'sustainable financing' as the two key strategies for addressing adaptation needs of the HKH region. For the way forward, emphasis is laid on, among others, promoting good practices with a hybrid approach to adaptations-mitigation for achieving dual purposes of climate change response. Finally, the paper suggests five action points to take the agendas of climate change adaptation forward as follows:

Investing on building human capacity: Innovative approaches and actions are essential to build adaptive capacity of mountain communities particularly through the hands of young researchers and managers. The resilience of communities can be enhanced by wise use of indigenous and local knowledge of communities along with current scientific knowledge; and by promoting conducive and policy and institutional environments. Community-led observations and data collection, documentations of the traditional knowledge and practices, and, promoting hybrid technologies may serve dual purposes of adaptation and mitigations. Likewise, mitigation measures coupled with adaptation benefits if integrated holistically with local innovations provide attractive options to the mountain communities. Researchers and planners of the HKH region need to be aware of the emerging environmental disciplines and technologies, which they can convert into useful knowledge to local actions.

Building institutional capacity: Institutions serve as mechanisms to mobilise human resources for translating a vision and thought into actions. Institutional capacity may be enhanced through devising new institutional mechanisms or revisiting the policies of existing institutions. Collaborations at regional, national and sub-national levels can offer practical solutions to address knowledge gaps and efficiently mobilise the limited resources in the HKH region. The existing research and training infrastructures can be mobilized for promoting innovative learning and practices on building adaptive capacity in mountain context. The Himalayan University Consortium may be an example of a learning platform. SAARC and ICIMOD are the right platforms for mobilizing stakeholders at various scales not only to generate and share knowledge but also to create common understanding among the mountain countries to respond climate change issues more collectively. Effectiveness of institutions lie on their proactive actions aimed at enhanced engagements among scientists, policy makers, and decision makers in the region. Institutions are instrumental in promoting interactions to improve understanding and augment capacity needed to respond climate change impacts.

Linking adaptation and mitigation: An important part of addressing climate change is dealing with its root causes by reducing greenhouse gas emissions from human activities while contributing to build climate resilient livelihoods and ecosystems. Examples of combining mitigation and adaptation actions include managing natural carbon sinks such as forests, vegetation and soils so that they absorb carbon dioxide while offering cushions to absorb climate shocks on livelihoods and ecosystems. Trees and other vegetation not only help to lessen the impact of floods and avoid soil erosion but also to absorb carbon dioxide and store it for decades. Likewise, biochar applications are also reported to be an effective approach to adaptation and mitigation in agricultural fields.

Tracking emerging issues in climate negotiations: Climate finance has become a crucial issue particularly after the funds pledged by industrial countries in international climate forum rarely received to the climate affected people of developing countries. Further, efforts are underway to find a common view of mountain countries led by Nepal under Mountain Initiative. Likewise the issue of 'loss and damage' was taken up by initiative of Bangladesh under some climate vulnerable countries at the recent Doha Conference. Without a sustained efforts and collaborations of HKH countries, crucial issues such as climate financing are unlikely to get through the steady and cumbersome climate negotiation processes.

Strengthening Good Practice Initiatives: There is a strong need of strengthening and replicating successful initiatives and practices undertaken in the HKH region instead of leaving them behind as isolated schemes. A number of past and present initiatives in the region are known for bringing a positive impact at a relatively smaller scale or piloting phase. They include among others the Nepal REDD research, Ecosystem based adaptation, Surya project of India, Early warning system of Bangladesh, GLOF mitigation in Bhutan, and ICIMOD's Kailash and Himalayan Climate Adaptation Programme. Though these types of initiatives have successfully established new approaches and contributed in generating relevant knowledge, and, learning for further interventions, their replications and learning are rarely applied in wider scales.

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1.0 INTRODUCTION

Globally, mountains are known for their high degree of sensitiveness to climatic and environmental changes often exhibited in the mountain hydrological systems at varied scales. Losses of high-elevation biodiversity and habitat and increased water stresses and water induced hazards within and beyond mountain regions are early indications. Mountains cover around 24% of the Earth's land surface (UNEP-WCMC 2002) and are home to 12% of the global human population (Huddleston and Ataman 2003), with a further 14% living in their immediate vicinity (Meybeck et al. 2001). Sources of nearly half of world's freshwater are in the mountain. Though mountains are known for rich bio-cultural diversity and heritage; they represent marginal, fragile and inaccessible geo-physical systems of the Earth. As stated, the mountains of Hindu Kush Himalayas (HKH) region, which are also known as water towers or the 'third pole' as they store more ice and snow than any other region outside the poles, are one of the most vulnerable regions from a climate change perspective. As such, mountains are considered reliable indicators of global warming and they provide an opportunity to understand the climate change impacts as they often exhibit early physical and ecological changes in HKH mountains (Singh et al, 2011). Climate change along with rapid expansion of infrastructures, and migration is transforming human-nature interactions and giving rise to new environmental pressures to the mountain ecosystems and livelihoods.

Mountain areas are repositories of biological and cultural diversity and provide vital services with a tangible economic value – such as water, power, tourism, minerals, medicinal plants, and fibres – to mountain communities and, even more important to often heavily populated downstream areas. It is estimated that about 10% of the world's population directly depend on the mountains for their livelihoods while it is estimated that 40% indirectly depend on water, hydroelectricity, timber, biodiversity and niche products, mineral resources and recreation (Schild & Sharma, 2011; Schild, 2008). Mountain ecosystems are thus vital for water, food, energy, forests and biodiversity. All of the world's major rivers originate in the mountains and more than half of the world's mountain areas play a vital role in supplying water to downstream regions (Viviroli et al. 2007). In recent years, mountains and the benefits they provide are under pressure for various reasons including those due to climate change. Though mountain people are relatively poor in human development aspects, they, nevertheless, have adapted to mountain ecosystems and possess wisdom to protect the local ecosystems.

The findings of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007) highlight broader implications of climate change about the mountain regions of the world. They include risk of extinction of approximately 20-30% of plant and animal species globally unless the rise of global average temperature stops below the range of 1.5-2.5°C; the share of water contributed by melting of snow and glaciers from major mountain ranges (e.g. Hindu Kush, Himalaya, Andes) is very likely to reduce affecting over one billion people dependent on these sources; about 200 million people are likely to be displaced by 2050; and, adverse health impacts of future climate like heat stroke, malaria, dengue and diarrhoea will severely affect the low-income countries and societies.

The climate projections undertaken in HKH countries for national adaptation plans generally reveal alarming trends of temperature rise and uncertain precipitation patterns in the future. The national adaptation plan of actions of various HKH countries highlight vulnerabilities of people and their livelihoods at varying scales, and, have drawn immediate adaptation needs to minimize severity of impacts of climate change.

Table 1: Climate trends and variability in some HKH countries

Country	Change in temperature	Change in precipitation
India	Increased 0.68°C over 100 years, post monsoon and winter witnessed higher warming rates.	Increased extreme rains in northwest during summer monsoon, reduced rainy days along east-coast
Nepal	Annual rise 0.09°C in Himalayas and 0.04°C in Terai region, higher warming rates in winter.	No distinct change in precipitation records for 1948 to 1994
Pakistan	Mean temperature rise between 0.6 to 1.0°C along coastal areas since early 1900s	10 to 15% decrease along coastal belt and hyper arid plains, increase in summer and winter precipitation in northern region.
Bangladesh	An increasing trend by about 1°C in May and 0.5°C in November during the 14 year period from 1985 to 1998.	Decadal fluctuations above long term averages since 1960s.

Source: Adapted from <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter10.pdf>

The inherent complexities of physical and social systems of the HKH region consist of dynamic processes that embody the dual needs of climate change adaptation and socio-economic developments. These processes exhibit both opportunities and challenges to the mountain people. These are intertwined with ecological, socio-economic and cultural dimensions having implications to the needs of knowledge and information to convert the challenges into opportunities. The HKH region, however, suffers from scientific knowledge gap due to scanty hydro-meteorological data specific to capture the vast geo-physical, climatic and ecological diversities. Nevertheless, studies confirm that glaciers are shrinking rapidly in the HKH, with serious implications on economic growth and ecological balance (Ericksson et al 2009, Macchi 2010, Singh et al 2011).

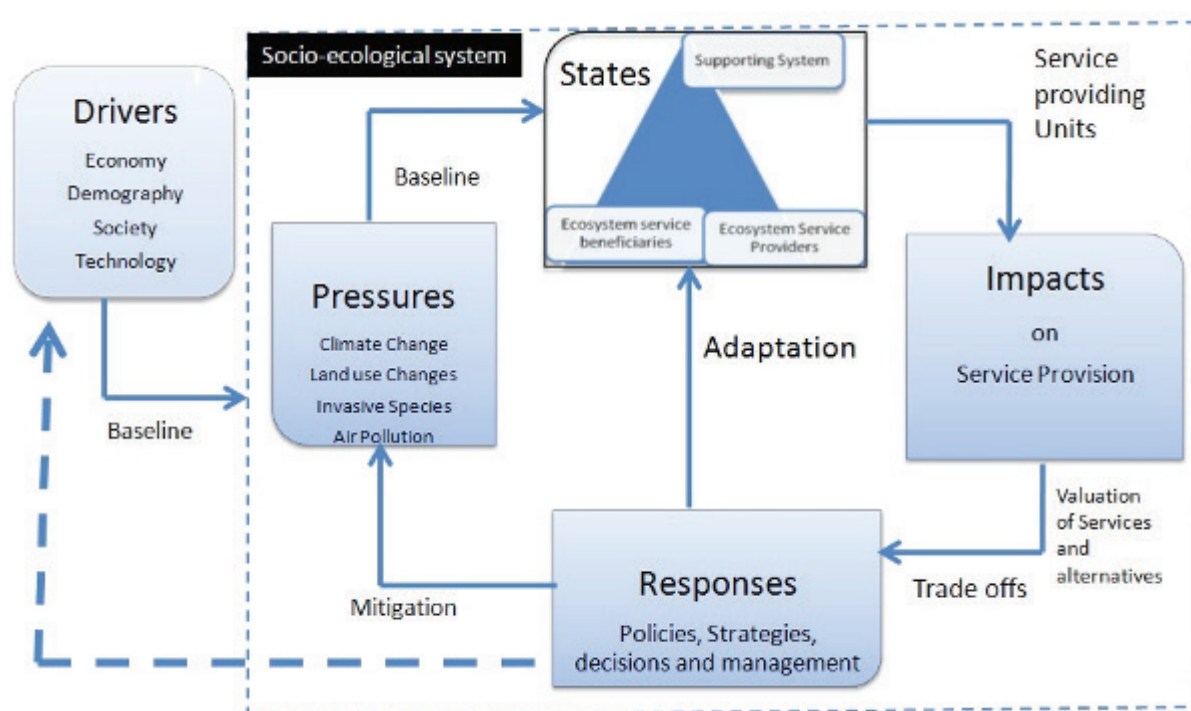
This paper attempts to capture current status of knowledge on climate change impacts, and, adaptation needs corresponding to the climatic vulnerabilities of the Hindu Kush Himalayan region primarily based on review of literatures and supplemented by an online survey. The underlying objective of the study is to identify issues on adaptation needs of the mountain people, and explore action points for ways forward. While focusing on the adaptation needs of the mountain people where climate change impacts are already spectacular, efforts are made to draw relevant principles and practices from elsewhere as relevant to the contexts of HKH region. Contributions from online survey respondents are other important sources of information applied in this study.

2.0 CONCEPTUAL FRAMEWORKS FOR ASSESSMENT OF ADAPTATION NEEDS

Adaptation needs are highly context specific to region, time, individuals, institutions and subject of concerns, therefore, cannot be generalized easily to fit into a particular framework. Accordingly, theories and practices of adaptation have changed over time with inputs after improved knowledge on climate change and consecutive impacts and implications to natural systems and societies. Consequently, a more sophisticated theory of adaptation, and a wider range of methodological approaches are suggested for guidelines to assess adaptation needs (Burton et al. 2002; Fussel 2004; Carter et al. 2007).

Grant et al (2008) worked out a useful framework combining the Drivers-Pressures-State-Impact-Response (DPSIR) and the cause-effect relationships between interacting components of social, economic, and environmental systems that has evolved into an interdisciplinary tool for analysis of environmental changes (fig. 1). The applicability of the framework, however, lies on identifying of indicators appropriate to the spatial and temporal scales and availability of information database.

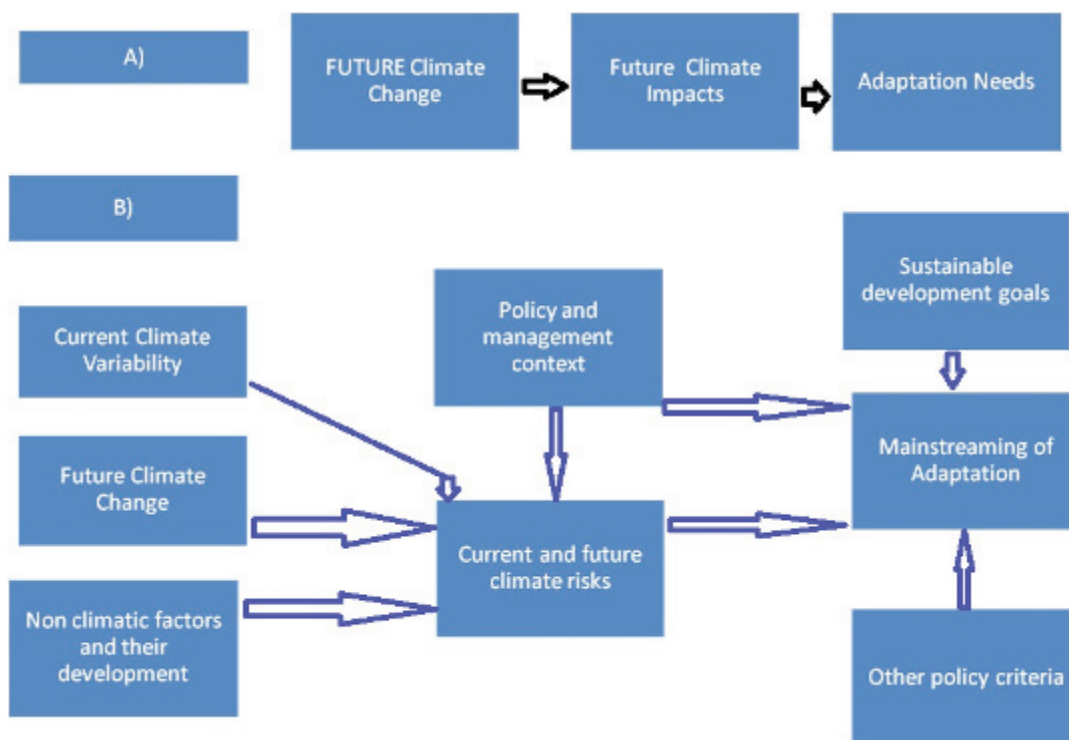
Fig. 1: Framework on coupled drivers-pressures-states-impacts-response and social-ecological system for the assessment of the effects of environmental change drivers on ecosystem services and adaptations (Adopted from Grant et al. 2008)



Fussel (2007) has proposed a framework to illustrate the development of adaptation need assessment by combining two contrasting approaches (Fig 2). The top diagram (A) indicates a linear cause-effect relation where climate

scenarios provide a basis for estimating future climate impacts, that helps define adaptation needs. This is the approach suggested in the IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations (Carter et al. 1994). The approach is also followed in the first national communications to the UNFCCC, most of which restrict considerations of adaptation to lists of potential adaptation options (Lim 2001).

Fig. 2: Adaptation need assessment framework with combination of two stylized approaches in diagram A and B (Adopted from Fussel, 2007).



Fussel and Klein (2004) suggest several conditions for effective adaptation which include 1) awareness raising on the problems based on processes and outcomes of vulnerability assessment and communication, 2) incorporating appropriate adaptation measures that may require new research leading to design a new set of adaptation options, 3) disseminating the knowledge of adaptation measures and their effectiveness through piloting, testing and other approaches; and, 4) promotion of the effective adaptation measures by mobilizing resources for implementation while emphasizing on co-benefits of adaptations and offering incentives while following culturally acceptable measures.

Based on Fussel (2007), the following principles may be useful for adaptation need assessment and planning:

1. The greater the climatic risks than those of non-climatic nature, the higher the need of undertaking detailed assessment of climatic factors.
2. Better knowledge on future climate changes and associated risks makes possible to identify and prioritise more specific action at present.
3. The less experiences in managing specific climate risks lead to create the

need for new and additional action.

4. Addressing the current climate risks in combination with future climate change is the most effective and efficient adaptation strategy when current climate risks are of large scale.
5. Planned adaptations do not necessarily depend on reliable climate impact projections in the case of existing low-regret or no-regret options are in place. Initial adaptation assessments usually identify a wide range of adaptation options which are more than those that can reasonably be implemented in the short term for resource constraints.

3.0 CLIMATE CHANGE VULNERABILITY OF HKH REGION

In general, adaptation needs of a particular region, individual and community are determined by the nature and degree of their respective vulnerabilities to climate change. Vulnerability of the HKH region to climate change is considered high due to 3 critical factors: 1) exposure to climate change as depicted by rapid temperature rise, uncertain changes in precipitation patterns, water induced hazards such as risks of glacial lake outburst floods (GLOFs); 2) high sensitivity in terms of fragile and inaccessibility mountain systems coupled with weak socio-economic structure; and, 3) low level of adaptive capacity as the majority of the mountain people live under poverty line and, their ability to enhance resilience are severely limited by the mountain specific characteristics such as inaccessibility and fragility. Maplecroft survey (2011) revealed that vulnerability of countries in HKH region is high in which Bangladesh's position is number one followed by India (2), Nepal (4), Afghanistan (8), Myanmar (10) and Pakistan (16). As Bangladesh, India and Pakistan have mountain regions only in small portion, their high degree of vulnerability, however, are not linked to the mountain vulnerability alone but combinations of several other factors.

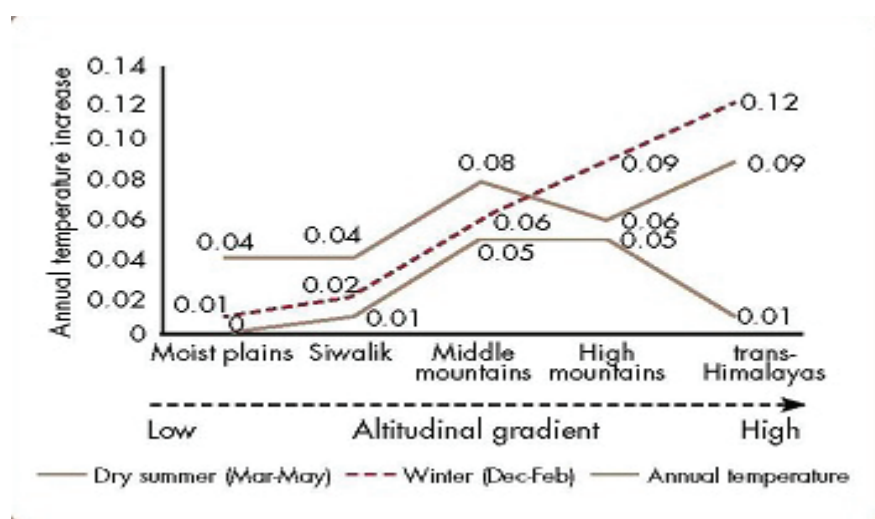
The high degree of vulnerability of the HKH region is the consequences of high exposures to the impacts of climate change, namely, temperature rise, erratic precipitations and increasing trends of extreme climatic events coupled with high sensitivity and low adaptive capacity of the mountain people. Even among the mountain communities, climate risks differ among various segments of the populations. Women, children, elderly, and marginalized groups are particularly vulnerable. In this context, understanding the key hydro-climatic parameters that lead to increased climate change vulnerability of the HKH people require an analysis of each of those contributing factors. They are briefly discussed in the subsequent sections:

- a. Temperature rise
- b. Erratic precipitation patterns
- c. Retreating glaciers and risks of glacial lake outburst floods (GLOF)
- d. Emerging black carbon as a short climate forcer

3.1 Temperature Rise

The pattern of potential impacts of climate change depends on the rate of temperature rise, and variations in precipitation pattern. Studies on HKH regions have shown consistent trends of overall warming in the past several decades (Yao et al. 2006; Shrestha et al 1999; Xu et al. 2007; Eriksson et al. 2009). These studies suggest that warming HKH region has been much greater than the global average of 0.74 °C over the last 100 years (IPCC 2007; Du et al. 2004). A study in Nepal revealed that the average maximum temperature increase was 0.6°C per decade between 1977 and 2000 (Shrestha et al. 1999). The temperature rise is higher in high altitude of the HKH compared to lowlands or plains (Figure 2). Dimri and Dash (2011) has outlined key findings based on analysis of temperatures data of winter (December–February) and precipitation data from 35 observation stations located between 2,192 masl and 3,250 masl in the western Himalayan region from 1975 to 2006. The study found that the increases in average temperature ranged from 0.6 to 1.3°C; the differences in the maximum temperatures across the stations ranged from 1.1 to 2.0°C and the minimum from 0.2 to 0.5°C.

Fig. 3: Changes in temperature in the HKH region between the 1970s and 2000 measured by types of altitude



Source: Cited in Singh et al. 2011 after Shrestha and Aryal, 2011

In the northeast Himalayas annual mean temperature (measured from 1975 to 2000) is increasing at a rate greater than 0.01°C per year (Shrestha and Devkota, 2010). The study noted that a warming trend that is relatively less ($\leq 0.02^\circ\text{C}$ per year) in the Yunnan Province of China, part of the Kachin State of Myanmar, and the north-eastern states of India and Assam while the same is relatively higher ($>0.02^\circ\text{C}$ per year) in eastern Nepal and eastern Tibet.

Shrestha (2009) analyses temperature trends of HKH region with the last two decades of data of twentieth century and reveals a warming rate 0.01°C per year. The study further discovers the temperature rise rates are in the range of 0.01 to 0.03°C per year in the western Himalayas, Eastern Himalayas, and the plains of the Ganges basin respectively. In the central Himalayas and the Tibetan Plateau, the rates are slightly higher (0.03-0.07°C per year). The warming trend in HKH region

is significantly higher than the global average (ibid.). The high warming trends clearly show that the HKH region is one of the world's climate hotspots.

3.2 Erratic Weather Patterns

One of the most critical concerns of HKH communities is the reduced duration of precipitation (both rainfall & snowfall) and resultant prolongation of dry periods, particularly during the pre- and post monsoon. This prolongation has serious implications for agriculture, water availability (domestic uses) and food security. Studies and media reports from the HKH region suggest that marked variations in precipitation characteristics are the most critical drivers of vulnerability in the HKH (see Macchi et al 2010, Practical Action, 2009). Climate model based projections indicate further changes in the future. For example Kulkarni et al. (2011) find that the precipitation is likely to increase by 20–40% in the HKH region when warming would increase in the range of 4 to 5°C by the end of this century.

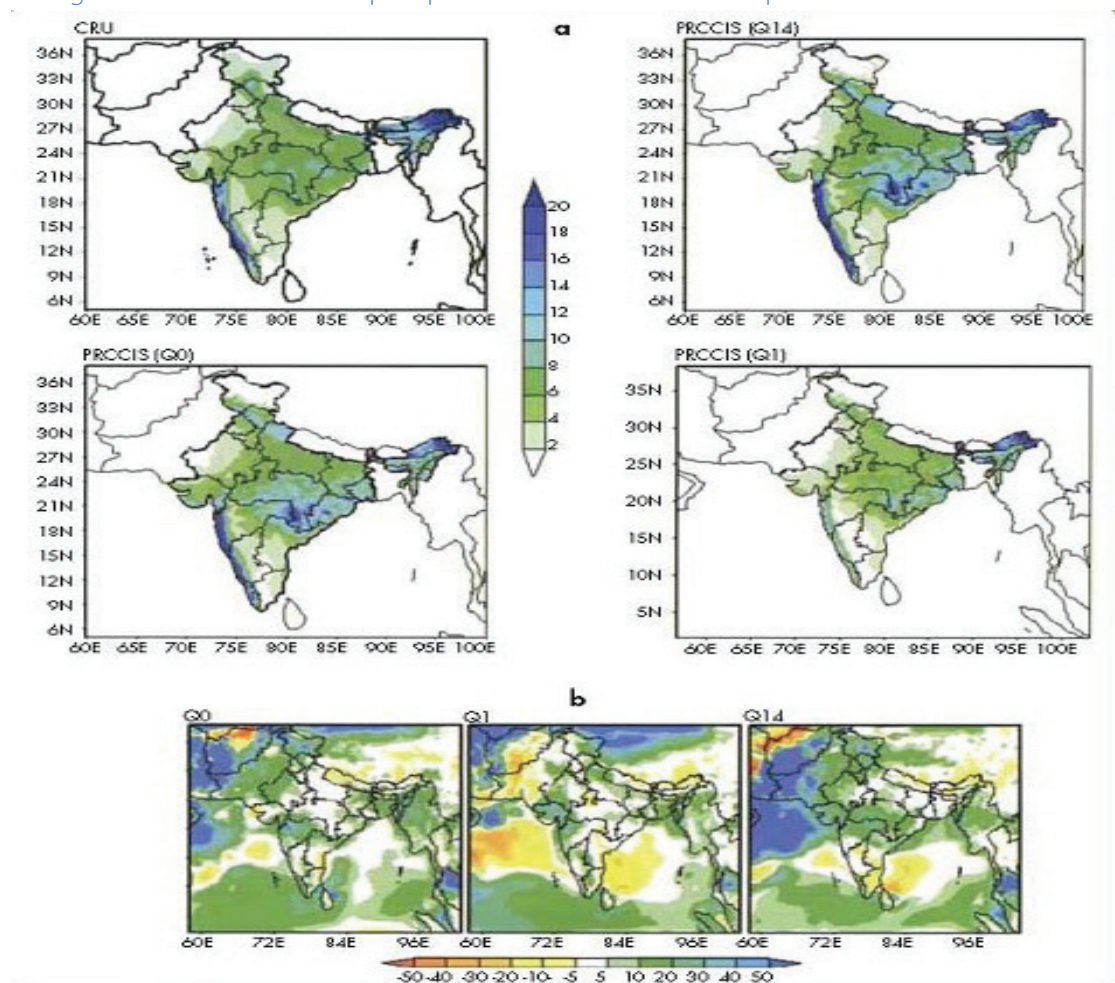
Based on an analysis of the three coupled general circulation models, HadCM3, CGCM2, and CSIRO MK2, Tse-ring et al. (2010) point out the future warming rate in winter to be in the range of 3.6 and 5.3°C, and summer between 2.8 and 3.8°C in the Eastern Himalayas. Regarding precipitations, the winter of the eastern Himalayas is likely to get 23 to 35% more than the present average and the summer monsoon by 17 to 28% with possibility of negative anomalies in some pockets. The net water balance is estimated to be negative in summer due to small increase in summer precipitation, and much greater loss through evapotranspiration as a consequence of sharp increase in temperatures in the region. In summary, the projections clearly indicate drier and hotter summers and milder winters with increased precipitations.

There is a substantial degree of uncertainty on the scenarios of climate change projections and consecutive impacts beyond 2050 due to inherent characteristics of the models. Nonetheless, the emerging stresses of climate change in the Himalayas over the span of this century are unequivocal despite of considerable uncertainties on precise projection mechanisms and impacts, particularly of precipitation (ibid.). Similar conclusions are drawn by Gosain et al. (2011) in the Brahmaputra basin where the study was focused on the impacts of climate change on water resources and hydrology.



Because of shortage of water and the water source are dying out villagers in Pangling village reserve water in two ponds at the whole night and discharge it for the village at day for consumption, Pingling Village Mustang.

Fig. 4: The three PRECIS simulations based summer monsoon rainfall compared with a) the observed climate (upper left panel) with the baseline period (1961-1990) and, b) projected changes in summer monsoon precipitation in the 2030s with respect to the baseline of 1970s.



Source: cited in Singh et al. 2011 after INCCA, 2010

Except the seasonal fluctuations, no clear trends are established on net changes in precipitations. The models have a high degree of uncertainty, as they are based on large-scale observations with limited verification and adjustment through ground-truthing. Based on the model simulated scenarios, the reports of erratic patterns of precipitations both temporally and spatially cannot be confirmed. Inadequate time series data remains a major constraint.

3.3 Retreating Glaciers and Risks of Glacial Lake Outburst Floods (GLOFs)

The HKH region that supplies sustained freshwater from its storages in the form of glaciers, lakes, river streams and ground water through the rivers fed by the glacier-melt water on which depend millions of people downstream is highly sensitive to changes in temperature and precipitations. The recent inventory of glaciers larger than 0.01 km² in the HKH region has listed over 50,000 glaciers with a combined glacial area greater than 61,000 km² (Bajracharya and Shrestha 2011).

The area makes about 30% of the total glaciated mountain areas of the world and is nearly double the previous estimate of 33,000–38,000 km² (Dyurgerov 2005) that probably did not include the entire HKH region.

The HKH is prone to glacial lake outburst flood (GLOFs) as has already experienced 56 GLOFs. Of these events, 4 occurred in Bhutan, 29 in China, 14 in Nepal, 9 in Pakistan, and 10 were trans-boundary in nature. ICIMOD has initiated documenting and monitoring of dangerously expanding glacial lakes in partnerships with regional member countries.

Bohner and Lehmkuhl (2005) suggest that the snow cover of the Himalayan regions would decrease by 43–81% in 2100 if the annual mean temperatures increase by 1 to 6°C as predicted by the IPCC. Studies of glaciers in the HKH region typically record only the position of the terminus, and in general, indicate a retreat of 15 m per year. With major focus on the Indian Himalayas, these studies have hardly taken any accounts of mass balance or changes in the depth of glaciers, are summarised by Raina (2009).

3.4 Impacts of Black Carbon (BC) Emission

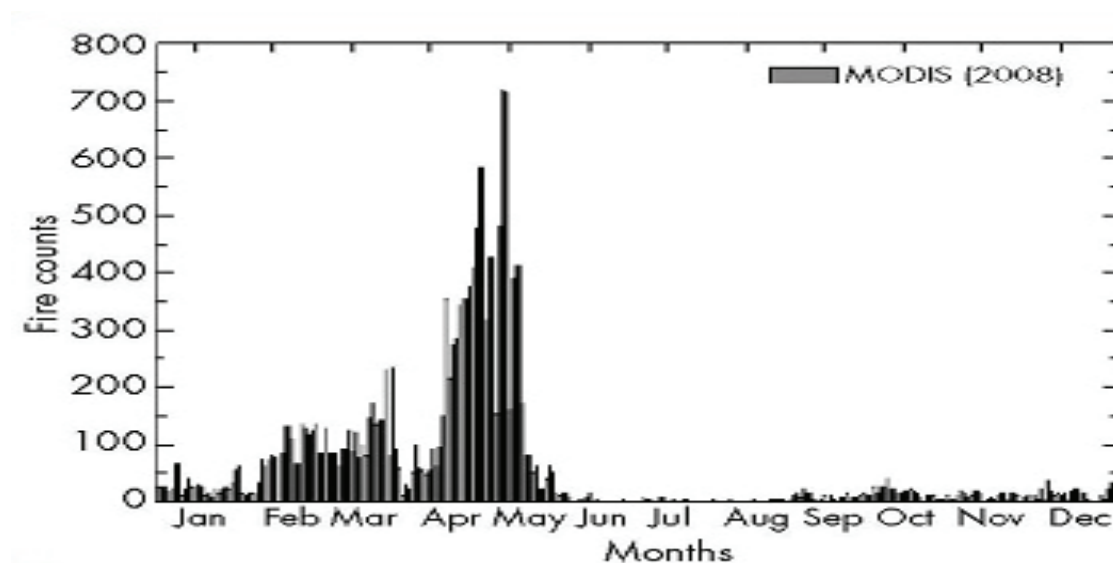
Growth of black carbon concentrations is a major concern for its force to accelerate temperature rise in the HKH region. Until recently, global warming triggered by greenhouse gases were thought to be the main reason for retreating glaciers in the Himalayas. In recent years, monitoring of black carbon particles over the Himalayas provided a clue to discover the greenhouse effects of the layer of these particles at higher rates than those of prevailing greenhouse gases. By monitoring the effect of orographic transport of carbonaceous and sulphate particles along the Himalayas Carbone et al. (2010) suggested that the valley breeze circulation in the high Himalayas provides an efficient mechanism for the transport of anthropogenic aerosols into the Asian upper troposphere (>5,000 msl). These aerosols in the form of dust, smoke, fly ash, and soot are widely released from burning of biomass and fossil fuels in HKH countries. These anthropogenic aerosols, which result from the incomplete combustion of fossil fuels, ultimately settle in the higher reaches of the mountains. Black carbon (BC) is one of the particulates. These particles when settle on the surface of white surface of snow or ice cover in the high mountains, imminently change the colour of the icy surface gradually into greyish or black one, thus, reducing albedo and paving the way for absorption of high solar radiation to the surface.

Ramanathan and Carmichael (2008) estimate the current annual global black carbon emission to be 8 Tg (1012 g or 1 million tonnes). Of this amount, the share of developing countries is nearly 84% and 60% of the total share is anthropogenic. Further the study reveals that open burning contributes 3.5 Tg/yr, residential burning for cooking and heating 2 Tg/yr, and fossil fuels for transportation 1.5 Tg/yr. Anthropogenic burning and fires, which are common during the dry season in agricultural areas of developing countries, are the major contributors of black carbon (Fig. 5). Kopacz et al. (2011) used a model to study the main contributors of atmospheric black carbon in the HKH region and suggested that they vary season wise as well as location wise with indication that the major origins are from northern India, central China, Nepal, Pakistan, the Middle East, and Africa.

According Ramanathan et al. (2007), the warming of HKH region by atmospheric black carbon on the south slope of the Himalayas is sufficient to account for the glacial recession in the region. The 'elevated heat pump' theory suggested by Lau

et al. (2006) indicate that the large amounts of black carbon at higher altitudes of the Himalayan foothills along with dust particles can draw more moisture to this region during the pre-monsoon that may intensify early monsoon. Gautam et al. (2009) suggest a close link between pre-monsoon tropospheric warming and the increased aerosol concentration over the Himalaya for the persistent warming in the pre-monsoon season over the Himalayan-Gangetic region and a 20% increase in early monsoon rainfall. Ming et al. (2009) observe that more than 30% of the melting of ice and snow in the HKH region in the last century is the result of a combination of the radiative forcing of black carbon and black carbon deposition which lower the albedo of snow and ice.

Fig. 5: Seasonal changes in fire counts in India



Source: Cited in Singh et al, 2011 after Dumka et al, 2010, and 2011, Naja and Sagar, 2011.

The HKH region across the different countries is by large consists of mountains in rural landscape that are non-industrialized. In these areas, burning of biomass at household cooking and those in agriculture fields - the two major sources of black carbon, can be reduced by rewarding actions such as replacing traditional inefficient stoves with efficient ones through biogas, briquette making and improved cook stoves (Singh, et al, 2011). These actions will bring a win-win situation- less emissions, thus, reduced indoor pollution and reduced health risks, and, reduced emissions of black carbon. Addressing emissions from growing number of vehicles and industries in the region are equally important not only to curb greenhouse gases but also to reduce air pollution-related health risks.

3.5 Climate Change Implications to Ecosystem Services and Livelihoods

Ecosystem services are the benefits humans derive from ecosystems. Provision of these benefits occurs at multiple spatial and temporal scales. The ecosystem services arising from the mountains of HKH region include water, biodiversity and niche products, hydroelectricity, timber, mineral resources, and recreation that support millions of livelihoods both upstream and downstream. Climate change, land-use change, and population dynamics are the main drivers of environmental

change in the HKH region having profound impacts on the ecosystem services and the livelihoods of mountain people, increasing their economic and environmental vulnerabilities dramatically (Sharma 2012). Small shifts in mountain climates can cause major problems in food security, especially in terms of water resources, potentially threatening the habitability of long-established communities (Schild & Sharma, 2011).

In order to address the knowledge gaps associated with complexities and impacts of climate change on ecosystem services in the HKH region, efforts are going on at various scales in recent years (Sharma, 2012). Resolving an appropriate course of collective action to pursue sustainable livelihoods requires a better understanding of the process of uncertainties on the interactions and feedbacks between the natural and human drivers of environmental change. As the interactions operate at different spatial and temporal scales, designing and applications of appropriate tools or frameworks is important.

In this changed ecological and social fabric, building resilience to vulnerabilities, disaster risks, adaptation or sustainable mountain development, labour migration and remittances, and changing gender patterns and women's roles, and new opportunities and forms of livelihood are the agendas of immensely importance (Schild and Sharma 2011). Four impacts of climate change on ecosystem services are reported in the eastern Himalayas (Tsering et al, 2011). They are 1) Habitat loss and fragmentation, 2) Proliferation of invasive species, 3) Species exploitation, and, 4) Environmental contamination. With temperature rises and reduced precipitation, alpine meadows and shrubs tend to migrate to new places higher up the mountains, but faces constraint by environments that do not have soils of sufficient depth for anchorage and nutrient storage. Wetlands are likely to continue shrinking in response to high evaporation, which further exacerbate due to the expansion of settlements and other human activities. Temperature rise in water bodies makes them more suitable habitats for proliferation of invasive species that displace native species and interact with climate change to threaten native organisms. Synergistic action between commercial harvesting and climate change will have detrimental impacts on subtropical and temperate timber forests. Nutrient enrichment from agricultural runoff could act synergistically with warming water temperatures due to climate change to enhance eutrophication in freshwater systems. However, there are also proportionally smaller benefits of climate change and rising temperatures in some of the higher elevations. For example, some high altitude villages have increased cereal and vegetable crop production due to longer season to harvest. But these small gains do not outweigh the adverse impacts over a much larger area.

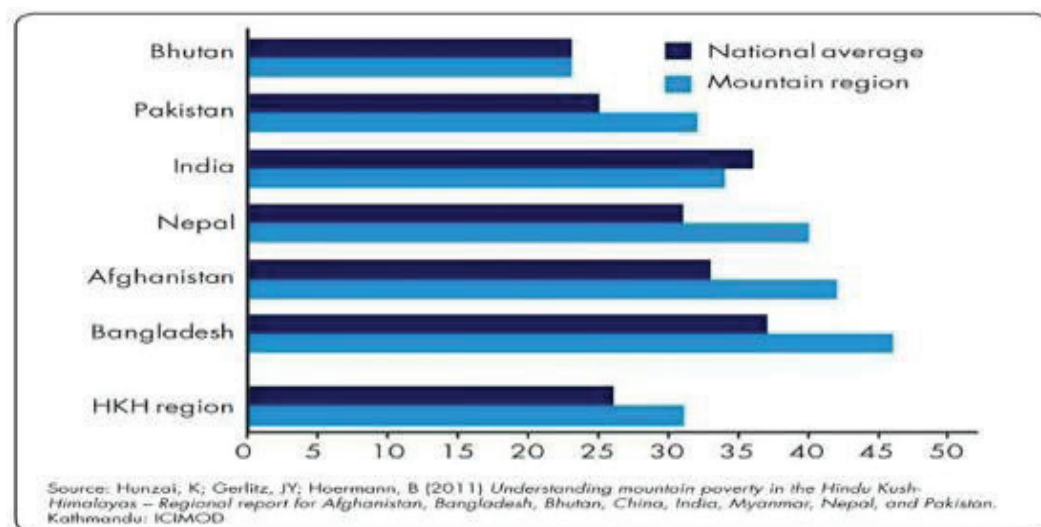
Confirming with the Nagoya Protocol to Convention of Biological Diversity, ICIMOD has spearheaded initiatives with HKH countries for sustainable management of ecosystem goods and services. They include Himalayan Climate Adaptation Programme and Kailash Sacred Landscape Conservation in cooperation with HKH member countries. The four broad recommendations made by Tsering et al (2011) to address knowledge gaps on building climate resilience in ecosystem services and biodiversity conservation of the eastern Himalaya are also valid to the rest of the mountain region. They include 1) research on ecosystem valuation, 2) research on ecosystem functioning, 3) research on monitoring of ecosystem and, 4) research on ecosystem management options. To further these recommendations, six action points are proposed for ways forward: efficient infrastructure (transportation, buildings, and communities – looking at increasing efficiency and promoting opportunities for innovation); sustainable forests and carbon sink management;

government leadership and outreach, water management, supporting research towards developing water resource management tools, integrated watershed management; and, ecological tax reform to address key consumption areas such as energy use, water use, and solid waste disposal – that directly or indirectly harm ecosystems.

The additional challenges added to the HKH region is due to climate change are likely to exacerbate the situation already under stress by persistent water scarcity, deforestations, poverty and conflict. This may lead to increase rates of poverty and outmigration of gendered working force leading to feminization of the social and economic landscapes. This shift of population is likely to add water stresses to the emerging societies along the lower HKH belts. Changes in availability of water for irrigation and growing competition with commercial and domestic needs are also putting additional pressure on water, food security and consequently on livelihoods.

On livelihood aspect, Hunzai et al. (2011) highlights that the economic growth represented by development indicators in HKH countries does not necessarily reflect the true status of mountain people who are actually fall behind in reducing the level of poverty. Figure 6 refers to the increased rates of poverty among the mountain communities of the HKH who suffer and are often marginalized from political influence and economic opportunities.

Fig. 6: Poverty is higher in the greater Himalayan Region



The reasons behind are their high exposure to the physical, social, and economic vulnerabilities created by processes of global change. For example, poverty rates in the mountains are, on average, 5% higher than national-level averages. Climate change impacts add as new sources of vulnerabilities. It is evident that climate change vulnerability is strongly linked with socio-economic status often determined by pre existing conditions of poverty and marginalisation.

In the context of growing climate change impacts, a key question is how to sustain and compensate the ecosystem services from mountains provided to downstream areas where those benefits are reaped. Designing appropriate response mechanism in terms of policies and strategies such as payment of ecosystem services (PES) are vital for making the services sustainable in the interest of regional development.

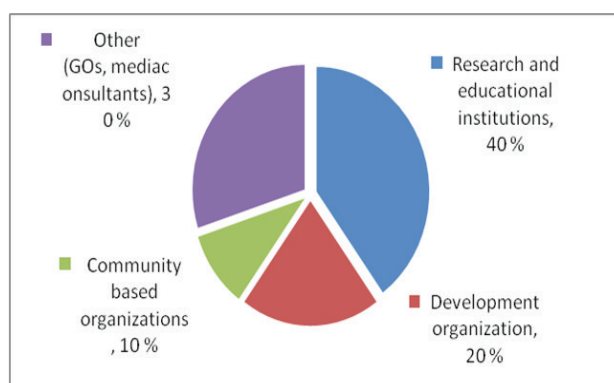
This is, however, unlikely to materialize without new scientific knowledge that is required for analysis and quantification of ecosystem services and making better decisions regarding the sustainable use and management of those services (Millennium Ecosystem Assessment, 2005). Predicting environmental change and its impacts on human well-being and natural ecosystems at local to global scales remains as significant challenges for the scientific community.

Singh et al. (2011) observe that PES concept may offer a popular incentive-based mechanism to natural resource managers and policy makers for addressing both environmental problems and poverty in HKH countries. The concept consists of a range of institutional arrangements including the direct beneficiaries of environmental services who are willing to pay to the providers' communities for watershed protection; state incentives for land use change; and emerging schemes for reducing emissions from deforestations and degradations (REDD) (ibid.).

4.0 PERCEPTIONS ON CLIMATE CHANGE ADAPTATION NEEDS OF MOUNTAIN PEOPLE

In order to capture prevailing perceptions of people in various climate change and environmental networks on various issues of climate change impacts on mountain livelihoods, adaptation needs and responses, an online survey was carried out between December 1 and 15, 2012 using a semi structured questionnaire. The questionnaire was sent to about 2500 potential respondents through email networks facilitated by ICIMOD such as Asia Pacific Mountain Network, Global Mountain Forum, and some other E-groups such as of Environmental Professionals, NGO Network, and Climate Discussion Group. Nearly 100 responses were received mostly from people who are either residents in any of the 8 HKH countries or who have worked there on any issues of mountain and people. Some of the respondents were also from South America (2%), North America (3%), Central Asia (3%), and Europe (4%).

Fig. 7: Respondents by professional affiliations



By types of organizations of respondents, majority belongs to research and education institutions (40%) followed by development organization (20%), community based organizations (10%) and other category (government officials, media, and consultants etc. 30%) (Fig. 7). Nearly 20% of the respondents were women, and rest men. Though it was not possible to identify exact relations of the respondents to mountain regions, we can assume that most of them may

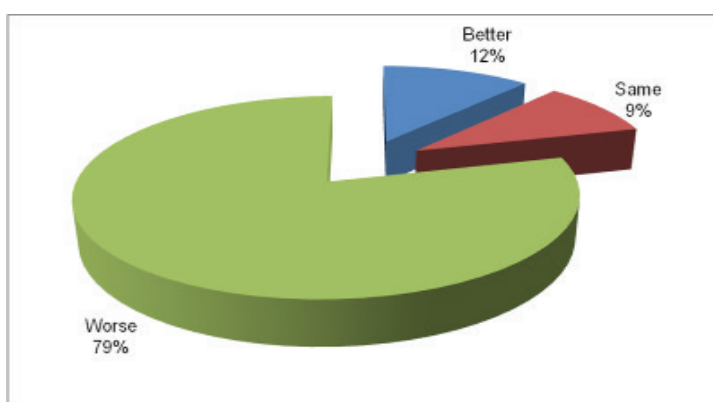
have their origins, professions or simply interests on mountain issues. The analyses in the subsequent sections below are based on partly the survey responses, conversations with experts and relevant project information available online and review of literatures.

4.1 Growing Impacts of Climate Change – A Common Concern

There are shared concerns among the respondents on emerging impacts of climate change on mountains where temperature rise rates are reported to be significantly higher than those of low-lying areas. Majority of respondents, however, refer to the rapid snowmelt over the mountain peaks and changes in precipitations as striking examples of climate change impacts. They view mountains together with ecosystem services and livelihoods of mountain people among the most vulnerable to climate change (fig. 8).

Majority of them are not satisfied with current approach to respond climate change issues for two reasons. First, the majority of policy responses are limited to plans which are rarely implemented effectively or too general to address concerns of the most vulnerable communities. Second, responses often fail to contribute to meet their basic needs of livelihoods and infrastructural development.

Fig. 8: What would be the situation of people in the mountain region after 10 or 15 years from the perspective of currently known climate change risks?



Specifically, the opinions of majority of respondents indicate that adaptation needs of mountain communities are yet to be articulated adequately and, quantified properly. The survey outcomes, however, are inadequate to identify specific adaptation needs and suggest measures to address them. Recent studies on farmers in various ecological systems of HKH region identify different types of adaptation practices and needs in high mountains and Inner Terai region (Macchi and Chaudhary, 2011, Tiwari et al 2012, and Practical Action 2010). Local farmers in all eco-regions expressed that drought was the major problem, and, suggested that better irrigation facility could help them address the climate change impacts. These studies also report about the concerns of high mountain farmers regarding degradation of the grass land and low grass production, thus, compelling them to limit the livestock numbers to unsustainable levels ultimately to change their occupations e.g. resorting to hotel business or out-migration. Further to the mid-mountain and inner-terai region, local people are found changing the planting time and cropping patterns based on their experiences with the recent rainfall

patterns as only few farmers have access to irrigation facilities.

4.2 Perceptions on Issues, Gaps and Response Strategies to Adaptation Needs of Mountain People

Based on the survey responses undertaken for this study, attempts are made to draw out the major issues and gaps. Among the wide range of issues raised, the more frequently mentioned are taken as top priority and outlined below. Further to these outlines, the strategies suggested to overcome the gaps are presented in table 2.

Understanding erratic weather patterns and impacts: Majority of the respondents view that unusual rain patterns, warmer weather, increased risks of glacier lakes outburst; frequent floods and landslides; and prolonged drought or reduced number of rainfall days among others are the key features of new weather patterns. Farmers are among the most vulnerable community due to multiple stresses for the lack of support systems that could offer new knowledge and information to respond the emerging changes in climate patterns, which they do not experience in the past. Without such a facility, they may fail to explain causes and effects behind the losses of crops and productivity for which they seek help from experts or concerned agencies, thus, leaving them in disadvantaged positions.

Inadequate efforts to mainstream climate change issues into livelihood development: Some survey respondents have highlighted the uncertain and difficult livelihoods of sizable mountain populations who struggle for meeting basic needs. Issues associated with mainstreaming of their adaptation needs into development programme as an incentive are emphasised. Finding ways to afford cost of adaptations; addressing challenges of water scarcity for irrigation and domestic uses; and needs due recognition and support to them are other issues of concerns.

Emerging socio-economic challenges: Vulnerability of mountain people to climate change impacts grows due to labor shortage, outmigration, gender imbalance, dependence on imported goods and food and remittances are identified as emerging socio-economic issues.

Effectiveness of policy implementation: A significant number of respondents have picked up the issue related to gaps in planning and implementation. Major gap exists between policy targets and actual implementations of development and adaptation programmes. The growing vulnerability of people is also blamed to the poorly implemented plans that have already identified the vulnerable communities or regions but failed to respond through appropriate programmes or projects.

Ecological imbalance: A significant number of respondents have mentioned biodiversity losses, forest degradations; haphazard constructions in fragile hill slopes that trigger erosion, block channels and cause air pollution leading to ecological imbalance as the major issues of concerns.

Building scientific database and knowledge disseminations: Inadequate scientific database and knowledge sharing continues to be major hurdle to support policy decisions are also pointed out as key issues.

The perceived response strategies corresponding to the aforementioned issues are summarized in the table 2. These responses collectively highlight the needs of addressing community level issues.

Table 2: Perceptions on priority issues and response strategies to adaptation needs of mountain people

Prioritized issues and knowledge gaps	Response Strategies
Understanding erratic weather patterns and impacts: Unusual rain patterns, temperature rise, risks of glacier lakes outburst; frequent floods and landslides; prolonged drought or intense rainfall.	Prioritise mountain focussed weather forecasting and early warning systems, built mechanism to generate local knowledge to build database; identify threat to community; enhance actions to slow down runoff and prevent groundwater depletion and soil losses; promote community based early warning system in mountain regions.
Ecological imbalance: Biodiversity losses, forest degradations; haphazard constructions in fragile hill slopes that trigger erosion, block channels and cause air pollution leading to ecological imbalance.	Enhance community ownership; reduce, reuse, recycle; prioritise water source and biodiversity conservations, promote alternate energy sources; enforce environmental standards in all development activities, invest in research to monitoring of ecosystem changes to help adaptations.
Inadequate efforts to mainstream climate change issues into livelihood development: People struggle for meeting basic needs cannot afford cost of adaptation; mountain people face water scarcity for irrigation and domestic use; needs due recognition and support to them.	Invest in creating livelihood opportunities by integrating adaptation needs; acknowledge local livelihood needs for climate adaptations; recognize innovations for bridging needs for livelihoods support and adaptations; give attentions of local concerns such as protecting sources of water, maintain drinking water facility, improve access to communication and transportation; innovate with new approach of agricultural practices by building on existing knowledge.
Emerging socio-economic challenges: Vulnerability of mountain people to climate change impacts grows due to labor shortage, outmigration, gender imbalance, dependence on imported goods and food and remittances.	Link climate change with development initiatives; Ensure community support; introduce appropriate crops varieties to reduce climate impacts; Use local expertise and products; adopt sustainable technologies; and mobilize youth.
Gaps in building scientific database and knowledge disseminations: Inadequate scientific database and knowledge sharing continues to be major hurdle to support policy decisions.	Consolidate of data generation, building knowledge, and, adequate use and sharing of information among the mountain communities (eg. Farmer-Scientist interaction in Agri-Horti); transfer of technologies and skills to development practitioners; promote applications of IT facilities.
Effectiveness of policy implementation: Major gap exists between policy targets and actual implementations of development and adaptation programmes. Climate vulnerable people are the most disadvantaged due to unfulfilled plans and commitments.	Limit policies or plans to the short term till adequate scientific information and resources are available for long term planning. Ensure ownerships by community stakeholders, build on local and indigenous knowledge, technologies and support mechanism such as climate adaptation funds. Highlight good practices and success stories as appropriate.

Source: Online survey on adaptation needs of the mountain people, 2012

The varied perspectives are often shaped by the level of understanding on risks of climate change and adaptation needs. Interests, education, experiences and exposure may have defined individuals' capacity to articulate issues and opinions.

4.3 Constraints in Assimilating New Knowledge into Adaptation Practices

There are real challenges to match development needs with those of adaptation needs. The mountain areas have a sizable population with dire needs of basic facilities such as water supply, food security, employment and sustainable ecosystem services. Adaptation needs twined with development could be a win-win situation, and merely adaptation without addressing the basics needs would be a less effective. Development needs are defined by the domestic contexts, and, often focus on meeting basic facilities to support livelihoods, and reducing poverty while the adaptation needs are targeted to address climate change vulnerability which consists of interactive factors grouped into exposure, sensitivity and adaptive capacity. In this context, adaptation needs comes on top of those of development needs and may contribute to sustain the developmental achievements. Though it is easier in differentiating adaptation and developmental needs in conceptual grounds, the same may not be true in ground realities where situations vary place to place. Often some extra precautionary measures applied for reducing risks of natural hazards while meeting developmental needs such as building infrastructural facilities eg. Roads, bridges, irrigation canals, energy generating plants and settlements would suffice. However this is not straight forwards because applying those 'extra precautionary measures' requires new knowledge of climate scenarios, their potential implications to the characteristics of hazards in terms of their intensity, frequency and processes and impacts on those developmental facilities.

An analysis of the survey responses indicates that the path of building adaptive capacity of the local communities faces many hurdles that range from knowledge and communication barriers to socio-economic and cultural obstacles. In general, the survey respondents pointed to a range of constraints including lack of support to meet basic needs for livelihoods, limited access to resources and development facilities including transportation, communication; difficult topography, poor socio-economic structure with extreme poverty among a significant population and lack of widespread hands-on demonstration of best practices. The responses can be broadly grouped as follows.

Lack of local capacity to access knowledge and technologies to respond emerging challenges: Mountain people face new challenges to maintain and upgrade livelihood. Their traditional knowledge is not sufficient and new knowledge either does not exist or beyond their access. Existing institutional support mechanisms on which they can depend are too weak or do not exists. Absence of agencies that can facilitate weaker sections communities of mountains face hardships and cannot bring new ideas. New experiences and knowledge gained by local people do not get recognition in literatures and policies. Some experts have used the term 'reflection shield' to describe a situation where the local knowledge does not penetrate the policy level while policy initiatives does not reach the grassroots.

Challenge of linking basic livelihoods to adaptation: Building adaptive capacity of the weaker sections of communities is a challenge as their immediate concern is meeting daily needs. For them needs of adaptation and poverty reduction are

almost same. In this context, planning long-term adaptation practices is irrelevant without addressing their immediate concern.

Weak policy enforcement mechanism: In absence of effective policy enforcement systems, agencies and individuals often engage in short term gains undermining environment, public health and safety goals. Corruptions, commercialization and unregulated market gain. Lack of cooperation and coordination among stakeholders (NGOs, government and private institutions) working in climate change is a hindrance to progress in building adaptive capacity.

Ineffective and non-transparent climate financing mechanism: In the absence of transparent financing sources to fund climate change programmes, there are evidences of fragmented initiatives, duplications and unaccountability. Mobilizations of climate funds under transparent public finance mechanisms are perceived as an option which needs strong monitoring mechanism.

Barriers to transfer knowledge and technologies to the grassroots: Knowledge and database is not accessible to local planners, managers and practitioners. They would benefit from a simple version of such measures. Regional and national institutions supposed to facilitate transferring knowledge and technology at local and regional levels are constrained by technical expertise and financial resources.

Bottlenecks for long term adaptation planning: Climate of the Himalaya is changing rather in complex ways and has added uncertainties. Inadequate evidence remains a major hindrance to propose specific impacts and plan adaptation measures. Climate projections available are too general with significant uncertainties. In some mountain communities, migration trends of young generation and hindered the knowledge transfer.

Weak institutions and resources: Often top down approach dominates. Such an approach tends to take local knowledge for granted and efforts and costs involved in maintaining the indigenous knowledge practices are not acknowledged. Local level institutions involved in knowledge gathering and disseminations suffer from inadequate resources and capacity.

4.4 Responses and Good Practices to Address Adaptation Needs

Climate change responses encompass across themes and regions for meeting adaptation needs. Both planned and autonomous responses are beginning to come into notices from various parts of HKH regions in varied scales from household level to national and regional levels. The nature of responses is as diverse as the aforementioned gaps and constraints. Some of the responses are of autonomous nature while others are planned with a focus on testing and piloting for research and learning purpose. It is, therefore, important to analyse the contexts behind causes of food insecurity. They may be related with socioeconomic structures, increased risks of climate-induced changes mostly at household and community levels. These are also vital for developing appropriate policies and strategies to enhance resilience of mountain communities in improving food security in the HKH region.

Autonomous adaptations are the usual responses at community and household levels which focus on addressing immediate needs with existing knowledge

and resources. Long term (strategic) responses are expected to lend support the autonomous adaptations into strategic or planned adaptations. For many local communities, adaptation and development will be synonymous because as incomes become more diverse and livelihoods improve, so will resiliency toward climate shocks.

Mountain communities find it challenging to adapt to the impacts of climate change without development infrastructures like roads, irrigation facilities, electricity, water supply and sanitation and, thus, should not keep these needs away from core adaptation needs. In the development of its adaptation strategies, for example, governments may consider the development of such basic infrastructure in the project prioritization process.

Responding impacts of climate change require multi-pronged strategies corresponding to the capacity gaps to build resilience against climate vulnerability. To address strategic adaptation needs of the HKH region, Singh et al (2011) suggest three areas of focus: ecosystem services, food security and livelihoods for both mountain and downstream people. In support to these priority areas for adaptation action, four thematic action pillars are recommended to fill knowledge gap (ibid.). They are:

- a. Climate change science and modelling
- b. Biophysical observation and research
- c. Socio economic analysis
- d. Policy research

An analysis of survey response reflects that there are scores of innovative approaches already in practice in parts of HKH region. These practices are often evolved over time to tackle with the immediate specific needs with conventional local knowledge. In the course of practices and replications, they undergo modifications to suit into the changed context, which is currently dominated by climate change induced stresses. Based on survey responses, a list of good practice examples is presented in the table 3.

Table 3: Good practices relevant to various adaptation needs

Country	Example of good practices relevant to various adaptation needs
Nepal	Innovations used for river training works; use of bioengineering to prevent landslides and soil erosion; Modifications in housing designs, Innovations used in designing construction materials.
	Changes in agricultural practices such as use of climate resilient crop varieties, diseases and drought tolerance crops
	Harvesting fogs in high mountain villages for drinking water supply, traditional practices of retaining runoff water in hill watersheds for recharging groundwater and dry season use, Replacing of inefficient flood irrigations to efficient use of drip and sprinkle irrigation techniques among small farmers; protection of spring sources using locally developed technologies,
	Restoring of degraded forests through community forestry practices; Watershed management for multipurpose uses including climate change adaptations in Charnawati watershed of Dolakha District, Ludi khola of Gorkha district and Kayarkhola of Chitwan district (a joint pilot project of ICIMOD, ANSAB and FECOFUN).
	Promotion of small and medium hydropower plants at the initiative of local communities.
	Promotion of renewable energy technologies like solar home systems, biogas plant, windmill
	Network of early warning system on the downstream of Tsho Rolpa glacier lake.
India	Promotion of bioengineering to check rain-induced soil erosions in mountain slopes.
	Micro hydro plants
	Reinforcement of the traditional ways of forest conservation
China	Innovations used in designing infrastructures of Aba Prefecture in China for saving water and energy.
Afghanistan	Community based approach of natural resource management in mountain Afghanistan. www.myafghanmountains.org
Bangladesh	Compensate disaster communities in the coastal area of Bangladesh
	Knowledge sharing with community and rewarding them using Electronic media (Eg: Farmer's TV show by Shaik Siraj in Bangladesh)
Pakistan	Micro-credit for local livelihood improvement
	Replication of indigenous traditional knowledge of agricultural practices
	Food security programmes by institutions such as WFP

Source: Online survey on adaptation needs of the mountain people, 2012

4.5 Analysis on Response Strategies and Gaps

Autonomous adaptation is often shaped by multiple factors such as social, economic, political and institutional environment. People respond to stress in various ways and autonomously. How do planned adaptation measures can be interfaced with the responses by individuals and households can suggest useful point of entry for adaptation. Migration, livelihood diversifications and behavioural changes to respond disaster risks are some common examples of autonomous adaptations being practiced in the HKH region.

Migration has emerged as a major issue in the mountains. It is critical because it is highly gendered—over 90% of the migrants are male, thus, feminization of mountains is evident. There are serious implications of migration on investment

priorities for climate change adaptation, socio-economic development, and, natural resource management. Adaptation strategies require focus on women. Examination of migration and key factors that drive within the context of adaptation may offer clues to identify courses of action for supporting vulnerable communities to manage impacts of climate change.

Livelihoods based on natural resources and agriculture is inherently susceptible to climate shock. Understanding roles of diversification of natural resource based livelihoods and incentive structures for enabling a smooth transition into non-agricultural livelihoods and socio-economic system are vitally important for refining existing response mechanisms.



Adaptation strategies are closely linked to disaster risk reduction tasks but gap exist between the climate adaptation and the DRR communities. For adaptation strategies to work effectively, individuals, households and communities must have increased access to meso (regional) level institutions and they must have the capacity to respond to the need thus expressed.

The United Nations Framework Convention on Climate Change (UNFCCC) first defined adaptation as the extent to which societies could tolerate changes in climate. In its efforts to bridge such a concept with practical necessities for on-the-ground action, distinction is made between adaptation and coping. For example ISET (2008) argues that adaptation is much more than coping and suggests that, in well-adapted systems, “people do well” despite changes in conditions which introduce new stresses, including those attributable to climate change. The reason they do well is either that they shift strategies for earning a living or that the underlying systems on which their livelihoods are based are resilient to absorb the impact of change. Adaptation encompasses both the ability to pursue alternative livelihoods as well as the ability to develop resilient systems.

Both planned and autonomous actions can support shift in strategies. Planned adaptations include those activities by a government or a donor agency to shape its policies, programmes and projects in response to climate change impacts. Dixit (2010) suggests that planned adaptation can be further classified as attributed and indirect. Attributed planned adaptation is the result of public policy decisions made by government with respect to climate change. Such decisions are designed to respond to the predicted impacts of climate change on ecological, hydrological and human systems.

When the uncertainty inherent in climate science and projection renders the adoption of measures which, by design, tackle specific impacts—adaptation—impossible, indirect planned adaptive measures can be adopted. Establishing systemic mechanisms that enable people to switch strategies autonomously and as a result, to do well falls in this type (Dixit 2010). Indirect planned adaptive measures may facilitate a shift to more adaptive strategies but their use is not

directly attributed to address climate change. This approach works independently of climate change but, serendipitously, enables strategy switches and autonomous adaptation.

Though the national adaptation plans of the HKH countries have identified and prioritized the needs of addressing community level response measures to some extent, their poor implementations generally left major gaps. Other national initiatives undertaken by some HKH countries such as Nepal's LAPA framework based projects and India's National Mission for Sustaining the Himalayan Ecosystem (NMSHE) also have recognized the community level needs of adaptations. However, they are limited to piloting and inadequately mainstreamed into regular development activities. Though filling data gap remained a key recommendations of previous studies such the one by Singh et al (2011) to remove the knowledge gap on climate change at national and regional scales, devising strategies for community based approach to fill the information gap in the HKH regions are yet to be addressed adequately. With respect to understanding strategic responses, Singh et al (2011) have pointed out five action points 1) defining the data deficit problem, 2) bio-physical data set, 3) socioeconomic data, 4) the needs for better climate models and interpretation of climate-related impacts, and, 5) focused research and policy formulation for protected areas. For filling micro level data gaps, networks of community organizations could be mobilized for generating data such as Nepal's community forest users' group. Community managed institutions such as schools, colleges or cooperatives are possible local partners for generating data and disseminating new knowledge.

Beyond filling the data and knowledge gaps, there are issues of disseminations. Overcoming the constraints of knowledge dissemination remains a challenge, as does the process of generating knowledge. These challenges are made serious by fragility, inaccessibility and poverty of the mountains. ICIMOD has been facilitating the regional countries of the HKH to pursue an analysis, design, and adoption of appropriate models. The trans-disciplinary approach aims to translate concerns into operational action by supporting interdisciplinary work; to institute programme monitoring and evaluation measures; and to optimise use of financial, human, and institutional resources (Singh et al 2011). Building capacity of individual, institutions and communities is a key challenge if a climate resilience society is to be built. The government has a crucial role in putting in policy instruments in places to contribute to the goal of enhancing climate resilience capacity of the society.

Difficulty in sharing the existing data and information, and disseminating knowledge are major issues. Implications of rapid temperature rise and changes in precipitations at micro level to future hydrologic patterns remain uncertain. This has jeopardized efforts to plan and implement adaptation schemes specifically at local level where adaptation needs are more urgent. Unmonitored flows of rivers and streams in mountains not only pose risks of water hazards and constrain planning adaptation measures. The flash flood that occurred in spring 2012 along the Seti River of Kaski District in Nepal is an example of how the limited knowledge can hinder attempts to reduce risks.

Likewise changes in spring flow in mountain are widely observed but often not properly documented. Lack of a reliable forecasting and poor track records of forecasting quality cause hardships in managing water supply. The gaps may be summarized as poor data availability, inadequate scientific understanding, lack of

awareness, poor institutional mechanisms, poor integration of existing knowledge and practices and lack of integrated management approach.

Uncertainty regarding future status of natural resources and ecosystem services of the HKH region as the climate scenarios available has coarse resolution poorly capture features such as monsoons and westerly regimes. Uncertainty is due to limited multi-model ensemble results. Absence of better information on the evolution of the climate in the future and impacts on agriculture, and water resources are key hindrance to assess impacts and plan measures for adaptation. A sizable number of respondents have spelled concerns about gradual loss of biodiversity and decline of ecosystem services.

5.0 WAYS FORWARD TO OVERCOMING ADAPTATION CONSTRAINTS

The discussions so far indicate gaps of past efforts undertaken to address various adaptation needs at community level in HKH region. The issues of gaps as identified by recent studies (Machhi, 2010, Singh et al 2011, Sharma, 2012) revolve around on deficiency of new knowledge and technologies, overcoming hurdles to support the vulnerable communities for meeting their basic needs of adaptations and building on existing capacity of institutions and households to address strategic needs of adaptations.

Developing process and criteria to define what constitutes adaptation are needed to scrutinise whether the approach supports adaptation strategies minimising vulnerabilities to expected climate change. Encouraging experimentation in developing multiple approaches for adaptive approaches must be tested in local context whether they are workable and replicable. Such approaches need to take systemic perspective. Information is the basis on which analysis is based, strategies are formed choices made. Transparent information can be source for informed dialogue. Education is the basis of conducting informed dialogue. Providing financial resources for innovation: Assessment of alternative strategies is not possible without groups having access to some resources for designing and analysis. In order to address the gaps identified in the previous sections, few major action points are discussed below to serve as ways forward.

5.1 Reaping Benefits through Collaborative Research and Global Knowledge Pools

A way forward for breaking the spiralling cycle of poverty and increasing vulnerability to climate change is to lobby effectively for soliciting international support to mitigate the causes of climate change in support of the people of mountain particularly the United Nations Framework Convention on Climate Change (UNFCCC) and associated processes (Macchi, 2010). The existing know-how with global institutions on various aspects of climate change can be beneficial to the HKH region based institutions through collaborations. Singh et al (2011) suggest to build such collaborations for the specialised technical matters such as biodiversity conservation, adaptive agriculture, seed banks, climate data acquisition and sharing, and downscaling of global models. International agencies, namely Global Biodiversity Information Facility (GBIF) and the Intergovernmental Panel for Biodiversity and Ecosystem Services (IPBES) among others can be accessed for this purpose. Likewise, the CGIAR centres for agriculture, and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), FAO on food security, and the IUCN on managing land and biodiversity resources can

offer strategic partnerships for bringing various know how to enhance scientific rigour in public policy platform of HKH region.

5.2 Capacity Building and Finance as Key Strategic Responses for Meeting Adaptation Needs

The adaptation needs revolve around two core issues- capacity development and finance. The capacity developments involves a range of activities from generating and dissemination of knowledge at individual, institutional, and government agency levels to mainstreaming adaptation into sectoral development, promotion of good practices and sustainable development. In this context, GTZ (2008) suggests following adaptation options which are mainly about building capacity:

Prioritisation of the identified adaptation measures and institutional roles to implement through a participatory process;

- a. Exploring of alternative crops that are better adapted to the future climatic conditions;
- b. Developing of water-saving irrigation and drinking water supply schemes;
- c. Raising of public awareness on expected changes in climate through exhibitions;
- d. Educating children through introduction of climate change topics into the school curriculum;
- e. Integrating measures to respond the expected hydrologic impacts of climate change into watershed management.

Regarding climate finance, international climate finance mechanisms are found very complex and uncertain. Schwank et al (2010) identified the difference between pledge money and actually deposited money to the international climate funds as US\$ 25,802.57 million and US\$ 8,121.91 million respectively. This indicates the complexity and barriers for overcoming challenges. The constraints or difficulties in accessing funding mechanisms apply to all developing countries, including the mountainous nations, and are significant for those with fragile environments, capacity gaps, and governance problems (ibid.). The governance issues particularly apply to least developed countries (LDCs). The available and potential funds address short to mid-term adaptation needs. But there are inadequacies in funding for the stable, long-term programmes that are required for strengthening the knowledge base on environmental and climate change impacts, particularly in the high mountains. This type of funding is limited.

A number of funds do support regional approaches, but those for addressing upstream-downstream inter-linkages face additional barriers in access. Further, transboundary cooperation is often constrained by governance challenges among the countries involved. In summary, the Adaptation Fund, the Special Climate Change Fund, and the Pilot programme for Climate Resilience offer opportunities customised to the needs of mountainous countries with regard to adaptation. The process for accessing the Least Developed Countries Fund (LDCF) is very slow and still limited in scope. There is a clear need of raising level of funding and easing access to these funds.

Looking back into the results of the online survey undertaken for this study, respondents have come up with a range of suggestions for which also provide references in identifying strategic intervention points as way forward. These are summarised into four broad categories in this section and also presented in the table 4. These activities essentially aim at enhancing research capacity and building of knowledgebase at the community level while emphasising the need for building cooperation between policy research institutions and community based organizations.

5.3 Build Database and Research Capacity

In order to address gaps in database and information, the suggested options include mobilizations of local people and institutions in research activities, prioritising of participatory and collaborative research with existing or new local institutions, and ensure dissemination of research findings in design phase. Further, suggestions include that the higher the involvement of the local institutions and individuals, the better the chances of enhancing cooperation and communication on building database and their research capacity.

Local institutions may be a university department or research centre, policy research institution, NGOs and individual. Public media and social networks are useful to assimilate and disseminate knowledge exchanged through this cooperation. Further, it is strongly suggested for integrating the useful knowledge, skills and technologies into ongoing practices as new knowledge. Maximum use of local products in existing or modified forms would also help enhancing cooperation. Prioritising research agendas on any topic of local interests can attract local support and willingness for long-term cooperation.

5.4 Generate and Apply New Knowledge for Adaptation Needs

A typical adaptation initiative begins with an assessment of vulnerability and capacity to establish a baseline; review current and future national adaptation strategies and their relevance to community level; assess and validate current and promising adaptation practices at the community level through action research and pilots; conduct policy analysis and impact analysis of selected policy changes; disseminate information and policy relevant knowledge.

For a smooth exchange of knowledge and information, media can play a vital role. It also could be a mutually beneficial to both media and collaborating institutions or communities. Various media such as local FM, radio, internet, newspaper, pamphlets, and posters can be an effective means to enhance communication with government institutions, private sector, schools, and professional or other interest groups. Ensuring practices of sharing research findings, outcomes of some collective actions and learning are vitally important to begin a culture of shared learning dialogue for enhance adaptive capacity of a community.

5.5 Enhance Community Focused Adaptive Capacity

Removing barriers for enhanced adaptive capacity requires a good cooperation and communication between regional policy organizations such as ICIMOD and SAARC; and, local institutions for bridging gaps, identifying appropriate climate response mechanisms; defining roles of each key stakeholder and launching programmes aimed at enhancing adaptive capacity and reducing climate change

vulnerability. A meaningful two-way learning between regional and local along with their intermediating partners would be possible if both sides agree on breaking the 'reflective shield' of communication and cooperation. Again, it is important to note that a small direct action in support of vulnerable community could be the best approach compared to any indirect activities, which produce no direct and immediate benefits.

An approach of experimental learning that involves both actions and research is essential for a adaptive capacity building process. Building functional networks among different stakeholders including academic institutions, CBOs, I/NGOs, enabling communities throughout the planning to implementation phase ensuring bottom-up approach and rewarding good community based practices, promotion of appropriate technologies are some vital activities which are already in actions but may in need of reinforcement support.

5.6 Provision of Adequate Funding for Adaptation Actions

Adaptation needs sufficient and sustained funding so that the institutions working in the HKH region can plan for and implement adaptation plans. All stakeholders in the HKH countries agree that without funding the progress made so far in adaptation fronts may weaken. Many estimates for financing adaptation actions have been produced though they may not be accurate. Without sustained funding, adaptation responses are likely to be limited to 'reactive' action, such as short-term emergency relief or humanitarian aid. Unless the sufficient funding and technical resources are mobilized, HKH region may face increased costs and greater risks in the future with the number of environmentally displaced persons outgrowing the number of 'traditional refugees'.

A range of action points are identified through the analysis of the online survey results undertaken for this study. Though not in sequential orders, these could still be useful references for planning processes specific to region or communities. A summary of perceived priority themes and recommended actions is presented in the table 4.



Dhaprakash Hirachan produces black plastic organic compost in Marpha village of Mustang District, Nepal.

Table 4: Perceptions based action points for way forward

Category	Action Points
Knowledge	Dissemination of good practices, research findings and knowledge to vulnerable communities regarding the consequences of climate change and potential adaptation measures. School children potentially play vital role to spread the knowledge and make people aware. Minimize the knowledge gap through the active participation of extension workers from the same region to avoid communication barrier between extension workers and target groups. Similarly, promoting good practices like land conservation and management using Livestock and Community Resources Development Plan suitable to Upland areas is another means for the same. Enhance existing cooperation among local, national and regional organizations from HKH countries on wide ranges of areas including research, education. Similarly, build mutual trust among them. Arrange seminars, workshops ensuring the participation of locals with experts and educate them the real danger. Continuous interaction and discussion with the stakeholders to review previous initiatives and plan for the changing environment for further endeavour.
Finance	A basket fund aiming to support victim of climatic anomalies including flood, draught targeting for the emergency period. Fund raising strategy includes through corporate social responsibility (CSR). Proactive initiatives such as infrastructure development, water source management rather focusing post disaster works.
Institutions	Build partnerships with communities, community based organizations, I/NGOs, governmental organizations, donor agencies, media as well as research institutions. Formation of a central implementing agency aiming to coordinate different activities including research, management, monitoring and evaluation and create forum for the various stakeholders. Government institutions possibly play the role of central entity. Loose networks are also imperative in this venture. Engage local experts/NGOs and form collaborative action teams. Help the community to be on sustainable development path.
Research	Action learning/action researching could be a good starting point following the legacy of Nepal's much talked about community forestry programme. Implementing joint research projects on cross cutting themes from grassroots level in both physical science and social science spheres and dissemination of research findings is imperative to get acquainted with rural communities problems. Manage ample research grants for universities, colleges and industries as well as allocate the fund for seminars, conferences. Conduct interactive discussions with local communities, youth, women, students, and tribes, which will explore the needs, expectations, what they want to weave for better lifestyle. Cover areas such as carbon sequestration, climate based insurance policy, climate forecast systems, resilient varieties of crops to be developed and used, and addressing water-related issues in research study.
Policy issue	Policy maker should know what actually mountain people want and how their livelihood can be improved and action accordingly.

Source: Online survey on adaptation needs of the mountain people, 2012

6.0 CONCLUSIONS

In recent years, there are rise in mean temperatures, number of warmer days and dry period having serious impacts on the region's natural environment and societies. The needs of climate change adaptations are urgent in most of the HKH region due to growing vulnerability of the large sections of populations dependent on the region's natural resources and ecological services. This study, to some extent, has captured gaps in climate change knowledge, identified constraints and offered response measures to overcome the gaps and constraints. Public perception highlighted the needs of translating the policies and plans into actions for enhancing climate resiliency of the HKH people. A special effort is needed to promote innovations for enhanced adaptive capacity giving due considerations to fragility of mountain social-ecological systems.

At local level, emphasis should be given to upscale isolated efforts of adaptation initiatives to comprehensive interventions by building on the good practices. Building information database of stocks and flow of resources in river basin scales would be useful to enhance regional cooperation. A starting may be made by data acquisition, and pursuing strategies for sharing data at all level of actions to filling knowledge gaps. To overcome these limitations it is clear that greater access to funding mechanisms for climate change adaptation is required, that particularly gear towards the needs of fragile mountain social-ecological systems. While this may be the case the reality is different, Schwank, et al (2012) suggest that complexity of climate and environmental change funding landscape has historical and political roots and is far from optimal from a user's perspective. This is a real challenge that mountain countries need to recognise and prepare accordingly to take forward actions.



Kaltin Thakuri from Pangling village of Mustang dries Bio-Briquette, an adaptation to shortage of fuel wood in High Himalayan Region.

An important part of addressing climate change is dealing with its root causes by reducing greenhouse gas emissions from human activities. Examples of mitigation actions include managing natural carbon sinks such as forests, vegetation and soils so that they absorb carbon dioxide (UNISDR 2008). Trees and other vegetation help to lessen the impact of floods and avoid soil erosion. Forests and other vegetation have the capacity to absorb carbon dioxide and store it for decades. Furthermore, they also help replace oil and other fossil fuels with wood as biomass energy can reduce emissions of carbon dioxide – the most potent greenhouse gas in terms of volume. Likewise, biochar applications are also reported to be an effective approach to adaptation and mitigation in agricultural fields (www.ibi.org).

Climate finance has become a crucial issue particularly after the funds pledged by industrial countries in international climate forum rarely received to the climate affected people of developing countries. Further, efforts are underway to find a common view of mountain countries led by Nepal under Mountain Initiative. Likewise the issue of ‘loss and damage’ was taken up by initiative of Bangladesh under some climate vulnerable countries at the recent Doha Conference. Without a sustained efforts and collaborations of HKH countries, crucial issues such as climate financing are unlikely to get through the steady and cumbersome climate negotiation processes.

There is an urgent need of strengthening and replicating successful initiatives and practices undertaken in the HKH region instead of leaving them behind as isolated schemes. A number of past and present initiatives in the region are known for bringing a positive impact at a relatively smaller scale or piloting phase. They include among others the Nepal REDD research, Ecosystem based adaptation, Surya project of India, Early warning system of Bangladesh, GLOF mitigation in Bhutan, and ICIMOD’s Kailash and Himalayan Climate Adaptation Programme. Though these types of initiatives have successfully established new approaches and contributed in generating relevant knowledge, and, learning for further interventions, their replications and learning are rarely applied in wider scales.

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