

Impacts of and Vulnerability to Climate Change in Eastern Bhutan

“Even the lamas cannot make it start or stop raining.”

Introduction

Bhutan is an entirely mountainous country. It is culturally and geographically distinct from its neighbouring Himalayan states, and was isolated from the outside world to a great extent up to the 1960s. The total population is 690,000 (VVB 2009) and society is predominantly matrilineal. The rural economy has been transformed from a purely subsistence to a semi-subsistence cash economy as a result of the high priority placed by the government on the agricultural sector. The special characteristics of Bhutan can be used to generate a more comprehensive understanding of climate change and its impacts in the Himalayan mountains.

Study Area

Three villages were studied in each of two districts (dzongkhags) – Pemagetshel and Trashi Yangtse – in Eastern Bhutan, the poorest part of the country (Table 10). More than 85% of the households in Eastern Bhutan are agrarian; they are particularly disadvantaged in terms of connectivity (Hunzai 2011), an important factor in determining poverty and vulnerability. The villages are at different elevations and differ in access to markets and roads and especially in access to water.

Bhutanese women have the presumptive right of land ownership in a matrilineal system with property controlled by an ‘anchor mother’ and passed on to female family members. The government provides free education and health services as well as an entitlement of agricultural land given for subsistence purposes. Nevertheless, 38% of the population in Pemagetshel lives below the poverty line (USD 1.08 per day), and 24% in Trashi Yangtse (RGOB 2007). The lower poverty in Trashi Yangtse may result from productive yields from more fertile land, as well as from widespread collection of yarshagumba (*Cordyceps sinensis*), a high value NTFP.

Table 10: Villages surveyed in Eastern Bhutan

District/Village	Altitude (masl)	No. of HHs*	Distance to next market (walking minutes)	No. of in-depth HH interviews
Trashi Yangtse				
Tarphe (with Cheng and Drongney)	2,350	24	360	9
Tsaling	1,900	45	15	9
Khamdang	1,500	155	0	9
Pemagetshel				
Gompasingma	2,000	20	30	9
Shali	1,200	60	20	9
Khangma	1,100	100	180	9

masl – metres above sea level; HHs = households

*Number of households estimated by local informants; the houses are scattered over a wide area and numbers are not exact

Communities' Perceptions of Change

Windstorms were seen as the greatest weather-related hazard by farmers in Eastern Bhutan. Storms are particularly destructive to maize – one of the primary food crops in the study area. Respondents felt that storms had increased over the past years, causing increasing damage to property and crops. Storms generally start in March and are extremely unpredictable, frequent, and intense. Almost every community in the study area experienced this as the greatest threat to farmers.

The villages studied in Pemagetshel suffered chronic water shortages as they lie far from sources of water such as rivers or streams and are highly dependent on the monsoon, which brings 60–90% of annual precipitation. Villagers thought that rainfall had greatly decreased, severely affecting the rain-fed agricultural systems. “We used to have plenty of rain in the off-monsoon seasons and now even the monsoon rain has decreased to half the usual amount”, claimed one respondent. Of the villages studied in Trashi Yangtse, two received ample rainfall throughout the year whereas one, Khamdang, faced an acute shortage. Khamdang is located in a rain-shadow area and used to limited precipitation, but even there the general feeling was that precipitation over the last decade had become scarcer and that winter precipitation had disappeared. The other two villages were at higher altitudes than most of the villages in the study and had experienced increasing rainfall. This would match findings of previous studies on climate change in the eastern Himalayas (Sharma et al. 2009) which observed increasing rainfall at higher altitude.

The most observable change seemed to be the increased unpredictability and variability of weather patterns. The monsoon onset was late in some areas, and early in others. “There is no rainfall by the time it would usually come. The young maize plants in the field keep drying up and we have to plant them over and over again!” exclaimed one respondent. Some communities in Trashi Yangtse noted variable monsoon rains and sudden heavy showers interrupted by dry periods, which hampered the growth of crops requiring continuous precipitation. The magnitude of hailstorms and hailstones appeared to have increased, but the incidence had decreased.

Farmers thought that temperatures were rising, particularly in winter. Older inhabitants speculated, “We often wonder what is going on, is the sun falling down towards the Earth or is the heat in the house caused by the metal roof?” Snowfall was less in the high altitude villages in Trashi Yangtse, which might also indicate warmer temperatures.

Comparison of perceptions of change with climate records

Aggregated climate and precipitation records were obtained from two hydro-meteorological stations, one in Trashi Yangtse at 1,830 masl and one in Pemagetshel at 1,618 masl. Data were only available from 1996, too recent for any climate trend analysis; the temperature and precipitation graphs are given in Annex 2. The data show the overall interannual variability of rainfall and temperature in both districts. There had been slightly less rainfall in the 3 years before the survey than immediately before that, but there was no clear overall trend. There is some indication of an increase in temperature in Trashi Yangtse between 2002 and 2010 and Pemagetshel from 2002 to 2007, but higher temperatures were recorded in both places before this period.

Without weather data from the actual village sites, longer-term data, or analysis of intra-annual differences, it is not possible to make a proper comparison of villagers' observations with climate records. But there is some indication that participants' responses mainly reflect comparisons with the most recent years, rather than long-term observations.

Impacts of Change on Livelihoods and Community Wellbeing

Unpredictable harvests

The variability of weather patterns has led to unpredictable harvests. Although households are mostly food sufficient, yields are affected by changes in rain patterns, temperature, and storms; disturbances from wildlife; and lack of labour. Wind and hailstorms are a big hazard and can destroy harvests such as maize. The communities studied did not have access to river water and were dependent on rainfall. Most fields were not irrigated, which limited production when rains did not arrive in the expected amounts at the expected times.

Pests and disease

More exotic plants (weeds) are appearing in fields and suppressing plants that could be used as fodder. Pests and disease in crops are of increasing concern to farmers. Blight in potato and chilli, which are major food crops, affected a large area of production, possibly a result of longer than usual rains increasing the chances of infestation. Citrus greening, transmitted by psyllid bugs ('jumping plant lice'), was affecting orange trees, leaving the fruits small and green and killing the trees. Numbers of wildlife, particularly wild boar but also porcupines and monkeys, have increased owing to a ban on hunting of wild animals, as well as a ban on shifting cultivation (as animals used to get scared by the fires and now have more places to hide with vegetation growing back); wild animals are causing increasing damage to maize and potato crops. Although human health statistics have improved with government services and outreach clinics, respondents reported more headaches and stomach aches. Increasing numbers of mosquitoes have also been observed over the last 5 years.

Workloads and labour

Most farming activities were conducted on time, but with some slight variation depending on the specific rain pattern. Farmers in Pemagetsel were sowing early, with early rainfall, and harvesting early. Harvesting was also preponed at times to prevent the crop rotting. Wage labour often complements farm work in the off-season when less labour is required for agriculture, especially for poor households that need income to purchase food. Some respondents remarked that they have less leisure time than before. Rural-urban migration is also an increasing trend. In 2004, nearly one-quarter of Pemagetsel's population, and at least one member from more than half of all rural households, had migrated to urban areas (mostly Thimphu) (RGOB 2004).

Emerging opportunities

Higher temperatures and increased precipitation in the high altitude villages of Trashi Yangtse had led to better crop yields. Orange trees flower earlier and are growing at higher elevations (almost 1,000 m higher), providing more opportunities for farmers. There was a similar altitudinal shift in exotic flora, previously found only at lower elevations and in the southern region.

Community-Based Responses to Change

Spirituality and religion are very important in the districts studied as in other parts of Bhutan. Local deities are invoked when rain is delayed or limited, when hazards affect crops and livestock, and for human health. Variability is difficult to prepare for and adjust to. However, farmers do use certain strategies to the best of their abilities.

The main responses to climate and socioeconomic change in the study area are summarised in Table 11 and discussed in more detail in the following paragraphs.

Religious coping mechanisms

Praying and performing rituals for local deities was the most common coping strategy reported by almost all the farmers interviewed. Rituals could include walking naked with painted faces, walking to nearby villages for three nights, or simple pujas (ceremonies) requesting local deities to bring rain. Most villagers felt completely helpless when there was too much rain, whereas rites were reported to be helpful in the case of too little rain. "Not even the lama can stop the rain", commented a 70-year-old resident of Pemagetsel. In the belief that trespassing on certain sacred forest areas angers deities, residents were banned from accessing these areas to prevent storms.

"We have no coping mechanisms as such, but we perform religious rituals to protect our crops and livestock if there is too little water, extreme temperatures, or hail or windstorms, and if we get sick. This traditional measure is sometimes sufficient. If pests or disease attack crops, we spread ash after we perform rituals. The head of the household usually takes the initiative to perform the rituals and each household deals with its problems individually. Often the community as a whole performs the rituals for the local deities. If the trouble concerns many households then we report it to the local agriculture or livestock extension office and ask for help."

– Tawrang, aged 48

Table 11: Community response to perceived change in East Bhutan

Perceived change	Experienced impact on livelihood systems	Response to change
Erratic precipitation patterns	Decline in agricultural productivity	Religious rituals Changes to agricultural calendar: delayed or early sowing and harvesting of crops Changes in crop varieties and types Introduction of new crops Increased engagement in wage labour Collection of NTFPs (e.g., yarshagumba)
	Crop failure	Re-sowing of crops (seeds provided by the government) Consuming food distributed by government Buying food from market Take loans
Overall decreased water availability	Decline in agricultural productivity	Religious rituals Pumping water from nearby springs Rainwater harvesting Afforestation of catchment areas
Too much water	Loss of harvests	Construction of side drains to divert water
Increased frequency of windstorms	Destruction of crops Damage to houses	Ban on trespassing in sacred forests Mixed cropping, for example beans and maize Tying roofs to the basement of the house or to trees
Increase in pests and disease	Reduced production	Traditional pest management strategies (spreading cow urine and ashes, crop rotation, and intercropping) Early planting and harvesting of crops to escape attacks Introduction of organic pesticides such as <i>Artemisia</i> Increased use of chemical pesticides Introduction of resistant varieties Introduction of post-harvest management technologies to avoid insect attacks
Increasing temperatures	Health issues (headache stomach ache, more mosquitoes)	None
	Beneficial conditions for crops	More than one crop or shorter cropping cycles Introduction of off-season vegetables
	Orange trees flower early	Orange trees grown at higher altitudes (up to 1,000 m higher)

Changes in agricultural practices

Communities have been found to adapt the agricultural calendar annually in response to the increasingly erratic precipitation patterns. Sowing and harvesting times are adjusted according to the onset of precipitation as well as to prevent rotting. Seedlings dry out when rain is insufficient, and crops are sometimes destroyed by natural calamities. Maize and other cereals (barley, wheat, buckwheat, and millet) and vegetables are re-sown if there is enough time for a crop to ripen. The seeds for re-sowing are usually distributed by the government.

In Bhutan, government institutions are strong and reliable partners for farmers and regularly provide them with services. These institutions are making considerable efforts to improve rural people's livelihoods and support them in adapting to changing conditions. For example, new crops have been introduced in particular areas to assess their adaptability and yield potential. Upland rice from Nepal has been introduced in high-altitude areas of Trashi Yangtse and communities are now food-sufficient year-round. Cash crop production – ginger, cardamom, oranges, potato – has been

encouraged in areas with potential for such crops, particularly focusing on poorer households. Also, a new concept of off-season vegetable cultivation has been introduced in order to increase farmers' income.

The Ministry of Agriculture supports application of chemical spray pesticides if crops are damaged by epidemic pests. When this is unsuccessful, seeds are replaced with resistant varieties. The government also strongly supports organic fertilisers and pesticides such as manure and *Artemisia* spp.

Traditional and new cropping technologies are taught by agricultural extension officers including early planting to escape pest/disease infection and subsequent rotting. Crop rotation (alternating different types of crops on the same piece of land on a yearly basis) has also been revived.

Specific strategies for storing produce have also been promoted in order to prevent destruction by insects (potato in Pemagetsel). Households have been helped to build structures with electric air circulation systems. Training on crop storage emphasising hygiene and proper aeration is provided to farmers. Farmers now prefer to dry chilli crops with electrical dryer systems as the quality is higher than with traditional methods – drying is uniform and the colour is retained.

Responses to too little water

Various approaches have been used to address problems of too little water. Where possible, trees have been planted around water sources. Local administrations have promoted a number of activities to protect catchment areas, including fencing and running awareness programmes on the effects of deforestation. The government also introduced rainwater harvesting in schools in 2007 and in communities in 2009. Rainwater is collected in a big tank and used for cattle, washing clothes, and to water vegetables in kitchen gardens.

Although the government has provided taps and water supply schemes, some users still face problems as a result of house location or the number of taps from a single source. One group in Pemagetsel had invested in an electric water pump to pull water from a nearby stream at a lower elevation, and now has sufficient water.

Livelihood diversification

Collection of NTFPs such as yarshagumba (*Cordyceps sinensis*) is a lucrative activity and households that have procured trade licences for these products are becoming wealthy. There is strict monitoring of the trade and collection of such products. The government issues special permits for these activities to ensure sustainability of harvests. Wage labour in off-farm activities is also widespread, for example in gypsum mining, road construction, production of cultural and religious items, and hand weaving.

Responses to natural and economic stress

Side drains have been built on sloping fields to divert water when strong rains set in. As a reaction to the increase of strong windstorms, people protect roofs from being blown away by tying them to the basement of the house or to nearby trees. Some crops, such as maize, are protected through mixed cropping – beans are planted next to maize so the climbers provide additional support to help the maize withstand wind

This roof has been tied to a tree with a rope to protect it from windstorms



and the roots make soils more fertile by fixing nitrogen. During food shortages, respondents reported that they would take loans in the form of cash or credit from wealthy neighbours or stores.

Differences in Vulnerability and Adaptive Capacity

Bhutan's unique geography and social structure are the main factors determining poverty and vulnerability to climate change. Gender, ethnicity, class, and literacy play a role, but somewhat differently than in other parts of the Himalayas.

Bhutan's Buddhist traditions and values consider men and women to be equal. In 1981, at its inauguration, the National Women's Foundation declared that the women of Bhutan had already come to enjoy "equal status with men, politically, economically and socially" (Savada 1991). But there is a differentiation in roles, for example more women than men are involved in agriculture (68% and 36%, respectively, in Pemagatshel). Eastern Bhutan has a high poverty rate compared to the rest of the country, which appears to be mainly influenced by social status, as indicated by literacy rates (Hunzai et al. 2011). Women's literacy rates in the study area were lower than men's (31% compared to 61% in Pemagatshel, and 45% compared to 64% in Trashi Yangtse). Literacy is important in the search for off-farm opportunities (aside from wage labour). With climate change and the reduction in harvests, other opportunities will have to be sought and the lower literacy rates for women in Eastern Bhutan will eventually affect their adaptive capacity.

Assets and lack of access to basic facilities also determine poverty in Eastern Bhutan. Although the government provides free basic education, the rural poor cannot always afford school uniforms or textbooks, or the cost of losing children's labour, and are thus less likely to be educated. Financial, physical, and social assets are crucial in adapting to climate change, for example in changing professions or introducing new seeds and improved agricultural technologies. Richer households can purchase more fertile land as well as fertiliser. Land belonging to poorer households is comparatively less fertile and the poor cannot afford either fertilisers or labour to collect leaf litter and forest topsoil to enrich their fields. Poor households also have less livestock to provide manure. Thus the resilience and adaptive capacity of poor farmers is limited.

Eastern Bhutan is also disadvantaged in terms of connectivity, especially to the centres of administration and commerce. Greater proximity to roads is generally associated with lower incidence of poverty and improved access to infrastructural services, which mainly exist in urban centres (Hunzai et al. 2011). The government has invested heavily in infrastructure and outreach services and is specifically targeting the poorest districts, but the rugged terrain, remoteness, sparse population, and lack of reliable communication facilities hinder the delivery of services (e.g., health services) in rural areas. Of the six villages studied, only one was located in a market area; farmers from the others had to walk between 15 minutes and 6 hours to reach the nearest market. Road and market access are crucial for farmers to be able to sell products to supplement their incomes.

Institutional Opportunities and Constraints

Informal institutions

Informal institutions such as monasteries and nunneries are important structures for the Bhutanese in terms of coping strategies, providing spiritual support. Rituals to please local deities are the primary coping mechanism and are performed by monks. Assistance from external institutions is only sought if the rites and donations to monasteries fail to rectify the situation.

Government institutions

The Government of Bhutan has been proactive in providing services to its citizens, investing in health care, agriculture, infrastructure, and others. The Ministry of Agriculture offers concrete support to improve agronomic practices including pest and disease management, planting techniques, and post harvest management. The government also offers direct support for crop damage – replacement seeds if the crop fails around planting time, food if the crop fails later. Farmers deal with their problems individually unless the problem is a community concern, at which time the local administration will be informed and the message passed on to regional and national level agencies. Respondents felt that their

workloads had decreased drastically with the provision of electricity and water. The government's campaign to ensure road access to every mid-level administrative centre (Geog) by 2013 will ease transportation problems and help in the sale of agricultural and other products, which will help livelihood diversification. The provision of meals at schools for students also ensures food security for children.

There are still weaknesses, however. The agricultural sector has been promised free water supply, including the labour and equipment to provide it; however, in practice, poor households located at the end of a water source may receive little or no water. The government has introduced new seeds and has had some successes, for example, maize plants were shorter and more storm resistant. However, some seeds have proven more prone to pests. Further, there may still be some discrimination; some community members believed that "only rich householders get good material to replace their roofs after a storm has blown them away, while poor farmers like us get simple plastic sheets". Equitable access and provisions, with priority given to poor households, is fundamental to build trust and reduce conflict.

Climate Change Policy

Bhutan was one of the first countries to develop a NAPA, completed in 2006, and has recognised the need to integrate climate change concerns and adaptation strategies into national and sectoral development plans such as the Tenth Five-Year Plan (2008–2013). Most of the nine identified priorities in the NAPA focus on disaster risk reduction. The projects target disaster management, GLOFs, floods, landslides, and forest fire management; few address long-term strategies for adaptation, but there is strong emphasis on climate change adaptation within the Tenth Five-Year Plan. Bhutan recognises the importance of managing the natural resource base for sustainable socioeconomic development. It has integrated policies and strategies aimed at managing the fragile mountain ecosystem and developing an economy based on niche products through approaches such as engaging communities through cooperatives, recognising traditional knowledge systems and agricultural practices, and enacting strong environmental protection laws.

Conclusion

Residents of the eastern districts of Bhutan have yet to experience any severe climate-related changes, and the changes there are relate more to variation and lack of predictability than to any clear trend. This might explain why relatively few coping and adaptation mechanisms were identified. Furthermore, with a small population and a strong and stable government, even people living in the remotest areas of the country can count on government support. This may reduce the need for communities to develop individual responses. Nevertheless, Bhutan will not be exempt from the impacts of climate change, and international and national research institutions need to monitor, document, analyse, and disseminate climate data so that appropriate adaptation measures can be proposed. Awareness raising on climate change will be essential at every level – from local households to national officials – in order to develop a common understanding on causes, impacts, and strategies. Finally, Eastern Bhutan is particularly vulnerable as a result of the high rates of poverty, low human capital, high dependence on agriculture, and low accessibility, and the government will need to continue to target this region.

