

# Poverty and Climate Change: How the Rural Poor Tackle Water and Temperature Stress in Uttarakhand

*"It does not rain when it should and it will rain when it should not."*

– 43-year-old man from Uttarakhand

## Introduction

Uttarakhand, formerly Uttaranchal, is a scenic but poor mountainous state in northwestern India, formed on 9 November 2000 after separating from Uttar Pradesh. Almost half of Uttarakhand's population live below the poverty line; the majority in hill areas where they depend on agriculture for their livelihoods. As agriculture is highly weather dependent, communities in the state are strongly affected by climate-related variability and change. The vulnerability of Uttarakhand's rural population to climate and socioeconomic change stems from a number of factors, especially dependence on ecosystem services, high levels of persistent poverty, marginalisation, and social inequality. In the 3 years from 2008 to 2010, Uttarakhand received less-than-normal rainfall which affected harvests and adversely affected the livelihoods of the majority of the state's population (WFP 2010).

## Study Area

Focus group discussions and interviews were carried out in June/July 2010 in four villages situated at different altitudes and of varying accessibility in each of two districts – Almora and Tehri Garhwal (Table 3). The people in these districts still follow a predominantly traditional lifestyle mainly dependent on agriculture, animal husbandry, and seasonal processing of forest products, and are guardians of a vast body of local knowledge. Besides climate variability and change, they are exposed to rapid socioeconomic changes that impact on their livelihoods, including increasing rates of male outmigration and the associated feminisation of agriculture.

**Table 3: Villages surveyed in Uttarakhand**

District /Village	Altitude (masl)	No. of HHs*	Distance to road (minutes)	No. of respondents interviewed in each wealth category				
				1	2	3	4	Total
Almora								
Natadol	2,100	209	75	4	4	4	4	16
Naikena	1,800	37	60	4	4	4	4	16
Gud Gadoli	1,200	27	120	5	4	4	3	16
Udiyari	1,100	42	15	1	7	4	4	16
Tehri Garhwal								
Kurn	1,850	203	180	4	4	4	4	16
Karn	1,300	37	120	4	5	6	1	16
Pali	700	60	15	4	4	4	4	16
Srikot	400	48	15	4	4	4	4	16

masl = metres above sea level; HHs = households

\*Source: GOI 2001

Table 4: Sources of income of respondents in different wealth groups

Source of income	Household wealth category								
	1 – Extremely poor		2 – Poor		3 – Marginally poor		4 – Other		Average
	A	TG	A	TG	A	TG	A	TG	
Agriculture alone	14.3	0.0	21.1	5.9	25.0	5.6	6.7	0.0	10.2
Remittances	0.0	6.3	0.0	17.7	25.0	44.4	33.3	69.2	23.4
Other (e.g., salary, business)	0.0	0.0	5.3	5.9	0.0	0.0	20.0	0.0	3.9
Agriculture and labour	85.7	93.8	73.7	70.6	50.0	50.0	40.0	30.8	62.5

A = Almora; TG = Tehri Garhwal

Analysis of data from the India National Sample Survey 2003 showed that poverty in Uttarakhand was much higher than the Indian Himalayan region average (Hunzai et al. 2011). Close to half of both rural and urban households in Uttarakhand were below the poverty line of USD 1 per day as compared to 17% in the remainder of the rural Indian Himalayan region; half of household heads were uneducated; and 34% of household members were illiterate. Close to 85% of the population was involved in agriculture.

The residents of the two districts classified themselves into four categories of economic status using their own criteria: Category 1 – extremely poor, Category 2 – poor, Category 3 – marginally poor, and Category 4 – other. The numbers interviewed in each wealth category are shown in Table 3. The sources of income identified by the different wealth groups are summarised in Table 4. Of the poorest families, 86% of households in Almora and 94% in Tehri Garhwal were dependent on a combination of agriculture and labour as their main source of income, but only 40% and 31% of the wealthiest households. The better off households thus appear to be comparatively less vulnerable as they depend on more diversified sources of income such as businesses, salaries, and remittances.

## Communities' Perceptions of Change

*"Sometimes it is difficult to distinguish between the various seasons. Even October is as warm as June."*

– a resident of Almora

Information on perceptions of change was obtained from the detailed interviews and also in larger focus group discussions. Regardless of the socioeconomic status of the households, water was seen as the most important resource required in agriculture. Given that arable land, and especially irrigated land, is a scarce resource in mountains, it is not surprising that in a society characterised by caste and class differentiation, the proportion of poor households with access to irrigated land was extremely low. Farmers without irrigated land depend solely on annual rains. In the past, some communities had adapted their agricultural activities to make use of the small amounts of rainfall falling in the non-monsoon months, but according to the communities, this phenomenon had now ceased almost completely. The winter precipitation is crucial for recharging groundwater. Some springs had dried up completely, affecting the availability of water for people, livestock, and irrigation. Overall rainfall was thought to have declined, but at the same time, there were more periods of high intensity rainfall, which can lead to floods, landslides, and soil erosion, as well as being associated with high surface run-off and limited infiltration of water to underground aquifers. The major observations are summarised in Table 5 and discussed in the following.

Winter precipitation has become extremely erratic and unpredictable. Instead of winter rains, some communities reported that it now rained in March/April when the winter crop is ready for harvest, causing the cereals to rot. Villages at high altitude used to have moderate to heavy snowfall in December to March, with up to 1 metre (several feet) of snow that would lie for a long time. Currently, it only snows for 1 to 2 months and with low intensity. It has not snowed in Almora for 3 to 4 years. Medium altitude villages that were accustomed to moderate to low snowfall now receive very little, if any. Snowmelt used to be an important source of water for agriculture as it extends the availability of water from precipitation for long after the precipitation event.

Table 5: Perceptions of change in Uttarakhand

Aspect	Almora	Tehri Garhwal
Annual precipitation	Significant reduction in duration; severe decline in amount; erratic, more intense events	Extreme reduction in duration; severe decline in amount; erratic, more intense events
Monsoon	Significant delay in onset and early completion	Significant delay in onset and early completion
Winter precipitation	Severe reduction in amount and delay in onset; erratic and unpredictable; severe reduction in snowfall (complete absence over the past 3–4 years)	Severe reduction in amount and delay in onset; erratic and unpredictable; high reduction in snowfall (now almost nonexistent)
Dry season	Severe extension of duration; high increase in intensity	Severe extension in duration; high increase in intensity
Temperature	Higher in winter and summer; more warm months	Higher in winter and summer; more warm months
Frost	Decline in duration and intensity	Decline in duration and intensity
Hailstorms	Decrease in incidence	Decrease in incidence
Crop disease and pests	Unprecedented increase	Unprecedented increase

The dry season has become longer, in line with the lack of precipitation. In 2006/07 and 2008/09 there was almost no winter rain and farmers in Uttarakhand experienced drought-like conditions. This could explain the strong perception of the communities that dry spells that usually lasted less than 2 months had now extended to more than 7 (Tehri) or 8 (Almora) months long. Farmers also attributed an increase in incidence of forest fires to the prolonged dry spells; fires are degrading the forests near villages and preventing natural regeneration by damaging the germination and growth of seedlings.

There was a significant perception that the temperature had increased with warmer summers and milder winters. People in all the communities studied felt that the warm season had been prolonged by several months and observed an overall increase in the intensity and frequency of hot days.

## Impacts of Change on Livelihoods and Community Wellbeing

The communities ranked prolonged dry spells and increase in temperature as having the most significant negative impact on their livelihoods. Increased attacks by insects and pests, forest fires, and landslides were identified as the major weather-induced hazards. Widespread crop damage by wild animals (wild boars, monkeys, porcupines, and other herbivores) was also attributed to forest degradation, partly associated with changes in the climate.

Positive impacts associated with changes in weather patterns included a decline in the duration and intensity of frost, less damage by hailstorms, and, in some communities, an overall decrease in the frequency and intensity of storms.

Agriculture is dependent on a proper combination of weather and associated factors, and is thus highly vulnerable to climate change – any slight change can have a severe impact on the yield of staple and cash crops. Close to 85% of the population of Uttarakhand is directly or indirectly dependent on agriculture for subsistence and income (Hunzai et al. 2011); the reduction in harvests greatly impacts food security and the ultimate source of income for these households.

## Anything affects a harvest

Lack of sufficient water immediately decreases the agricultural harvest. Similarly, the timing of rainfall is important – a delay in the monsoon forces farmers to delay the sowing of rice, especially on rainfed fields, and the yield declines considerably. Conversely, incidences of intense rainfall erode the nutritious topsoil, cause landslides that destroy farmland, interrupt roads and thus access to markets, and lead to loss of life and property. Changes in precipitation can also affect the incidence of pests. Farmers reported a significant increase in kurmula (white grub) over the past 5 to 7 years, damaging major cash crops such as potato, other tubers, kidney beans, pulses, and vegetables, and reducing cash income. Lack of snow was thought to be the cause because heavy snowfall kills the eggs; warmer

temperatures might also be conducive to the growth of this pest. As harvests fail, communities are becoming dependent on external markets. Previously, households could rely on two types of cereals to fulfil their basic needs for at least 11 months of the year, but now some respondents said that they only had enough food to last for 2 to 3 months of the year. However, this should not only be attributed to climate change. Among others, high rates of male outmigration and the associated reduction in workforce had led to widespread fallowing of land.

A new phenomenon observed in Uttarakhand was double flowering of apple and Malta orange trees, leading to two harvests in a year. This adversely affected fruit quality; fruits were smaller and less tasty (and not fit for sale). "Over the past few years the climate has changed drastically. There is very little snowfall and the weather has become quite warm and it seems that this is affecting the flowering pattern of apple and Malta trees here", reasoned a villager. Horticulturalists are concerned that the double fruiting could result in crop losses and impair the overall health of the orchard, as it prevents the trees from recuperating between crops and makes them weaker.

## Women work more

Nearly two-thirds of respondents (61%) thought that an increase in male migration rates was leading to increased feminisation of agriculture, which was increasing women's workloads. Around 80% believed that they have to travel longer distances to fetch fodder – the burden of fetching fuel and fodder falls solely on women. Similarly, drinking water has to be carried from the nearest springs (some of which are drying up) or someone has to wait in a queue of 2–3 (or more) hours at the tap, another responsibility adding to the workload. Measures to counter the impacts of climate change – for example, repeat sowing in the event of crop failures; spreading traditional and chemical fertilisers and pesticides; walking longer distances to fetch water and fodder – are all activities implemented by women and adding to their regular workload. The limited number of oxen available for ploughing in the villages (and the inability to afford to rent these animals) is compelling women to use shovels to plough their fields. However, land is increasingly left uncultivated as a result of both high levels of outmigration and decreasing productivity. Changes in animal husbandry practices (moving from bigger to smaller ruminants) have reduced the time required to tend them from the previous 3–4 hours to 1.5 hours a day, relieving some of the workload for women.

Conversely, as household food production is becoming insufficient, more food needs to be purchased from the market, and men, as the main cash income earners, are driven to seek wage labour wherever possible, adding to their workloads.

## Health and nutrition suffer

Occurrence of disease and illness is perceived to have increased. Common ailments include colds, fever, jaundice, typhoid, and kidney stones. Elders believe that the warmer temperature is conducive to germs. Unused to purchasing market food, communities do not trust bought grain and suspect that chemicals used in the production process could also be causing illness. Traditional knowledge of medicinal herbs to treat sickness is fading, and the plants are also being lost as a result of forest degradation and overexploitation. The drying up of springs adds pressure to the remaining springs and this could be leading to water pollution, explaining the increase in water-borne diseases. Women suffer the most when households lack adequate quantities of food – they consume food after serving the men and children and might have to sleep hungry. Accidents are also becoming more common as women travel farther to fetch fuelwood and fodder, and have to climb steep slopes and slippery ridges.

## Community-Based Responses to Change

Mountain agriculture has traditionally been highly dynamic, with farmers continuously having to adjust to extreme environmental and climatic conditions over time. However, farmers have been unable to adjust agricultural processes to the fast pace of change in weather patterns experienced in recent years. They are mainly adopting short-term measures to cope with climate stresses; adaptive measures are difficult to introduce in agriculture without extensive financial and physical resources.

The main responses to climate and socioeconomic change in the study area are summarised in Table 6 and discussed in more detail in the following paragraphs.

Table 6: **Community response to perceived change in Uttarakhand**

Perceived change	Experienced impact on livelihood systems	Response
Erratic precipitation	Decline in agricultural productivity	Changes to agricultural calendar: delayed or early sowing and harvesting of crops Changes in crop varieties and types Increased engagement in wage labour Labour migration
	Crop failure	Re-sowing of crops Buying food from market Reduced meals Barter
Overall decreased water availability	Less flow in springs and streams; drying up of springs; lowering of groundwater levels	Re-adoption of traditional water management systems Catchment area protection Replacing large livestock with smaller species Less land area under cultivation Walking longer distances to fetch water
	Reduced soil moisture	Mulching
	Decline in agricultural productivity	As above
Decreased or absent winter rains	Decreased yield from winter crops (decline in agricultural productivity)	As above
Increased frequency of intense rainfall events	Soil erosion and landslides	Watershed management: afforestation
Increase in pests and disease	Reduced production	Traditional pest management strategies (spreading cow urine, salt, or ashes; crop rotation; setting fields on fire) Setting up 'kurmula' (white grub) traps Increased use of pesticides
Increasing temperatures	Health issues (increased incidence of vector-borne diseases)	Use of medicinal plants if available Increased reliance on western medicine
	Beneficial conditions for crops	More than one or shorter cropping cycle Introduction of new crops at higher altitudes (e.g., peanuts, mango, banana)
	Double flowering of orange and apple trees diminishing fruit quality	None
Warmer and shorter winters with less snowfall	Beneficial conditions for certain crops	As above
	Increased incidence of pests and disease	As above
Reduction in available workforce	Increased workload for those left behind	Less land under cultivation Move from big ruminants to smaller livestock

## Responses to erratic rainfall and reduced water availability

In response to erratic rainfall patterns, farmers were adjusting their agricultural calendar on a yearly basis by delaying or advancing the sowing of rice and other crops that depend on the monsoon precipitation. Winter crops such as potatoes and wheat were also planted earlier or later in some places depending on the arrival of the winter rains. Farmers reported that in 2009/10 they had planted their winter crops up to 30 days late in expectation of rain. As a result, the harvesting of these crops also had to be delayed to allow for maturing. When there was an early season crop failure because of inadequate rainfall, households that could afford a second batch of seeds either re-sowed the crop or replaced it. Rice was replaced with soybean, mustard, pulses, or madira (fodder grass); maize with soybean or vegetables; and mandua (millet) with pulses, soybean, or potato.

In the past, communities in Almora had had a traditional irrigation system with water sharing rules and regulations using ghuls (water channels), but this mechanism had fallen out of use. Following the lack of rainfall and prolonged dry spells, this traditional rotational irrigation system has now been revived. The system fulfils everyone's needs and eliminates conflict over shared water. However, farmers situated at the end of the ghuls, mainly from the lowest economic strata, reported that they had to postpone sowing of rice by between 15 and 30 days while waiting for their turn for water, and this adversely affected their harvest. Another response to decreased water availability was protection of catchment areas by planting oak trees around spring catchments near villages.

Aajeevika (an IFAD funded project) distributed improved seeds of numerous vegetables such as eggplant, tomato, and capsicum, which are tolerant to water stress and germinate well giving a high yield despite dry conditions and lack of water. Unfortunately, other seeds provided for millets, pulses, and beans gave only mediocre results. The same project also provided *Aloe vera* plants, which thrive in arid and semi-arid conditions.

## Living with rising temperatures

As a result of rising temperatures, potatoes were found to mature faster and could be harvested in 3 to 3.5 months instead of the traditional 5 to 6 months. This additional time offers new opportunities to farmers and was successfully used to grow cauliflower and peas as cash crops for a higher income. Other new crops introduced included ginger and turmeric, both because they withstand water and temperature stress better, and because they are popular cash crops which fetch a good price in the market. In addition, prolonged growing seasons now allow for more than one crop cycle per year and rising temperatures were found to be suitable for new crops, such as ground nuts and fruits such as mango and banana, which were described as being larger and better tasting and even fit for sale.

## Combating the increased incidence of pests and disease

Traditionally, ash, cow urine, and salt have been used as pesticides but their effectiveness appears to be decreasing as illustrated by the drastic increase in pests. Fires are lit post-harvest to kill insects and pests but can also kill earthworms and other microorganisms beneficial to the soil. "Earlier, traditional methods of pest control like spraying of salt or ash were effective in controlling the pests, but now, because of the increase in pest infestation, these methods have become ineffective," said Ram Singh from Gud Gadoli village in Almora. Chemical pesticides have been more effective in reducing crop pests and damage, but according to the farmers, their effectiveness is also reduced after 2 to 3 years of use. Uttarakhand Parvatiya Aajeevika Sanvardhan Company (UPASaC), created to implement Aajeevika, is providing ingeniously designed traps that have been used successfully to attract and kill kurmula (white grub).

## Dealing with environmental and socioeconomic change

Cornhusks and leaves are being used as alternative fuels to reduce the hard work of collecting fuelwood as this resource becomes increasingly scarce. Farmers reported that medicinal plants were also rarer, possibly as a result of a combination of overexploitation and forest degradation, and thus people have become more dependent on more costly western medicine.

Changes in livestock composition had also been made in order to cope with fodder and water scarcity and the reduced workforce resulting from the high levels of outmigration. Households were reducing the number of large ruminants and focusing on rearing goats, which require less labour, fodder, and stall feeding; goats also have more than one offspring per litter and offer increased gains for farmers.

When agricultural yields were insufficient for household needs, small/marginal farmers traditionally supplemented their incomes through wage labour on other farms or by rearing other people's livestock. With decreasing agricultural productivity, the number of people in search of wage labour is increasing, while the demand for wage labour has fallen, and farmers have to look for work in nearby markets or towns. Decreasing agricultural productivity is also an important push factor for seasonal and rural/urban migration. At the same time, the tourist season appears to have lengthened with the lengthening of the summer in the Uttarakhand mountain areas, providing more income-generating opportunities. Young people in particular are shifting to non-farm activities – roadside eateries near tourist circuits,





Excessive dependence on agriculture influences the vulnerability of poor households

taxi driving, and other small businesses – disillusioned by agriculture and attaching little value to it. This phenomenon appears to be mainly due to changes in norms and values, but climate change is an aggravating factor.

## Differences in Vulnerability and Adaptive Capacity

Socioeconomic and sociopolitical factors also play a role, in addition to the geophysical environment, in determining the vulnerability and adaptive capacity of communities.

The poorest households' excessive dependence on agriculture predetermines their vulnerability. Literacy and an educational background are also crucial in seeking other professions or income opportunities in the endeavour to adapt to changing conditions. Among the four income categories, only 35% of the respondents in the extremely poor category were literate, compared to 51% in the wealthiest category. Wage labour was seen as the only livelihood option apart from agriculture for the non-literate. The relationship between poverty and literacy is a vicious cycle: Poor households do not have access to higher education or vocational training (or even basic education in some cases) since they cannot pay the costs, whereas the wealthy can afford to send their children to nearby towns or cities for higher education. In addition, the poorest households had the fewest migrants and thus the least access to financial remittances as well as to new skills, knowledge, and other strategies for improving wellbeing.

The low incomes of the poor also resulted in low savings. In Tehri Garhwal, the average monthly income of people in Category 1, the poorest, was INR 969 (approximately USD 20) compared to INR 13,000 (around USD 265) for those in Category 4, the wealthiest. With this income, it is difficult to even meet daily requirements and savings are

practically non-existent. The lack of financial capital also makes it difficult for the poorest to diversify their livelihoods, for example by setting up a small business. Poor farmers do not have enough collateral for a bank loan, and farmers are anyway hesitant to apply for loans because of the volatility of their income. The main asset base was landholdings, and these were small and unviable for both Category 1 and Category 2 respondents. Households in Category 1 had average landholdings of 0.13 hectares, of which only 0.005 hectares were irrigated. In terms of their adaptive capacity, the poorest were unable to risk diversifying crops, for example by growing cash crops instead of staples, for fear they would lose their food security, and they also could not afford some of the coping strategies; for example, a second batch of seeds was too expensive for repeat sowing.

Socially discriminated groups like women and Dalits (the lowest caste group, previously considered untouchable) are more vulnerable to the impacts of climate change. Patriarchy is still widespread, and women are economically poorer and also have limited access to resources. Within households, in terms of nutrition, women are the last to eat and the first to be affected by food deficiency; they have greater responsibility for activities such as fetching fodder, fuel, and drinking water, and are also more prone to accidents while involved in these activities. Coping strategies require labour that is usually provided by women – repeat sowing, spreading pesticides and fertilisers, and ploughing with shovels. The Dalit groups have smaller landholdings and are dependent on wage labour in other people's fields, thus they suffer the most as agricultural productivity, the main source of income, declines.

The lack of access of the rural poor to markets and institutions is a major constraint in tackling the impacts of climate change. Health centres and veterinary hospitals were on average 1.5 kilometres away, agriculture and allied departments more than 3.5 kilometres away. As a resident of Bageshwar said, "It takes one full day to go to the government offices and get home, so we approach them very rarely". Many villages are not connected by motorable roads and others do not have regular transport facilities, further limiting accessibility. Thus access to social safety nets, another key determinant of adaptive capacity, is also limited, particularly for more remote communities and marginalised groups.

## **Institutional Opportunities and Constraints**

Institutions can be crucial in determining and influencing the adaptive capacity of any group, particularly by structuring impacts and vulnerability, mediating between individual and collective responses to climate impacts and thereby shaping outcomes of adaptation, and delivering external resources to communities in order to facilitate adaptation (Agrawal and Perrin 2009). Some of the more important formal and informal institutions active in the study area are listed below together with the associated opportunities and constraints.

### **Traditional institutions (formal and informal)**

**Traditional water harvesting systems** – In Almora, indigenous water harvesting systems were set up to counter the frequent water shortages and make use of the high surface runoff in the hills. Some of these traditional structures are still in use today, but many are on the verge of decline. Revitalising these structures and combining their use with the traditional institutional mechanisms for water sharing could be an important way of adapting to increasing water stress of the type faced by the communities in the years preceding this study.

**Van panchayats** – Van panchayats are autonomous democratic local institutions characteristic of the state of Uttarakhand. They are an institutionalised form of resource management through state community partnerships which regulate the utilisation and protection of forests and forest products. Each van panchayat functions according to specific rules and regulations which are based upon the traditional knowledge of the communities (Mukherjee 2003). Strengthening the existing 12,000 or so van panchayats in Uttarakhand and increasing their awareness of climate change related risks could be an effective strategy for guaranteeing the sustainable use of forest products and forest regeneration, as well as for sustainable water management.

### **Formal institutions**

**Gram panchayats** – The gram panchayat, headed by a gram pradhan, is the lowest rung of the three-tiered local self-governance system. The gram panchayat oversees a cluster of 3–4 villages. It channels government funds for small-



scale development and is responsible for the 'public distribution system' (PDS) as well as for issuing the 'below poverty line' (BPL) cards that determine subsidised rations and work allowances under the Mahatma Gandhi National Rural Employment Guarantee Act (NREGA). Unfortunately, the lack of transparency in the use of these funds and corruption in the issuance of BPL cards has damaged the credibility of these institutions and limits their effectiveness in assisting the coping and adaptive strategies of the most disadvantaged.

**Fair price shops** – The government ensures the supply of essential commodities under the public distribution system through networks of fair price shops that ensure affordable prices. With the shortfall in household food production and the need to purchase food, fair price shops have an important role to play in food security protection, but they need to enhance the quantity and quality and ensure the regular supply of food products.

**Agriculture and other departments** – The state departments for agriculture, fisheries, animal husbandry, and horticulture were set up to provide agricultural extension services. Unfortunately, the officials in these departments lack awareness of climate change and believed that "there is no need to worry unnecessarily", which was reflected in the complete lack of funds for climate change awareness or adaptation programmes, and limits their role in assisting rural farmers in tackling the impacts of climate change. These departments are perceived by the communities to be poorly managed and to distribute untimely and inadequate outreach services. Making these departments aware of the challenges that rural communities are already facing, partly as a result of climate change, strengthening their human and financial resources, and ensuring transparency will be very important.

**Revenue Department** – Some compensation for crop damage due to drought was provided by the state through the revenue department, but communities claimed that the compensation provided was insufficient and distributed inequitably. Introduction of crop insurance is one way to strengthen the social safety net for rural communities, and could be another important step in enhancing the resilience of the rural poor.

## Climate Change Policy

India's National Action Plan on Climate Change (NAPCC), released in June 2008, outlines current and future policies and implementation mechanisms addressing both climate mitigation and adaptation (C2ES 2008). Under the NAPCC, the Federal Government of India identified nine missions, and requested line ministries to lead them. Two of these missions are directly relevant for mountain communities. One focuses on sustaining the Himalayan glaciers and mountain ecosystem. It suggests continuing and enhancing monitoring of the Himalayan ecosystem in order to preserve important ecosystem services, in particular freshwater reserves. The mission further stresses the importance of building the capacity of local communities to preserve the Himalayan ecosystems. This mission is complemented by the National Mission for Sustainable Agriculture, which focuses on improving the productivity of rainfed agriculture, taking the traditional knowledge of people into account. However, mountain farmers and their concerns need to be addressed at the local/state level as a national plan cannot hope to accommodate the diversity of needs. When implementing these missions, it will be crucial to acknowledge the specific needs of mountain communities and their local knowledge, possibly through the formulation of Local Adaptation Programmes of Action (LAPAs), rather than depleting their assets, for example by establishing exclusionary protected areas.

## Conclusion

Poor farmers not only face rapidly changing socioeconomic conditions, they have also been coping to the best of their ability and resources with water and temperature stresses resulting from climate variability and change. These stresses are expected to continue and increase, and the constant coping will have consequences, eventually depleting the asset base of the rural communities if new measures are not taken. Young people are already disillusioned, and most try to leave if they can. The trend of seeing agriculture as an unviable livelihood option and leaving has implications for household and food security. Assisting farmers in adding value and productivity to agriculture will be of the utmost importance, for example through the development of value chains for high value products. But other livelihood options and associated human capital development will also have to be promoted, by involving actors from state government, local institutions, non-governmental organisations, and primarily the stakeholders. Persistent poverty and social inequality needs to be addressed, in particular supporting women and members of the lower castes.

