Partner Report Series No 1

Integration of climate adaptation into development and conservation planning in Bhutan:

issue identification and recommendations

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ADAPTATION KNOWLEDGE PLATFORM

REGIONAL CLIMATE CHANGE ADAPTATIONKNOWLEDGEPLATFORM for Asia

The *Partner Report Series* highlights the insights and outcomes of studies, assessments and other field activities that our national implementing partners have undertaken in their countries to mainstream adaptation into plans, policies and programmes. The intention of the series is to disseminate their findings to partners and relevant professionals in Asia.

We welcome suggestions or comments.

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About the author

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Front Cover:
Snow-capped mountain in Wangchuck Centennial Park
Photo Credit: Phurba Lhendup

Back Cover:
The head of the River Chamkhar Chu in Wangchuck Centennial Park; used for hydropower generation
Photo Credit: Phurba Lhendup

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Alpine lake in Wangchuck Centennial Park
at 3500 meters high; source of water down stream
Photo Credit | Phurba Lhendup

Preface

During the last three years, the Regional Climate Change Adaptation Knowledge Platform (AKP) has worked towards building bridges between existing knowledge on adaptation to climate change and the governments, agencies and communities that need this knowledge to inform their adaptation to the impacts of climate change, while working to reduce poverty and sustain the environment. AKP's work has been carried out following three key objectives:

1. Promoting dialogue and improving the exchange of knowledge, information and methods within and between countries on climate change adaptation, and linking existing and emerging networks and initiatives.

2. Generating new climate change adaptation knowledge, promoting understanding and providing guidance relevant to the development and implementation of national and regional climate change adaptation policy, plans and processes focused on reducing vulnerability and strengthening the resilience of the poor and women, the most vulnerable segments of society in many parts of Asia.

3. Synthesizing existing and new climate change adaptation knowledge and facilitating its application in sustainable development and poverty reduction practices at the local, national and regional levels.

This publication is a result of these objectives. AKP supported thirteen countries in the Asian region, to strengthen their capabilities to introduce effective adaptation measures. This includes undertaking activities at the national level to create an enabling policy, regulatory, planning and budgeting environment for the adoption of adaptation measures, and at a sub-national and local level where most adaptation activities are implemented. In each country, the platform facilitated adaptation action and strengthened adaptive capacity.

AKP is being facilitated by the Stockholm Environment Institute (SEI Asia), the Asian Institute of Technology Regional Resource Centre for Asia and the Pacific (AIT RRCAP), and the United Nations Environment Program Regional Office for Asia and the Pacific (UNEP ROAP) with funding provided by the Swedish Government through the Royal Swedish Embassy in Bangkok and the Swedish International Development Agency (Sida).

Bhutan is one of the thirteen countries. This publication highlights the insights gained from the implementation of activities in Bhutan through WWF Bhutan. Readers may also want to read the following related publications:

Lebel, L., Li, L., Krittasudthacheewa, C., Juntopas, M., Vijitpan, T., Uchiyama, T. and Krawanchid, D. 2012, *Mainstreaming Climate Change Adaptation into Development Planning*, Adaptation Knowledge Platform and Stockholm Environment Institute. Bangkok. pp. 32

Thapa, S., Soussan, J., Priya, S., Lhendup, P. and Krawanchid, D. 2010, *Enhancing Adaptive Capacity in Bhutan and Nepal, Policy Research Brief No. 1*, Regional Climate Change Adaptation Platform for Asia (Adaptation Knowledge Platform). Bangkok. pp. 12

AKP's publications provided insights that catalyzed further actions to deepen adaptive action in the region. A consolidated initiative, known as the Asia Pacific Adaptation Network (APAN), has been established and will be fully implemented starting 2013. Its ultimate objective is to assist the region to build climate resilience of human systems, ecosystems and economies through the mobilization of knowledge and best practices, enhanced institutional capacity and informed decision making processes, and facilitated access to finance and technologies.

The outcomes of AKP have been made possible by the active participation of partners and various stakeholders. SEI acknowledges the editorial assistance provided by Marion Davis, Paul Bulcock, and Skye Turner-Walker. SEI also expresses heartfelt thanks to John Soussan, Lailai Li, Kai Kim Chiang, Lisa Schipper, Sabita Thapa, Tatirose Vijitpan, Muanpong Juntopas, Nantiya Tangwisutijit , Chanthy Sam, and Dusita Krawanchid for their contribution to AKP.

A fir forest in Dochula Pass in Thimphu
Photo Credit | Phurba Lhendup

Introduction

Climate change poses particular hurdles for developing countries and communities as they work towards sustainable development. The key issue for millions of people in Asia is how to adapt to the changes and uncertainty in their economic and ecological systems. International attention has been focused largely on mitigating future impacts by reducing greenhouse gas (GHG) emissions. However, adaptation to climate change is gaining more attention, with an emphasis on building and sharing knowledge.

One major challenge is to understand how and where planning and development decisions need to change in order to strengthen resilience and reduce risks. A number of initiatives have been launched to assist countries throughout Asia to build their capacity to respond to the changing climate, yet many of these have been undertaken independently of one another. The Regional Climate Change Adaptation Knowledge Platform for Asia (AKP) aims to address this challenge by building bridges between initiatives, researchers, policymakers and business leaders.

Bhutan is one of 13 countries covered by the AKP. In June 2010, a climate adaptation scoping study was undertaken, with input from stakeholders in government, non-government organizations (NGOs), and academia. The study's key findings were:

1. Awareness of climate change was quite strong. However, there was no overall framework for addressing adaptation at policy or planning levels.

2. Both short- and long-term climate risks need to be better integrated into planning and policy making processes, in relation to 1) sector-specific responses to both climate variability and extreme events, such as floods, and 2) planning and implementation approaches that reflect, and can cope with uncertainty.

3. Bhutan's adaptation capacity was also a concern. Several training activities had taken place, but a systematic appraisal of training needs and the development of a strategy for both human resources and institutional change were required.

In order to support adaptation capacity-building at the local level in Bhutan, the AKP provided both financial and technical support for a pilot programme focused on scenario-building and analysis. These exercises aimed to strengthen community-level resilience with respect to livelihoods and natural resource management, and build stakeholders' capacity to plan for a changing and increasingly uncertain environment.

Mr Yeshey Penjor, UNDP Climate Change Specialist, making a presentation
Photo Credit | Phurba Lhendup

A typical Bhutanese farm house in Wangchuck Centennial Park
Photo Credit | Phurba Lhendup

WWF Bhutan was selected as the national partner. The Freshwater and Climate Change Program of the WWF Bhutan office directed the programme activities.

This project report is divided into two parts. The first identifies issues concerning the integration of adaptation into conservation and development plans. The second presents a climate change vulnerability assessment for communities within one of Bhutan's protected areas.

Bhutan

Area : 38,394 sq km

Population : 671,083

Economy : 79% of the population depends on natural resources, for income and livelihoods: agriculture, animal husbandry and forestry. Staple crops include rice, wheat, maize, potatoes, buckwheat and barley. Livestock are important as a source of milk, meat and power. Forests provide timber, fuel-wood, medicinal herbs and food. Other economically important sectors include tourism and energy (hydropower).

Profile of Bhutan

Bhutan is a small Buddhist kingdom nestled in the steep mountains of the Eastern Himalayas. The country has a complex topography of deep narrow valleys ranging from about 150m along the southern border to above 7,000m in the northern mountain peaks. This diverse geography, combined with equally diverse climate conditions, contributes to Bhutan's biodiversity, with a number of ecosystems and bio-geographic areas (including sub-tropical, mid-temperate and alpine zones). A network of 10 protected areas connected by biological corridors helps to conserve these natural resources.

Bhutan has long been a model for environmental stewardship. Its commitment to conservation is demonstrated by its proactive responses to the challenge posed by climate change. Bhutan is one of the few countries in the world whose carbon sinks are greater than its GHG emissions, primarily due to its large amount of intact forest cover and its low level of industrialization. Bhutan has also pledged to remain a carbon-neutral (or carbon 'positive') country. Climate change is global and its impacts are already evident in Bhutan. Adaptation will be challenging, but it is critical to the future of Bhutan's people, economy and ecosystems.

Integrating ADAPTATION WITHIN BHUTAN'S DEVELOPMENT AND CONSERVATION FRAMEWORK

This section is based on a two-day workshop held on 10-11 February 2011 at the WWF conference hall. Sabita Thapa (Stockholm Environment Institute), Bijan Gurung (WWF Nepal) and Phurba Lhendup (WWF Bhutan) led the workshop on issues identification and stakeholder engagement, which was attended by representatives from the government, NGOs, corporations and civil society. The presentations and group discussions covered issues such as the drivers of change, issues concerning adaptation within Bhutan and the role of stakeholders in adaptation.

Due to active geological conditions, variations in precipitation and steep, high-elevation terrain, Bhutan is highly vulnerable to various climate change impacts and natural hazards. In addition to landslides and erosion, the mountainous region is becoming increasingly susceptible to glacial lake outburst floods, thought to be the result of climate-change-induced glacial melting. As global GHG emissions continue to rise, Bhutan faces climate impacts with profound implications for its diverse ecosystems, livelihoods, culture and development. Thus Bhutan urgently needs to develop a set of approaches to prepare for climate change and reduce the vulnerability of natural resources, communities, development goals and economy.

Until recently, Bhutan's main adaptation strategy is focused on disaster risk reduction, particularly regarding glacial lake outbursts. This focus reflected the rapid changes that had been observed at high elevations and the rapid formation of glacial lakes, which have the potential to cause serious harm. Now a more robust understanding of the depth and breadth of these impacts is developing among policymakers, scientists, and the general population. Climate change impacts are visible in agriculture, hydropower, human health and sanitation, environmental and biodiversity conservation, and infrastructure development and planning. A few examples include increased risk of glacial lake outburst floods, erratic rain fall, landslides, flash floods, changes in water availability, and warmer ambient temperatures leading to phenological changes and glacial retreat. The severity of these impacts is expected to increase.

Bhutan's government has chosen a low-carbon development path, which includes small-scale hydropower to supply electricity to1,700 rural villages that currently burn wood and kerosene. This has reduced the cost of energy for communities and increased the efficiency of land and forest management practices. Partial financing for low-carbondevelopment has come from the Least Developed Countries Fund under the United Nations Framework Convention on Climate Change (UNFCCC). Bhutan has not yet attracted any international carbon offset projects. However, this could increase the funds available for climate-related projects.

Climate change integration needs and barriers

Bhutan is still in the very early stages of identifying the appropriate responses to climate change risks and has limited practical experience in mainstreaming of adaptation into national development planning. However, it is an area of concern and increased focus, as the continuous and uncertain nature of climate change poses significant risks for Bhutan's development and goals. The approach to adaptation activities needs to be a long-term, cross-cutting policy that serves both conservation and development planning. If the two sectors fail to integrate, they run the risk of inadvertently increasing vulnerability to climate change.

An alpine grassland in Wangchuck Centennial Park
Photo Credit | Phurba Lhendup

Several barriers limit Bhutan's efforts in mainstreaming adaptation into development and conservation planning:

- A lack of clear government policy and strategy to address climate change impacts;
- Inadequate cross-sectoral coordination among organizations and agencies concerning adaptation;
- Inadequate institutional knowledge and capacity to address the challenges of climate change;
- A political system where conservation remains secondary to economic development;
- An inadequate socio-economic capacity within communities to face the challenges of climate change;
- A lack of financing for climate-change activities at the national and local level;
- A dependence on climate sensitive production systems and sectors, such as agriculture and livestock.

Workshop participants identified several factors that affect how climate change is felt in Bhutan:

- Infrastructure development, including road construction, hydropower development, aviation development, urbanization and other forms of development;
- Pollution from vehicle emissions, industry and inappropriate waste management;
- Population growth, and
- Rapid economic development.

The negative consequences include a decrease in agriculture production, land fragmentation, pollution, and biodiversity loss, as well as increased natural disasters and cultural erosion. Positive consequences include greater opportunities for employment and income generation.

The next step was to identify stakeholders in the implementation of climate-related activities in Bhutan – including potential partners, groups that should be engaged, and organizations that should be consulted or kept informed. Table 1 details the categories of stakeholders.

Table 1: Stakeholders in climate change activities.

Keep engaged	Consult	Partner	Inform
• National Environmental Commission • Gross National Happiness Commission (part of Centre for Bhutan Studies) • Ministry of Agriculture and Forests • Ministry of Economic Affairs • Ministry of Home and Cultural Affairs • Donors	• Politicians • Druk Holding & Investments • Central Monastic Body • Farmers • Religious institutions	• The International Centre for Integrated Mountain Development (ICIMOD) • Royal Society for Protection of Nature • District administration offices	• Centre for Bhutan Studies • Ministry of Works and Human Settlements • Bhutan InfoComm and Media Authoritay • Media • Natural Resources Development Corporation • Bhutan Agriculture and Food Regulatory Authority • Information and Communication Services • Private sector

Integrating adaptation into conservation and development planning

Integrating adaptation within the national policy cycle

Currently Bhutan's national visions, strategies and policies (including the conservation and management of its protected areas) do not consider climate change or the risks arising from it. Incorporating climate change and adaptation into policy is certain to raise awareness of this issue, its impacts, and the need to adapt to them. As national policies provide the overall framework within which the lower level policies operate, the inclusion of adaptation at the national level can help shape priorities and provide a framework to facilitate adaptation at the sector and project levels. The inclusion of adaptation within national policies could also influence the allocation of the national budget by highlighting climate change adaptation as a key element in investment decisions. Therefore, adaptation should also be incorporated within relevant national policies and strategies.

Education and training

Education and training on climate change in Bhutan to date has been limited; there are very few people with an adequate knowledge of adaptation, even at the national level. Therefore, in order to develop greater awareness, climate change should be integrated into Bhutan's national curriculum and be taught as part of students' environmental education. National officials, sub-national officials and NGO workers require this training as well. Bhutan also needs access to the best available information of the current and future implications of climate change, including current climate conditions and extremes; projections of future climate change; and assessments of potential impacts and vulnerabilities. Sources include academic papers, published studies, vulnerability assessment guides and web sites. Assessments of climate change impacts and vulnerabilities have also been conducted for most developing countries and been summarised in national communications to the UNFCCC's archive of developing nations' assessment plans could guide Bhutan in preparing similar studies.

Financial resources

Bhutan's national budget is allocated to its ministries, which prepare their own five-year plans for development. This may involve prioritizing certain programmes and activities. For adaptation related activities, it is important to allocate funding to more vulnerable sectors or regions, because Bhutan has no national plans and thus no designated funding. In order to generate additional financial resources, adaptation plans and strategies need to be prepared; these will help guide the preparation of future funding proposals.

Communication and awareness

Some government officials and NGOs already are raising awareness of adaptation. However, this is a huge task, as there are a vast number of people and interests that must be considered. This calls for outreach activities of a much greater magnitude. The government needs to encourage local authorities, NGOs, educators, the media and the entertainment industry to play a role. Until the causes of climate change and its impacts are communicated to all stakeholders, the planning and mainstreaming of adaptation will remain difficult.

Group work in progress
Photo Credit | Phurba Lhendup

Stakeholders' awareness of climate change, and the associated threats and opportunities for adaptation needs to increase, alongside stakeholder involvement, ownership and responsibility for activities that adapt to and/or mitigate against climate change impacts. This awareness should also include advice and examples of best practice on how to communicate and deal with adaptation.

Leadership and coordination

Bhutan's government organizations require a clear mandate and a strong focus on adaptation. Centres of power within the national government need to coordinate adaptation into planning for the efforts to succeed. In many cases, adaptation was not integrated into national planning because key senior government figures deemed it unimportant. Because the impacts of climate change cut across ministries, Bhutan requires the establishment and management of cross-sector coordination mechanisms. Currently, limited coordination between different sectors has led to duplication of activities and poor outcomes. A dedicated climate adaptation organization should monitor adaptation activities throughout Bhutan and analyze their impacts.

Technical 'know how'

Adaptation within Bhutan will also require an amalgam of technological innovations about the mitigation of GHG emissions, and the rapid, widespread transfer and implementation of these technologies. The transfer of technology for adaptation to climate change is important for reducing Bhutan's vulnerability, and this technological innovation must take place quickly and continue over a prolonged period of time. Such technologies should be environmentally sound, support sustainable development, and include indigenous knowledge. Moreover, adaptation capacity needs to be built at the national and sub-national levels.

Using VULNERABILITY ASSESSMENTS TO IDENTIFY CLIMATE CHANGE ISSUES

A vulnerability assessment helps determine whether a system is susceptible to climate change, and often provides a first step in identifying appropriate adaptation measures. A good assessment not only gauges climate-related risks, but also ascertains which risks can be reduced and which can be endured. Ideally, a vulnerability assessment can supply relevant scientific research, stakeholder engagement, policy and institutional analysis, and economic and development projections.

The assessment done for this project focused on a section of Wangchuck Centennial Park, in north-central Bhutan, with special attention to livelihoods and on natural resource management practices and policies that could support adaptation.

Since the project aimed to demonstrate how adaptation can be mainstreamed into conservation and development planning, the site chosen is one of Bhutan's 10 protected areas, but one with communities living within the jurisdiction. Wangchuck Centennial Park is the largest of Bhutan's protected areas and contains a diverse array of agro-ecological zones and ecosystems. The park covers five Dzongkhags with 10 geogs[1] . It is managed by WWF Bhutan, who facilitated the field work for this study. Figure 1 shows the maps of the protected areas in Bhutan.

There are 580 households in and around Wangchuck Centennial Park, with a total of about 3,400 people; 12% are yak herders; the rest are mostly subsistence farmers (WCP Draft Management Plan, 2011). The yak herders do not own any agricultural land and rely entirely on their yaks to provide milk, butter, cheese, meat and fur, which they barter for food rations or sell for cash. Herders have customary grazing rights over traditional grazing areas. However, these areas are not officially registered under their names. A 2010 survey counted 11,442 yaks within the park (WCP Draft Management Plan, 2011). The herds move to higher elevations in the summer and return to lower elevations in the winter. Other animals raised in the area include cattle, horses, sheep and poultry; their products are primarily used for daily subsistence.

The majority of agricultural land farmed by these communities falls outside of the park boundaries, with the exceptions of Zhabzethang and Nagsephel villages under Chhokhor geog. Thus, unlike in other protected areas, there is little agricultural impact on biodiversity. Planting patterns and crops vary among geogs and include wheat, barley, buckwheat (sweet and bitter), paddy rice, mustard, potatoes and vegetables, depending upon the altitude of the village. Potatoes are often grown for cash and exported to India.

Some people from outside the park collect biological resources from the park area; this is of some concern, but these people are still considered stakeholders and are allowed to collect forest products, including timber, for their own personal use from forests surrounding their village, as well as from other designated areas.

[1]Dzongkhag is the term used in Bhutan for an administrative district or province. A geog (also known as a gewog) refers to a group of villages in Bhutan, and is also the administrative term for the administrative sub-district within a Dzongkha

Snow covered mountains
Photo Credit | Phurba Lhendup

Figure 1: Map of protected areas in Bhutan

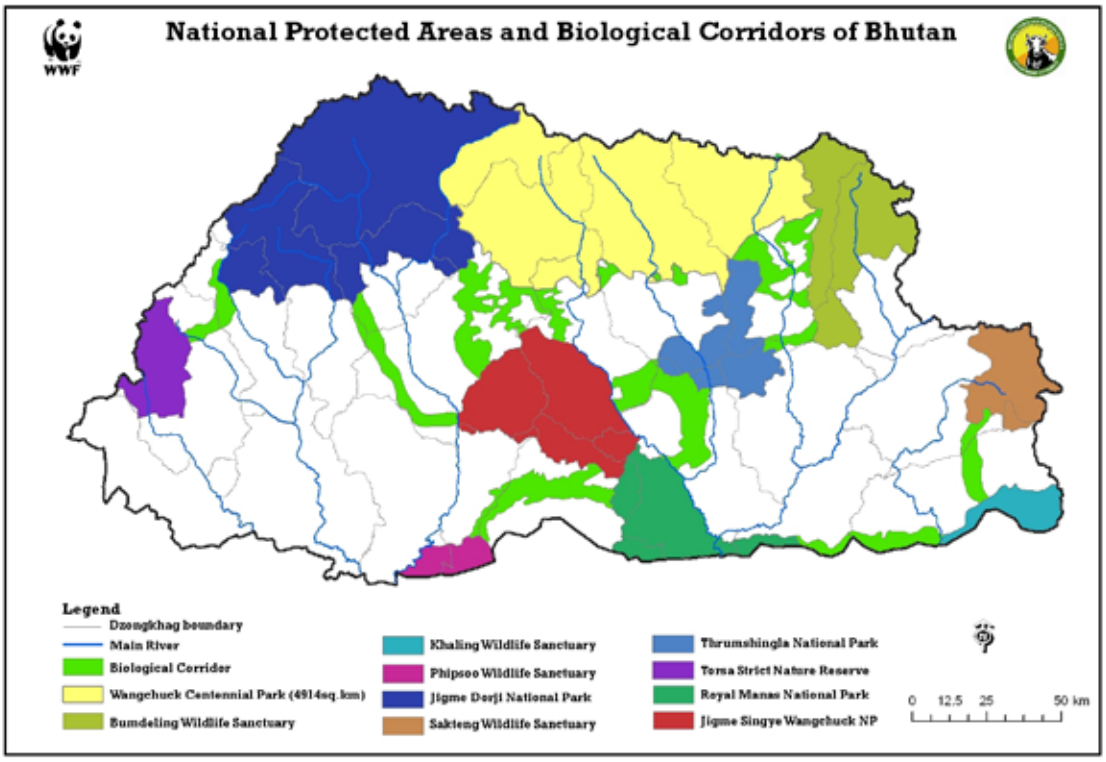


Figure 2: Map of Wangchuck Centennial Park, showing the study area

Survey sample

For this study, a representative sample of households from across Wangchuck Centennial Park was selected and surveyed (Figure 2). The results were then extrapolated for the entire park region. In order to gain a complete picture of climate change impact and vulnerability in the area, sampling covered all the major agro-ecological zones and vegetation zones. In total, three representative geogs were sampled (Table 2).

WWF Staff doing an interview
Photo Credit | Phurba Lhendup

Table 2: Sampling sites

Site category	Geog under the site	Agro-ecological zones	Vegetation zones	Altitude range (m)
Yak herders	Chhokhor and Sephu	Alpine	Alpine and sub-alpine	> 3500
Dry land farmers	Chhokhor and Sephu	Cold temperate	Mixed conifer forest	2000-2500
Wetland farmers	Nubi	Warm temperate	Cool broadleaf forest	1500-2500

Chhokhor geog

Chhokhor geog, located in the northern part of Bumthang Dzongkhag, is home to more than 600 households, including 220 in and around Wangchuck Centennial Park. The villages in the study were located between 2000m and 5500m above sea level. The primary socio-economic activities were farming and rearing livestock. The main food crops produced were wheat, barley and oilseed. The main cash crops produced were potatoes and vegetables. The villages within Chhokhor geog were located 10 to 25km from the Dzongkhag headquarters. All households are connected to feeder roads and have access to electricity, telecommunications, agriculture and livestock extension centres, basic health facilities, and schools.

Sephu geog

Sephu geog, in the northeastern part of Wangdue Dzongkhag, contains 283 households, which largely depend on forest resources. The terrain is mostly rugged, at 2800m to 5000m above sea level. Settlements are scattered, and some households are migratory in nature (yak herders). Households located close to roads have access to electricity, while others use wood as their main source of energy. The primary socio-economic activities are farming and rearing livestock. The main food crops are wheat, barley, buckwheat and millet, while predominant cash crops are potatoes and vegetables. The region has access to agriculture and livestock extension centres as well as basic health services and schools, although some farmers must travel more than a day to access these services. The geog is popular for its bamboo products such as baskets, ropes, mats and etchings, which are sold to people from other Dzongkhags.

Nubi geog

This geog is in the northern part of the Trongsa Dzongkhag, at 1500m to 2500m above sea level. The geog has 362 households, including 75 households within the park. The primary socio-economic activities are farming and rearing livestock. The main food crops are wheat, barley, buckwheat and millet, and the predominant cash crops are vegetables, including potatoes and chilies. Most households do not have access to electricity or roads. However, there are agriculture extension and livestock centres, basic health units and schools.

Across all three geogs additional livelihood activities included collecting cordyceps[2] for cash; working as a wage labourer on construction sites; and transporting goods in areas where there are no roads, for wage.

[2]An insect fungus collected from high-altitude areas

Data collection approach and methods

The research employed both qualitative and quantitative methods. Primary vulnerability data were collected at the community and household level through key informant household interviews and focus group discussions. In addition, researchers collected data by observing people's actions, situations and preferences and behaviour.

Key informant household interviews

Key informant interviews were conducted using surveys that asked questions about perceived changes in climate and weather patterns; the observations on which these perceptions were based; and the community's capacity to deal with these changes.

Respondents included men and women between 25 to 75 years of age, selected in consultation with local community leaders. A sample size of 10% per geog was maintained. In total, 68 people were interviewed across the three sites, including 25 yak herders. Table 3 provides more details on the respondents.

Table 3: Respondent details

Goeg	Total households	Total no. of respondents (10%)	Age range	Male	Female
Chhokhor	220	22	27-75	10	12
Sephu	283	28	28-70	13	15
Nubi	75	18	25-73	8	10
Total	578	68		31	37

Focus group discussions

The participants in the focus group discussions were chosen in close consultation with local community leaders in order to select those who knew about climate change and were able to discuss it. In total, 192 men and women participated (Table 4).

Table 4: Total number of participants in focus group discussions

Goeg	Male		Female	
	Count	%	Count	%
Chhokhor	43	41.0	35	40.2
Sephu	33	31.4	25	28.7
Nubi	29	27.6	27	31.0
Total	**105**	**100.0**	**87**	**100.0**

Participatory planning meeting in Jigme Singye Wangchuck National Park
Photo Credit | Phurba Lhendup

The discussions used a combination of participatory tools:

Hazard ranking was conducted in order to identify the various climatic hazards faced by local people and understand their current coping strategies. The hazards that people cited were ranked in terms of their perceived impact upon people's livelihoods.

Livelihood resource ranking was used to identify the most important livelihood resources among the community. This was done by listing all the livelihood resources and ranking them in order of perceived importance.

A vulnerability matrix was then used to determine the hazards that had the most serious impacts on the community's livelihoods, to identify vulnerable livelihood resources, and to identify current coping strategies. The most important livelihood resources identified were aligned vertically on the right hand side of a chart, with the most important resources at the top. Participants were then asked to align hazards horizontally, starting with the most hazardous. After listing and ranking the livelihood resources and hazards, the participants were then asked to determine the impact each hazard had on the corresponding resource, using a score of 0, 1, 2 and 3 (where 0=no impact, 1=a low impact, 2=a medium impact and 3=a significant impact).

A Venn diagram exercise was also used to identify the most important institutions to communities and analyze the engagement of different groups in the local planning process, access to services, and the availability of social safety nets. Boundaries for each village (in the form of an oval outline) were drawn on a chart, and participants were then asked to think of all the institutions and agencies that are located within their locality. These were then graded, based on the extent of service they provided to the community. The most important institutions were placed inside the village boundary (inside the oval) and the next most important institutions were placed along the village boundary. Finally, the least important were placed outside.

All the above information was then tabulated and analyzed. Quantitative information derived from the household survey was collated and then analyzed while the qualitative analysis of information generated in the focus group discussions and key informant interviews relied on graphing the responses.

Result and discussion

In the survey interviews, 91% of the 68 survey respondents said they had heard about climate change via the media (radio broadcasts, TV and other sources). Others had been informed through personal conversations. Eighty nine percent (89%) of respondents reported that they felt that the climate was changing.

Analysis of the key informant interviews showed that over time, the local communities had observed changes to climate parameters such as temperature, rainfall, snowfall and frost (Table 5). These changes had affected their livelihoods.

Table 5: Perception of changes in climate parameters identified from the responses of 132 key informants during focus group discussions in different geogs

Climate parameters	Climate is changing		No change		Unsure what the changes are	
	No	%	No	%	No	%
Temperature	29	22.0	2	1.5.	2	1.5
Rainfall	26	19.7	5	3.8	2	1.5
Frost	10	7.6	15	11.4	8	6.1
Snowfall	28	21.2	4	3.0	1	0.8
Total number of responses (N = 132)	**93**	**70.5**	**26**	**19.7**	**13**	**9.8**

Temperature

Speaking about temperatures, 22% of the key informants reported that temperatures had increased and they were now experiencing fewer cold days. However, they also said the minimum temperatures experienced in extreme cold events were more intense (with lower temperatures), although these cold events were now shorter. Physical evidence supports these perceptions: vegetables usually associated with lower altitudes can now be grown at higher elevations, and there have been changes in plant phenology, increased outbreaks of new plant and [domestic] animal diseases. Mosquitoes are also appearing in the Sephu and Chhokhor geogs. Heat waves were reported to be more prominent during the months of June, July and August.

Rainfall

Respondents said that rainfall had become erratic. For instance, sometimes the peak 'rainy season' was dry, whilst the 'dry season' was now characterized by occasional periods of heavy rainfall; 20% of key informants thought that the pattern of rainfall had changed and had become unreliable, 4% reported no change, and 2% said they didn't know. There were also reports of an increase in rainfall intensity and a decrease in the number of rainy days. In general, respondents said the intensity of rainfall had increased over the past 10 to 20 years. The onset of rainfall had also become unpredictable. In addition, people reported more incidents of hailstorms destroying crops.

Snowfall

The pattern of snowfall has also changed, according to 21% of key informants. Currently, snowfall starts in November, but it used to start in January and February. Snow falls more frequently than in the past, about seven times per year, rather than three, but the intensity of the snowfall has decreased. Snow accumulation is less than half of what it used to be, and it stays on the ground for only about three days, if not less. Key informants across the three geogs have also noticed changes to their surroundings; for instance, hillsides that were once covered in snow throughout the year were now often bare and dry.

Frost

Fewer key informants had noticed changes in frost patterns: 8% reported changes, but 11% did not; the remaining 6% said they didn't know. It was indicated that frost mainly occurred from December until the beginning of March. Those who stated that there was a change indicated that frosts now occurred from October to April with many gaps in between. In addition, they reported that the incidents of frost were occasionally more severe.

A river in Wangchuck Centennial Park
Photo Credit | Phurba Lhendup

Paddy farming in the buffer area of Wangchuck Centennial Park
Photo Credit | Phurba Lhendup

Impact on agriculture

Agriculture in and around Wangchuck Centennial Park follows traditional cultivation practices that rely on seasonal rain. Changes to the pattern of rainfall are therefore likely to have adverse impacts on livelihoods in most of these communities and increase their risk of food insecurity. An erratic rainfall pattern hampers the growth of crops and can also result in soil erosion, landslides and flooding and sedimentation downstream.

In the Chhokhor and Sephu geogs, wheat and barley are sown in February. This requires enough soil moisture for germination, which in turn is dependent on the previous year's snowfall. However, a reduction in winter snowfall has resulted in a soil moisture deficit that limits the potential increase in yield as a result from the increase in temperature. The change in the pattern and intensity of frost has also been damaging vegetables, which are just emerging when the last frosts occur. For example, a thick frost cover on the morning of 3 March 2011 in Bumthang destroyed most of the emerging paddy rice seedlings in local nurseries. People report that the timing and intensity of this frost was quite unusual.

Recent research has found that a greater temperature variance increases the risk of frost damage (Rigby and Porporato, 2008). This trend is likely to continue; although the length of periods of frost is likely to shorten, the associated decrease in snow cover would increase the likelihood of the ground freezing (Venäläinen et al. 2001). In addition, the onset of the cropping season is marked by incidents of hail, which damages germinating seedlings and remove the flowers and buds of more mature plants. Respondents in the Sephu geog reported that hailstones are now as large as marbles. Meanwhile, in some southern towns, car windshields have been broken by hail.

The problem of pests and diseases similarly appears to be on the increase. People reported a high incidence of pests such as ants in potatoes, trunk borers in rice and wheat, and fruit flies. Cut worms eat through the stem of cabbage and chili seedlings above ground, and feed on potato and turnip below ground. Some crops also are affected by diseases such as citrus greening and by fungal diseases which infest vegetables and even paddy. The increase in the incidence of pests has led farmers to use more pesticides, which in turn harms ecosystems. There is also a fear that traditional pests and diseases of lowland ecosystems may eventually affect hillside and mountainous areas.

Responses from local people and accompanying field observations indicated that invasive weed species such as *Galingosa parviflora*, which appeared around five years ago in Sephu and Chhokhor geogs, is becoming more prevalent, competing for space in vegetable gardens. Another new weed species, *Tagates minuta*, was reported in the Chhokhor geog. This species occurs along the edge of the fields, but does not have a serious impact on crops.

Predicted climate change impacts can also be positive. Temperature increases and improved humidity could expand the arable land in the higher latitudes of the northern hemisphere (Zhang and Cai, 2011). Therefore, the impact of climate change on agriculture was found to be mixed. Respondents were happy with the possibility of growing new crops, especially vegetables, to supplement their diet and raise extra cash income. Historically, in Sephu and Chhokhor geogs in Bumthang, radish, turnip and onion were grown, with the addition of small amounts of lettuce. However, over the last 10 to 15 years, farmers have started growing vegetables such as chili, beans, peas, cabbage, cauliflower, brinjal, cucumber, and more recently, tomatoes. In the Nubi geog, squash also has been introduced.

Impact on livestock

Livestock feed in and around Wangchuck Centennial Park is provided through forest grazing and crop by-products. Livestock provide a wide range of services and products, including power, manure, wool and supplementary nutrition. Despite the environmental hardships, the diversity of livestock remained rich and varied, with approximately 11,422 yaks, 6,271 cattle, 873 horses and 531 sheep (WCP Draft Management Plan, 2011).

Rising temperatures and changes in rainfall patterns appear to have increased the spread of vector-borne diseases and macroparasites in animals, alongside the emergence and spread of new diseases. Local people have also observed an increase in the populations of some common livestock insects, including lice, fleas and ticks, which cause cattle to become weak and unhealthy, reducing production of dairy products. The incidence of foot-and-mouth disease has also increased. An unpalatable weed species (*Taraxacum officinale*, the common dandelion), has invaded most of the pastures in Tang Chudtod village (Chhokhor geog). As a result, livestock are no longer able to graze in these areas, and the grass cannot be harvested to make hay for the winter.

In March 2009, 20 yaks were reportedly killed by avalanches in the northern part of Sephu geog. In this instance, people believe that the snow was no longer able to hold the yaks' weight. In addition, smaller avalanches occur quite frequently in the northern part of Chhokhor geog, destroying the yaks' trails.

Impact of climate change on glaciers and glacial lakes

The 25 yak herders interviewed clearly indicated that the rate of glacier retreat is increasing. In addition, new glacial lakes were being formed, while some glacial lakes were disappearing. Figure 3 shows changes to a glacier in the northern part of the Wangchuck Centennial Park area known as Rinchen-zoe La, which is monitored by Bhutan's Department of Geology and Mines. A comparison of the picture taken in 1984 with the one taken in 2009 shows the glacial retreat can be seen as well as a small glacial lake that has formed.

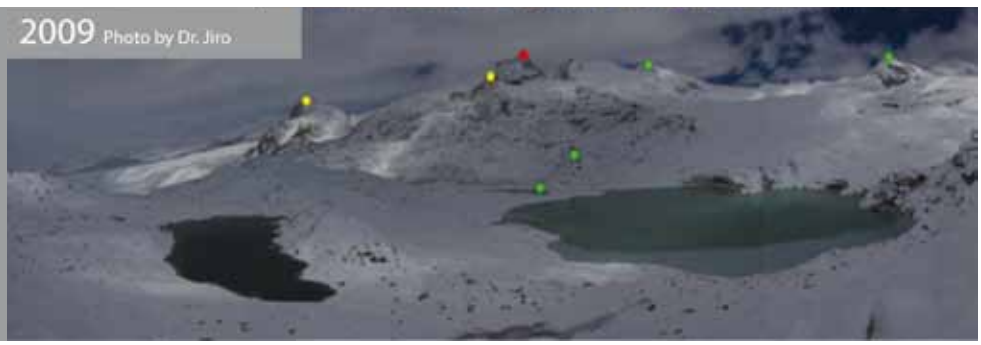
Figure 3: Retreat of Rinchen-zoe La glacier

Northern side of Rinchen-zoe La

In1984, no water body

After the formation of Lake, rapid retreat observed

Roughly 500 m retreat in 25 years (high retreat rate)

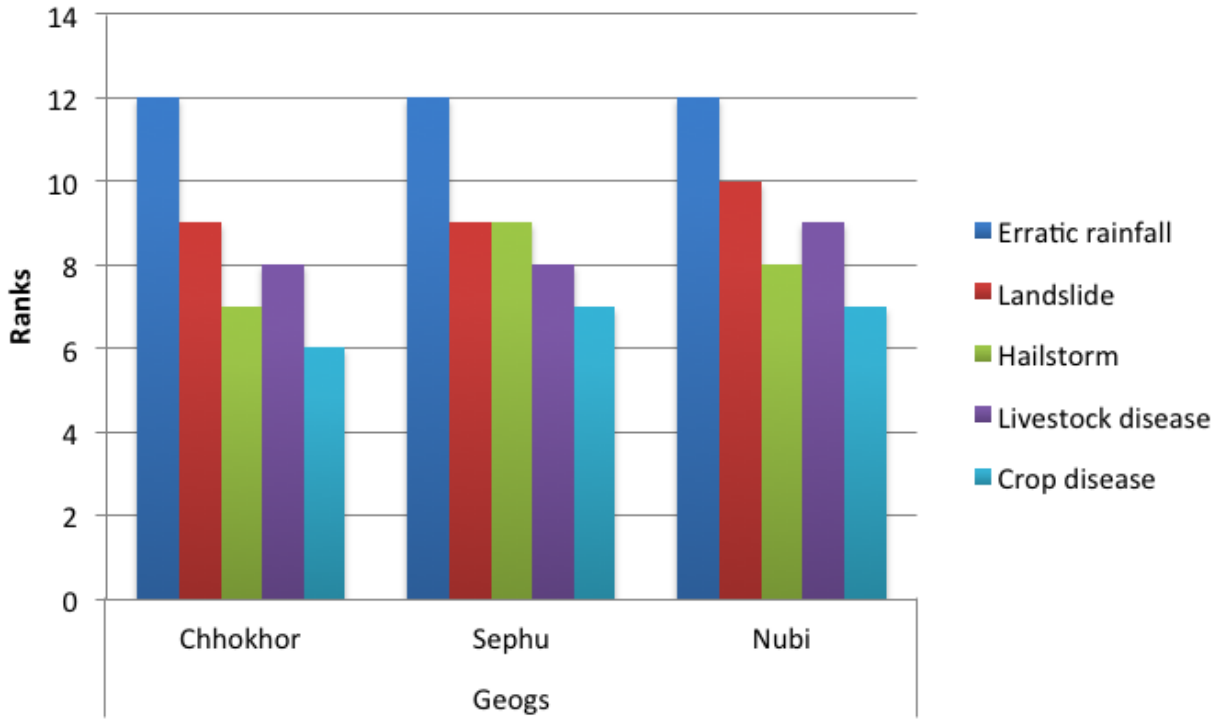


Courtesy : Department of Geology and Mines, Bhutan

Perception of climate-related hazards and impacts

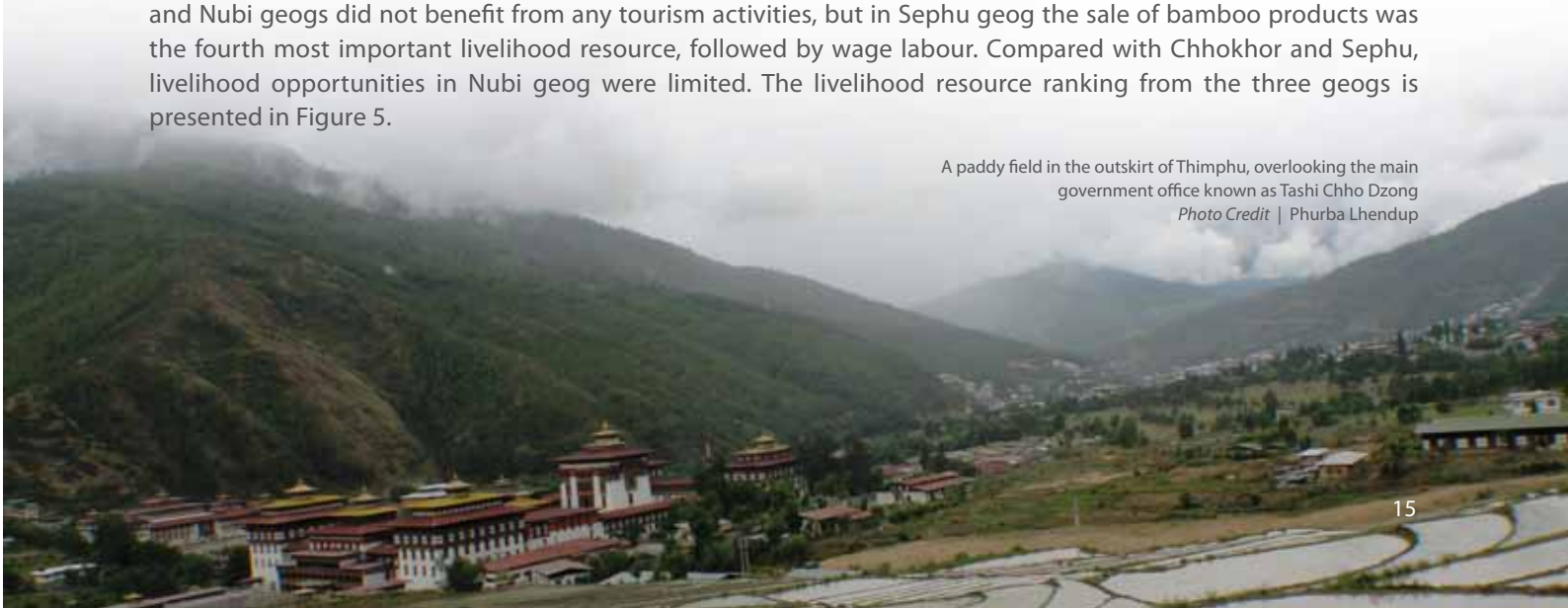
Focus group discussions with local communities suggested that erratic rainfall, landslides, hailstorms, livestock disease and crop diseases are seen as the most important hazards related to climate change. Erratic rainfall was considered to be the most hazardous impact of climate change faced in all three areas. This was closely followed by landslides, which are connected to the erratic rainfall. The impact of hailstorms is higher in Sephu, which is at a higher altitude. Hazards perceived as minor included flash floods, human disease, avalanches, frosts and erratic snowfall. Hazards in each locality were ranked based on their intensity of impact upon the most important livelihood. Figure 4 shows the hazard ranking in the three areas.

Figure 4: Hazard ranking based on local perceptions



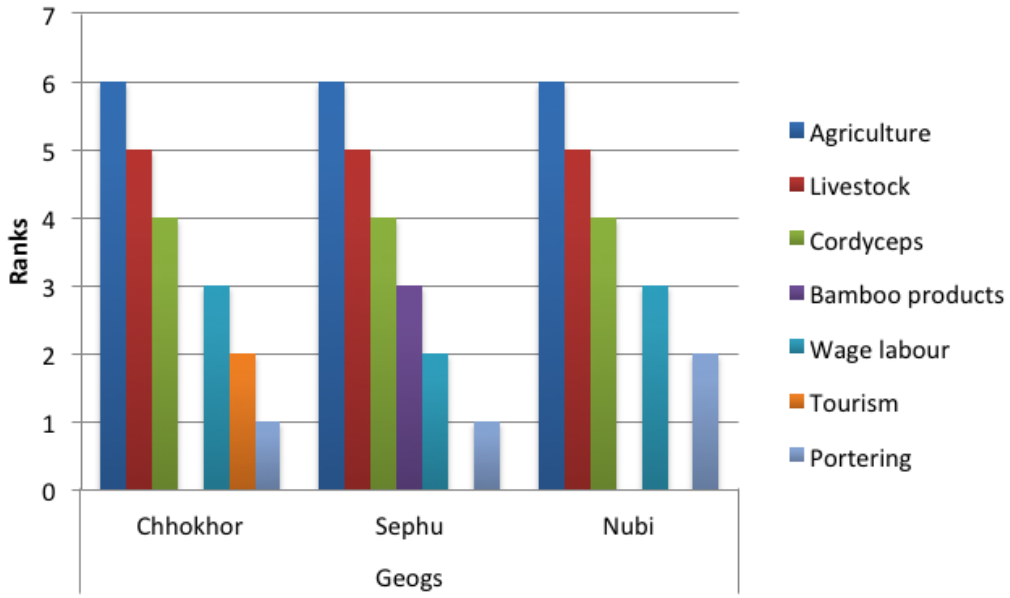
Vulnerability of community livelihood resources

To understand the vulnerability of the communities' livelihood resources, individual livelihood resources were identified and ranked according to community perceptions. Agriculture, livestock and cordyceps were ranked as the three most important livelihood resources in all geogs. In Chhokhor geog, construction wage labour was the fourth most important livelihood resource; tourism also provided remuneration, through the sale of local products and the employment of local people as porters, cooks and guides to tourists. Porters were hired by government officials and construction companies in all three geogs, particularly in places without motorized transport. Sephu and Nubi geogs did not benefit from any tourism activities, but in Sephu geog the sale of bamboo products was the fourth most important livelihood resource, followed by wage labour. Compared with Chhokhor and Sephu, livelihood opportunities in Nubi geog were limited. The livelihood resource ranking from the three geogs is presented in Figure 5.



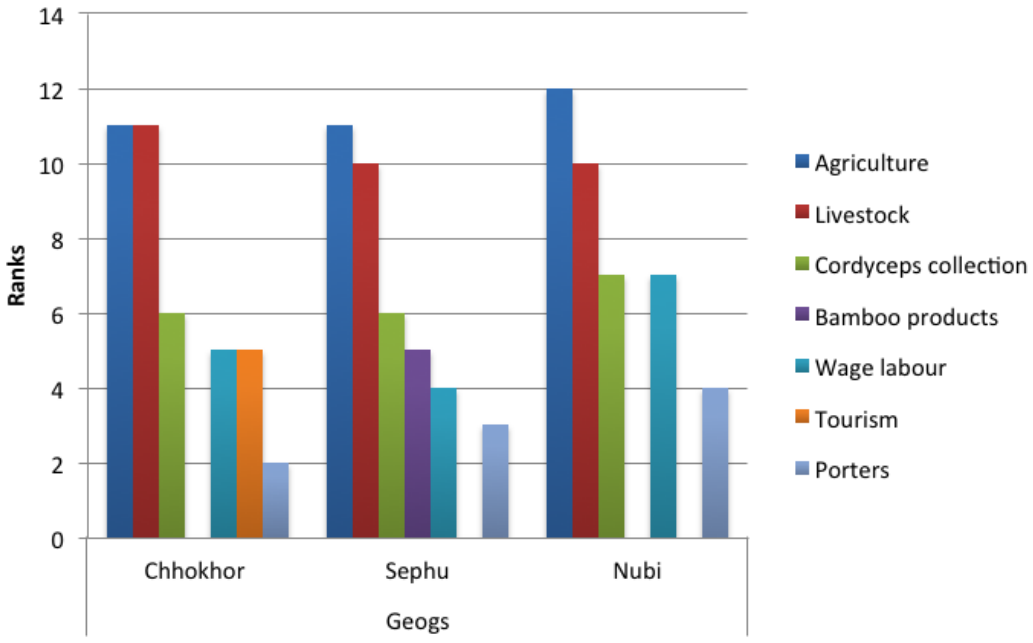
A paddy field in the outskirt of Thimphu, overlooking the main government office known as Tashi Chho Dzong
Photo Credit | Phurba Lhendup

Figure 5: Livelihood resource ranking in the three geogs



The focus groups and vulnerability matrix revealed the most vulnerable livelihood resources to climatic hazards in all three areas, as shown in Figure 6. The top three were also the three most important livelihood resources: agriculture, livestock and cordyceps collection, which were ranked first, second and third respectively. Vulnerability in Nubi geog was found to be the greatest, followed by the Sephu and Chhokhor geogs.

Figure 6: Livelihood resource vulnerability in the three geogs



Nubi geog's main food crop is paddy, which requires very large quantities of water; an erratic pattern of rainfall is affecting its cultivation. People also reported that their paddy fields had been washed away due to landslides. Ten years ago, Nubi's most important cash crop was chili. In fact, entire households grew chill on a large scale, which they then dried and sold or used for barter with other geogs during the winter. However, a few years ago, the entire crop was wiped out by chili wilt and an unknown disease. Some people think that this disease could have been introduced via imported hybrid chili seedlings, whilst others thought that an increase in temperature created favorable conditions for the disease. The agriculture extension office was contacted, but so far, no cure has been found.

An ecotourist lodge built by WWF in the Royal Manas National Park
Photo Credit | Phurba Lhendup

In addition to these major losses, people in Nubi have no tourism revenue to fall back on. The majority of the villages in the geog also have no access to roads or electricity. Therefore, in extreme climate events, it is likely that the people of the Nubi geog will be the most severely affected.

Sephu geog was found to be the second most vulnerable after Nubi. Here, only a few villages are near roads and have access to electricity. Bamboo products (mats for hut construction and fencing; baskets, ropes for cattle and fences) are a major income source, and an abundant supply of wild bamboo made this possible for generations. However, the bamboo has started to die; people as old as 73 years have reported that this is unprecedented.

It is a natural phenomenon for bamboo to die after flowering and seeding. In fact, the flowering of bamboo is considered a botanical enigma and the factors responsible are still not clearly established (Jeeva et al., 2009). Bamboo flowers once, and then dies after seeding. It therefore takes a few years for new bamboo plant to appear. This leaves behind bare, exposed soil which can be disastrous in mountainous regions (ibid.), due to erosion.

Vulnerability among households

Although no detailed studies were made on household income levels, the majority of households appear to have low incomes. The Intergovernmental Panel on Climate Change *Fourth Assessment Report (IPCC, 2007)* notes that the poor are the most adversely affected by climate change, due to their level of exposure and the impacts on their livelihood assets.

Households at all income levels have been affected by climate change in the study area, but poor households have had greater difficulties adapting, due to factors such as education level, income, access to information, options and opportunities. For example, wealthier households had the ability to buy seeds that can adapt to the new conditions in their localities (tomatoes, cabbages, cauliflowers) and also could secure insecticides and chemical fertilizers. This was not the case for poor households. Similarly, in the case of livestock, richer households generally kept cattle breeds that could graze local pastures. Poorer farmers remained dependent on large herds of traditional breeds that required forest grazing or less nutritious fodder and which fought diseases, especially forest ticks, and in turn, further reduced productivity. In the case of yak herding, richer households kept greater numbers of yaks and could easily replace them if they died. Poorer households had fewer yaks. Therefore, in many ways, poorer and marginalized groups of people were the most vulnerable to the impacts and changes brought about by climate change.

Institutional arrangements

This study also revealed a lack of institutions conducting climate change activities, especially raising of awareness. In general, local people were aware that the climate was changing, but did not appear to know the reasons why. The United Nations Development Programme (UNDP), under the project Regional Climate Risk Reduction, has trained some local communities in Chhokhor geog on climate risk reduction, but mostly focused on minimizing the risks presented by glacial lake outbursts and earthquakes. No meetings or training programs were conducted for adaptation. However, since adaptation activities are not that much different than those of traditional services provided by local institutions, it appears that some level of adaptation and coping activities have already being mainstreamed.

In the Venn diagram session that mapped and ranked institutions according to their proximity and importance, local residents rated the Renewable Natural Resources sector, which incorporates the extension offices of agriculture, livestock and forestry, and the Basic Health Unit, as most influential in their lives. The agriculture extension office provides subsidized farm input supplies and conducts land management training programs. The livestock extension office attends to livestock services: most importantly, the annual livestock vaccination. The forestry extension service helps people plant trees in degraded areas and in embankments on landslide-prone areas. Therefore, as mentioned above, some amount of adaptation is already mainstreamed into traditional services, although the term 'climate change adaptation' is not used specifically. Table 6 shows the findings of this group discussion.

Table 6: Local institution ranking (from Venn diagram)

Primary institutions	Secondary institutions	Tertiary institutions
Renewable Natural Resources institutions (agriculture, livestock and forestry)	Bhutan Power Corporation	Tourism: all tourist guest houses and agents
School: secondary, primary and community schools	Central Machinery Unit (CMU)	Bank of Bhutan (BoB)
Basic Health Unit	IMTART (Indian Military outpost)	Royal Insurance Corporation of Bhutan (RICB)
Geog Administration (Gup Office)	Wangchuck Centennial Park (WCP)	World Wildlife Fund (WWF)
Bhutan Development Finance Corporation Ltd. (BDFCL)	Renewable Natural Resources Research Centre (RNRC-Jakar)	
Royal Bhutan Army (RBA) outpost	Natural Resources Development Corporation Ltd. (NRDCL)	
Nunnery School		

Current coping strategies

The majority of local people did not appear to have a clear idea of coping and adaptation strategies. This indicated a lack of awareness and knowledge and also contributes to a limited preparedness to potential climate-change impacts. Despite this, some communities seem to have adopted certain measures. Farmers had changed their cropping patterns and more varieties of vegetables are now grown. For instance, in Chhokhor and Sephu geogs, buckwheat (bitter and sweet) has been replaced by potatoes. The latter change was reported to be due to the commercialization of potato crops, although some people reported that the buckwheat production had declined. In Chhokhor geog, community focus had shifted from the cultivation of cereal crops and intensive farming to subsistence vegetable farming. In Nubi geog, some communities introduced pipes as a means of transporting irrigation water, instead of the traditional direct open drainage irrigation sources that are prone to evaporation and damage by landslides. Some communities had also started using greenhouses to cultivate vegetables (tomatoes, onion leaves, coriander and lettuce) to protect them from frost.

Since the natural pastures and other grazing areas in the forest are shrinking due to land degradation, some communities had started rearing improved breeds of cattle rather than large herds of traditional breeds. These improved breeds are stall-fed or graze close to the households. A socioeconomic survey conducted in 2010 revealed that there were 1308 improved cattle in Chhokhor geog, 306 in Sephu and 115 in Nubi. In addition, yak herders now move to alpine areas earlier in order to escape the heat and also remain there for longer. During the time spent in the alpine areas, yak herders maintain the trails and build small temporary bridges for transportation in case the streams become engorged during the monsoon season.

Information on the predicted changes to weather patterns is crucial in timing when farmers plant their fields. However, ordinary farmers do not have access to the appropriate technologies. Local institutions could collate this information and share it through their networks.

Proposed ADAPTATION STRATEGIES

Climate change is a cross-cutting issue affecting all sectors. Hence, adaptation measures require an integrated approach across agriculture, water resources management, soil and forest conservation and management, disaster risk reduction, and strategies concerned with the diversification of community livelihoods. It is essential to mainstream climate change into all development sectors, with a view that climate change and its impacts can affect development and vice versa. Many of the adaptation strategies proposed below are based on the vulnerability assessment conducted in Wangchuck Centennial Park, but they are more broadly applicable.

1. Raising awareness of the causes of climate change and its impact

Climate change has affected Bhutanese livelihoods for some time, yet the vulnerability of livelihoods to climate change has not been sufficiently studied. This review found that the communities who are likely to be the most affected had a very limited understanding of the causes of climate change and climate change impacts in remote areas. Rural communities already had a good understanding of local climate patterns and were accustomed to dealing with them, but future climate change scenarios are predicted to be uncertain and possibly more extreme. Current local practices, processes, systems and infrastructure that have already been used to adapt to the existing climate variability could also become increasingly unsuitable. This is further aggravated by local perceptions and interpretations of climate variability among communities and also within different social groups.

Greater community awareness is required to help reverse these trends and increase local resilience. Likewise, an increased awareness of the causes of climate change will help encourage the communities to take part in climate mitigation activities: protecting forests, collecting trash, turning off electronic items when not in use, and planting trees in critical areas such as river banks, and watershed areas. Awareness activities will also help enhance the adaptation planning process by identifying the problems related to climate change, and gaps in interventions including the use of local knowledge and practices.

2. Diversifying livelihood resources

Diversifying livelihoods is a priority issue, because some livelihood options may be lost with climate change; for example, as noted above, communities in Nubi geog can no longer cultivate chili due to the outbreak of disease. Meanwhile, people in Sephu geog are witnessing the death of their bamboo forest, which was once a major source of cash income.

An alpine grassland in Wangchuck Centennial Park
Photo Credit | Phurba Lhendup

3. Diversifying agricultural crops

Agriculture will continue to be a key part of rural people's livelihoods and should therefore be supported as the climate changes. With families growing larger, landholdings growing smaller, and the effects of climate change being felt, it is likely that fields that would traditionally yield enough for families will no longer be adequate. Soil productivity has also diminished as a result of inappropriate soil management. Therefore, crops need to be diversified to include those that can perform well under erratic rainfall and water conditions. Grain crops are the priority, so if a crop species fails to perform, farmers automatically turn to the next preferred grain crop.

If annual crops fail, farmers should be encouraged to go for perennial crops, including fruit, and crops that can withstand erratic weather conditions. Promoting organic pesticides and fertilizers will increase production, as yields are reduced due to changes in the climate and the incidence of pests and pathogens. Organic pesticides can be produced with materials available from farms that will not damage the condition of the soil.

4. Sustainable land and soil management

Soil and land management policy will also need to build the resilience of agricultural land to an excess of water due to increased rainfall. It also will need to respond to a lack of water. The organic content of soil should be conserved through low tillage and the maintenance of soil cover. This practice will improve and stabilize the soil structure, allowing soils to absorb higher amounts of water and thus preventing soil erosion and flooding. Crop rotation should also be encouraged to maintain permanent soil cover. Crop residues and cover crops will increase the organic content of the soil and reduce the impacts from flooding, erosion, drought, heavy rain, and so forth.

5. Livestock intensification program

Livestock husbandry is one of the most important livelihood activities, and so a livestock intensification program could provide local people with more options for income generation. Dairy products such as milk, butter and cheese comprise the major part of the Bhutanese diet (although current production is not able to meet public demand). Community-based dairy farms in areas such as Nubi, could therefore be very viable options, while, the supply of hybrid Jersey bulls is another potential option.

6. Promotion of fruit and fodder trees in the villages

As revealed by this study, local people generally rely on farming and rearing livestock as their main livelihoods. This exerts pressure on already degraded forests. People often have to travel far from their villages to graze their cattle, resulting in conflict with wild predators. Thus, communities are

Melting glaciers in Wangchuck Centennial Park
Photo Credit | Phurba Lhendup

beginning to turn to improved livestock breeds that require less manpower, but need to be stall-fed. This requires the production of fodder and the farming of native fodder tree species. Training about planting and husbandry, as well as distributing seedlings in collaboration with forestry and livestock extension agents in each geog, are also essential. The planting of fruit trees around houses and along the periphery of fields will create additional income-generating opportunities as well as improving nutrition levels.

7. Local capacity-building

Another necessity is to increase the capacity of local leaders and their communities to make informed decisions concerning the different crop and livelihood options. Before planning any intervention, a proper assessment of the impact of climate change is essential. Adaptation measures such as crop diversification, crop and livestock insurance, and risk transfer mechanisms should be developed in order to minimize the risks associated with climate change.

8. Linking with relevant institutions

The study's institutional mapping process provided information about the existing institutional capacity in the three study areas. As a result, it is strongly recommended that future interventions work through this network in order to optimize the targeting of community needs and to minimize set-up costs. The most important institutions are those concerned with agriculture and livestock extension and local administration offices.

9. Mainstreaming adaptation into geog development plans

In order to identify the key climate change niche risk areas, vulnerability assessments and mapping should become an integral part of geog development plans. The integration of development plans in promoting adaptation strategies is also important. A geog development plan should incorporate strategies and actions and promote community-based adaptation. Local leaders should also be encouraged to consider the long-term impacts of climate change when working on five-year plans.

10. Building ecosystem resilience

Extensive research is required on opportunities and constraints for the conservation of biodiversity and the risks and vulnerabilities posed by climate change. These should focus on which species may be lost and why, and on the implications of these impacts for the livelihoods of communities. The results and recommendations of these should be mainstreamed into the wider WCP conservation management plan.

The integrity of the ecosystem should be maintained by conserving niche ecological systems, corridors, and forest and wildlife resources. Additionally, integrated natural resource management practices should be implemented, such as integrated watershed management in order to improve fragmented resources, ensure access and provide benefit sharing mechanisms through the payment of environment services. Adaptation measures concerning land use and landscape management, agro-forestry and species selection, and silviculture practices in different ecological zones should be introduced. The existing protected area network system also needs to be strengthened to prevent further habitat fragmentation that could obstruct the adaptive migration of species.

11. Local disaster risk reduction initiatives

Small-scale disaster risk reduction efforts, such as building embankments, establishing plantations in barren and degraded areas, and repairing infrastructure should be prioritized at the community level. These could contribute greatly to minimizing the effects of climate change. Training on these activities, including low-cost measures using locally available resources, should be the priority at the community level.

Conclusion

Farmers thrashing wheat in Tang Chudtoed Village in Wangchuck Centennial Park
Photo Credit | Phurba Lhendup

Communities in and around Wangchuck Centennial Park have shown that they are already experiencing increased temperatures and erratic rainfall patterns, as well as changes to the intensity of frost and less snowfall. These assertions were supported by a number of indicators such as the invasion of weeds, the outbreak of pests and diseases, landslides, soil moisture deficiency, and so forth. These changes have made sectors such as agriculture and livestock, the main sources of livelihoods in the region, increasingly vulnerable. Poor and marginalized households become particularly vulnerable as they are less able to respond (due to a lack of education, income, information and knowledge, and a lack of access to adaptation options and opportunities). Among the three study sites, Nubi geog was found to be most vulnerable due to a limited number of alternative and viable sources of income and a lack of developmental activities.

Local knowledge, practices and innovations are important elements of community-based coping and adaptation mechanisms. Changes to cropping patterns, the choice of crops, and the use of embankments to prevent landslides are already under way, yet these are constrained by the resources, expertise and knowledge available. Other areas, such as forestry and rearing livestock, had relatively fewer innovations and practices in place to deal with climate risks and hazards. There was also limited awareness, knowledge and capacity in the study areas at the local level, in terms of understanding climate change scenarios, addressing issues, and conducting long-term planning.

The study found that no dedicated institutions dealt with climate-related issues in the study areas, nor were any institutions (agriculture, forestry, livestock, and health) aware of climate change and its potential impacts. Therefore, the deliberate mainstreaming of adaptation into their regular activities is almost nonexistent. There is a need to build the awareness of these groups to the threats posed by climate change and how they can provide technical and financial support to vulnerable communities. A shift towards sustainable land management and strengthening agriculture systems is recommended as a short-term adaptation strategy, while research and development, technology transfer, financing and stakeholder mapping are suggested long-term adaptation measures.

Bhutan, despite having the world's second lowest per capita GHG emissions, has demonstrated an ongoing commitment to confronting the challenges posed by climate change. The impacts of climate change are already evident and will continue to manifest themselves well into the future. Adapting to these impacts will be critical for the future of the people, economy and ecosystems of Bhutan.

One widely suggested strategy is to mainstream adaptation into development planning, but a great deal of work still needs to be done. Currently, there is no specific national policy or program for adaptation and mitigation in Bhutan, apart from the National Adaptation Programme of Action. There is an urgent need for a framework to guide and facilitate the implementation of measures for Bhutan to not only remain carbon-neutral, but also address the impacts of climate change.

The results of the vulnerability assessment also present a compelling case for parallel courses of action to address gaps in climate change knowledge and to implement specific programmes to increase the adaptive capacity of ecosystems and communities alike. The main priorities established in this report include increasing the capacity of local institutions to provide information and resources about hazard mitigation, climate change preparedness, crop diversification, and the management of water to communities. The path forward will require a consultative process, where continuous feedback concerning climate change from assessments can be integrated into roadmaps for conservation and development planning.

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Participatory hazard mapping in Sephu geog
Photo Credit | Phurba Lhendup

A wheat plantation in Gyetsha in the district of Bumthang, near Wangchuck Centennial Park
Photo Credit | Phurba Lhendup

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