Chapter 15
Strengthening Climate Change Adaptation in Nepal: Needs and Perspectives

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Abstract Nepal is one of the countries most vulnerable to the impacts of climate change, due to its geographical fragility and socio-political circumstances. The effects of climate change are observed across regions, society and villages, mostly impacting the wellbeing of poor and marginalized households. This research explores the existing challenges of managing climate change adaptation in Nepal. The research is based on a case study of three different locations of Nepal, representing different landscapes. The findings show that the impact of climate change differs based on the socio-economic characteristics of households and communities. Poor and marginalized households seem to be more affected by the impacts of climate change than the rich and well off, because of their resource limitations. The findings also show that responses to and management of climate change at the local level are constrained by limited information and knowledge on climate change, inadequate access to technology and services and other governance challenges. The findings imply that local, national, regional and international collaboration is needed, to address the knowledge gap and issues related to financing and technology transfer in Nepal.

Introduction

The scientific evidence indicates that human activities are mostly responsible for changing the climate (IPCC 2007). The nature of climate change risk and vulnerability varies across regions and countries, over time, and depends on unique socio-

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economic, biophysical and other conditions. Among the many Least Developed Countries (LDCs), Nepal is one of the most vulnerable to the impacts of climate change due to its fragile ecosystems and socio-political circumstances (NCVST 2009). Data from the climate risk index ranking of 1993–2012 indicates that Nepal is among the 20 most vulnerable countries (Sönke and Eckstein 2013). The effects of climate change are already being observed across society and villages in Nepal, mostly impacting the well being of poor and marginalized households. Several studies show that poor, women and marginalized households living in rural areas of Nepal are suffering from the negative impacts of climate change (Jones and Boyd 2011; Regmi and Bhandari 2012).

The vulnerability context of countries like Nepal emphasizes the need for effective adaptive measures to deal with climate change risks and impacts. Adaptation has emerged as a central area in climate change research, in country-level planning, and in implementation of climate change strategies (IPCC 2013). Nepal has in recent years made significant progress in devising policies and conceiving programmes on climate change adaptation (Helvitas 2011). However, the implementation of policies and plans remain largely uncertain due to lack of a clear strategy on how to implement them, and governance issues (Pant and Gautam 2013).

The literature shows that lack of information, knowledge management and technology transfer are major hurdles to promoting adaptation and climate resilience programmes in Nepal. Several studies have indicated the prevalence of a gap in knowledge and information on the impacts of climate change in Nepal. Bolch et al. (2012) argue that climate change projections in Nepal are speculative and incomplete due to poor understanding of climate change processes, combined with the diversity of climatic conditions and the extreme topography. In this case, undertaking multiple location-specific studies by government and Nepali stakeholders would enrich the knowledge and understanding of climate change in Nepal.

Therefore, this chapter is timely as it provides a multi-dimensional analysis of the climate change context in Nepal by outlining different factors that shape the climate change vulnerability and adaptive capacity of communities. It also adds value to the on-going debate on integrating climate change adaptation in development, by providing evidence of the associated links between the socio-economic conditions of households and their degree of exposure and vulnerability to climate change. In addition, it contributes to filling an important information gap by providing empirical case studies on the existing opportunities and challenges of managing climate change adaptation in Nepal.

This chapter specifically examines the existing state of climate change practices and the future need to strengthen climate change adaptation responses in Nepal. By providing an analysis of the opportunities and constraints of implementing mainstreaming initiatives, it contributes to an enriched understanding of how climate change adaptation responses should be designed and practiced. This research will therefore potentially assist decision makers to develop effective policy and governance mechanisms for strengthening climate change adaptation at the local level.

Methodology

Approach

The study was conducted in Nepal using a comparative case study methodological approach, in order to generate specific evidence on climate change in different geographical locations of Nepal. It also sought to enrich understanding in general of the complex issue of climate change. Case studies emphasize detailed contextual analysis in specific locations or conditions and their relationships. They also allow an empirical examination of the theoretical hypothesis of the research (Yin 1994).

Research Sites and Participants

The study involved in-depth research in six different geographical locations in Nepal. The districts selected cover three major ecological belts: high hill, mid hills and terai, representing different altitudinal zones of Nepal. Three major development regions of Nepal were included, namely the central, western and mid-western regions, in order to capture different vulnerability contexts. Within the development region, one district was selected based on the National Adaptation Programme of Action (NAPA) vulnerability criteria (refer to Table 15.1). Likewise, in each district, one Village Development Committee (VDC) was selected. The selection of the VDCs was carried out based on the available socio-economic and disaster data. The VDCs selected for this research are among the most vulnerable in the districts because they faced severe climate change impacts and had low coping capacity.

The participants in the research included policy makers, practitioners and communities in the selected research locations. A total of 17 policy makers, 28 practitioners and 288 households were identified to participate. Purposive sampling was used in order to capture the experiences of policy makers and practitioners in

Table 15.1 Research sites and selection criteria

VDCs selected	Districts	Ecological region	Major climate change disasters reported in the districts	Categorization of vulnerability by national adaptation programme of action (NAPA)
Ramche and Bhorle	Rasuwa	High hill	Landslide	Moderate
Dhungegadi and Bangesaal	Pyuthan	Mid hill	Drought	Low
Betahani and Holiya	Banke	Terai	Flooding	Very low

Table 15.2 Showing the features of the research stations that was used for analysing climate data

Station name	District	Index no.	Type of station	Lat (degree/min)	Long (degree/min)	Elevation (m)	Remarks
Nepalgunj	Banke	0416	Climatology	28/04	81/37	144	Plains
Bijuwartar	Pyuthan	0505	Precipitation	28/06	82/52	823	Mid hills
Ghorai	Dang	0515	Synoptic	28/03	82/30	634	Mid hills
Dhunche	Rasuwa	1055	Climatology	28/06	85/18	1,982	Mountains

climate change. Of the total 288 households, there were 96 households for each district. Stratified simple random sampling was employed to best represent the socio-economic diversity of households and communities. These sampling strategies helped the researchers to best identify different categories of households for the research process.

Research Methods and Analysis

The study employed mixed approaches to data gathering. Participatory data gathering methods such as interviews and focus group discussions were used. Climate trends were analyzed using data collected between 1981 and 2010 from four reference stations located in the terai plains, mid hills and mountain areas of Nepal (Table 15.2). For all reference station data, Mann-Kendall (non-parametric test) and the least square fitting statistical analyses were utilized to test the significance of trend in time series. Trends were also identified using the least square fitting method and Sen's slope method. These tests were applied because they are simple, robust and can cope with missing values and values below a detection limit (Gilbert 1987).

The presence of a statistically significant trend was evaluated using the Z value of normal distribution. A positive (negative) value of Z indicates an upward (downward) trend. In this analysis, if the value of Z was greater than 1.96 or less than -1.96, then it was considered a significant trend at the 5 % level. In addition to this non-parametric test, the simple least square fitting method was also utilized to identify trends and their significance based on R2 values.

Limitations of the Study

The analysis undertaken in this chapter has some limitations to be taken into account when reviewing the findings. The first limitation is related to the availability of climate data; a limitation often encountered with data holdings in the developing world (IPCC 2013). In analyzing the trends, data gaps were noted.

For the Nepalgunj station, data was missing for only 1 or 2 years over the entire period. As there were some gaps in data on temperature at the Bijuwartar station in Pyuthan, data was taken at a proxy station from nearby Ghorai (Dang) for both the temperature and rainfall analyses. There were some data on continuous temperature and rainfall missing at the Dhunche and Ghoari stations respectively and this impacted the data analysis. The second limitation concerns the focus of the study. The study was conducted in Nepal and focused on a few districts and VDCs of Nepal.

Findings

Temperature and Rainfall Trend

The results showed a decreasing trend in average maximum and minimum temperature in mountain areas compared to the mid hills and terai plains. This result contrasts with a general observation of an increasing trend in temperature with a vertical rise in topography. This may be essentially due to gaps in continuous data; primarily the lack of temperature data on the Rasuwa district. However increasing trends in mean temperature were observed from the terai plains to the mid hills.

In Nepalgung station, the temperature rise trend was highest in the Pre-Monsoon season (0.04 °C/year) and lowest with a slightly negative trend during the winter season (−0.01 °C/year). The trends during the monsoon and post-monsoon seasons were 0.002 and 0.004 °C/year respectively. At the Ghorai station, where data were available from 1989 to 2010, the mean annual maximum temperature showed a rising trend of 0.06 °C/year. The rising trend was highest (0.12 °C/year) during the winter season and lowest (0.04 °C/year) during the monsoon season. In Dhunche, there was a sharp decline in mean annual maximum and minimum temperatures by 0.02 and 0.05 °C/year (Table 15.3).

Table 15.3 Temperature change trend by stations

	Temperature change (°C/year)		
Temperature parameters	Nepalgunj	Ghorai	Dhunche
Mean annual maximum temp	0.01	0.06	−0.02
Mean pre-monsoon maximum temp	0.04	0.05	−0.02
Mean monsoon m maximum temp	0.002	0.04	0.11
mean post-monsoon maximum temp	0.004	0.05	−0.04
Mean winter season maximum temp	−0.01	0.12	0.018
Mean annual minimum temp	0.02	0.01	−0.05
Mean pre-monsoon minimum temp	0.05	0.04	−0.1
Mean monsoon minimum temp	0.01	−0.03	−0.04
mean post-monsoon minimum temp	0.04	0.02	0.02
Mean winter minimum temp	0.03	0.01	−0.04

For all stations, the temperature trend was identified using both Sen's Slope method and the least square fitting method, and the significance of trends was tested with the Mann Kendall test as well as the R2 value in least square fit. The trend value obtained from both the least square fitting and Sen's slope methods did not differ greatly. Temperature trends were not consistently significant. In Nepalgunj, the rising trend in mean annual minimum air temperature was significant, but the trend for the mean annual maximum air temperature was non-significant. While in Ghorai, the significance of the temperature increase was reversed for two temperature parameters. At the Dhunche station there were non-significant trends for all the temperature parameters across all seasons (Table 15.4). The variation might be due to the limited availability of data from this station over the entire period.

In terms of rainfall, the results indicate a high variability in rainfall trends between the terai plains, mid hills and mountains. There was a sharp decline in rainfall in the terai plains compared to other parts of Nepal. A decrease in winter and post-monsoon season rainfall was observed, which concurs with the responses of communities. The significance of the temperature trend was different from season to season and from maximum and minimum temperature parameters.

The annual rainfall total shows a large inter-annual variability, with the value ranging from 1,000 to 2,000 mm. At Nepalgunj station, the annual rainfall total and rainfall total for all seasons showed a decreasing trend. The decreasing trend in total annual rainfall was about 14.7 mm/year. In the mid hills, Ghorai station had a slight increase in total annual rainfall (5 mm/year), however in Bijuwartar there was a decreasing trend of 9.6 mm/year. In comparison to Ghorai, there was a decreasing trend for all seasonal rainfalls in Bijuwartar. However, in Dhunche, the total annual rainfall displayed an increasing trend (1.6 mm/year), and by season the highest increasing trend was observed around the monsoon (20.9 mm/year). However the pre-monsoon, post-monsoon and winter rainfalls showed a decreasing trend by 4.31 mm/year, 6 mm/year and 3.5 mm/year respectively (refer to Table 15.5).

Rainfall trends were analyzed using both Sen's Slope method and the least square fitting method, and the significance of trends were tested with the Mann Kendall test as well as the R2 value in least square fit. The findings show that during the winter and post-monsoon seasons, all four stations showed a decreasing trend. This indicates a decrease in winter and post-monsoon season rainfalls over large areas of Nepal. Relatively, the significance of the rainfall trend is very low (Table 15.6).

Analysis of temperatures and rainfalls at all the three stations clearly shows that climate change is occurring in the study area. There was a sharp increase in temperature and frequent variability in rainfall observed at all three sites. In comparison with the rainfall data, there were more significant trends in temperature parameters. The perception of communities also shows that more than 98 % of respondents across the three regions had experienced increasing temperature and a large variability in rainfall patterns.

Table 15.4 Analysis of station temperature trends using Mann-Kendall with Sen's slope method

Station name	Time period	Season	Max air temperature			Min air temperature		
			Z value	Sen's slope (change per year)	Significance of trend	Z value	Sen's slope (change per year)	Significance of trend
Nepalgunj	1981–2010	Monsoon	0.04	0.003	No	1.87	0.01	No
		Post-monsoon	0.45	0.006	No	2.70	0.04	Yes
		Winter	−0.38	−0.008	No	1.8	0.03	No
		Pre-monsoon	2.02	0.05	Yes	2.69	0.05	Yes
		Annual	1.25	0.01	No	2.21	0.02	Yes
Ghorai	1981–2010	Monsoon	1.63	0.05	No	−1.54	−0.02	No
		Post-monsoon	2.35	0.05	Yes	0.51	0.02	No
		Winter	2.99	0.1	Yes	0.58	0.02	No
		Pre-monsoon	0.67	0.05	No	0.51	0.03	No
		Annual	2.72	0.06	Yes	0.42	0.01	No
Dhunche	1981–2010	Monsoon	2.1	0.09	Yes	−0.85	−0.04	No
		Post-monsoon	−0.4	−0.04	No	0.7	0.02	No
		Pre-monsoon	−0.27	−0.01	No	−0.96	−0.12	No
		Winter	0.18	0.02	No	0.7	0.04	No
		Annual	−0.17	−0.01	No	−1.17	−0.06	No

Table 15.5 Rainfall change trend by station

Rainfall parameters	Precipitation (mm/year)			
	Nepalgunj	Ghorai	Bijuwartar	Dhunche
Total annual rainfall	−14.787	5.0094	−9.6523	1.66
Total winter rainfall	−1.5011	−1.1973	−0.2	−3.5
Total pre-monsoon rainfall	−0.6591	2.7996	−0.87	−4.31
Total monsoon rainfall	−11.594	3.6438	−5.3	20.94
Total post-monsoon	−1.0736	−0.0323	−1.12	−6.07

Impact of Climate Change on Different Livelihood Resources

The evidence shows that the sectors most impacted by climate change in the regions are agriculture and water. The losses of major agriculture crops and production decline have been major issues at the study sites. The farmers in the Pyuthan, Rasuwa and Banke districts mentioned losing crops of the traditional varieties of rice due to rainfall variability. According to the farmers, these local varieties need continuous rainfall for 4 months in order to mature and yield. Farmers at all the three sites also reported a declining yield of barley, wheat and legumes (see Table 15.7). They indicated that the seedling period had changed, affecting the production yield. This supports the research finding of Devkota et al. (2013) that seeding rice before and after the optimal seeding dates reduces crop yield and yield stability significantly because of spikelet sterility induced by both high and low temperatures.

Climate change had also visibly impacted forests and biodiversity. A shifting of vegetation patterns and crops is evident at higher altitudes in Nepal. The field evidence from the Rasuwa district indicates that a succession of the vegetation had been observed in the Thulo Syabru area. People indicated that rhododendron and juniper are now appearing at higher altitudes than their normal distribution range. Similarly, communities are experiencing changes in the plant behavior and flowering season of rhododendron. A recent study carried out in the Western Himalayan eco region by Joshi et al. (2012) showed that with increasing temperature, a shift to higher altitudes in all forest types was observed. A research study in India reveals that the suitable bioclimatic envelope for rhododendron has shrunk considerably under the envisaged climate change scenario (Kumar 2012).

Climate change is also a major threat to water resources and the hydrological cycle. The global circulation climate model also suggests that climate change will impact total flows, seasonal runoff, high- and low-flow conditions, and surface-groundwater interactions (Manandhar et al. 2012). Climate change was also impacting water resources in the study areas. Communities at the research sites perceived that depletion of water resources had impacted them directly. Villagers in the Rasuwa and Pyuthan districts expressed that the drying up of springs and rivers was a major concern for them, reporting that almost 50 % of the local springs and water sources had dried up in their villages. Likewise, communities in the Banke

Table 15.6 Analysis of station rainfall trends using Mann-Kendall with Sen's slope method

Season	Pre-monsoon			Post-monsoon			Winter			Monsoon		
Station name	Z	Sen's slope	Significance	Z	Sen's slope	Significance	Z	Sen's slope	Significance	Z	Sen's slope	Significance
Nepalgunj	−0.52	−0.74	No	−1.31	−1.13	No	−1.69	−1.28	No	−1.84	−11.98	No
Bijuwartar	−0.89	−1.3	No	−1.18	−0.88	No	−0.27	−0.31	No	−0.99	−4.69	No
Dhunche	−0.1	−0.42	No	−2.29	−4.64	Yes	−2.03	−3.47	Yes	2.14	22.2	Yes
Ghorai	0.9	1.8	No	−0.05	−0.17	No	−0.98	−0.91	No	0.66	7.40	No

Table 15.7 Impacts of climate change on agriculture

District	Impact on agriculture	
	Cereals (loss of species)	Legumes (declining yield)
Rasuwa	Local landraces/varieties of rice—(Marsi, Bhangari, RatoDhan, Kalokathe, Bunglange, Sikrimarshi)	Bhatmas (soybean), Bodi (beans), Rice bean, Gahat (horsegram), Kheseri and Mas (blackgram)
Pyuthan	Local rice varieties (Simtharo, Marsi, Hasi)	Wheat, Lentil, Peas
Banke	Local rice varieties (Anadi, Dhunmuniya, Masuli, Shyamjira, Tilki, Barma, Sungapankhi, Deruwa, Rudhan)	Wheat, Lentil, Chickpea, Mustard

district reported excessive water and flooding in the rainy season and a massive decline in the water table during the winter.

The evidence presented in this section clearly indicates that climate change is already impacting upon major livelihood sectors such as the agriculture, biodiversity and water sectors. Other areas may also be impacted by climate change impacts, such as health and migration. However, due to lack of access to data, the total picture of climate change impacts is difficult to ascertain.

Socio-economic Context

This section of the paper provides a brief summary of the socio economic contexts of the study sites, arguing that vulnerability at the local level is high because climate change is having a greater impact relative to the existing coping and adaptive capacity.

The findings show that the lack of access to education for women leaves them more vulnerable to climate change impacts compared to men. The mean education ration in the study VDCs is 51.7 %, which is lower than the national average (CBS 2011). In comparison with males, the females have a much lower educational status. The household survey shows that only 22.89 % of the female populations within the six study VDCs are literate. There is variation within VDCs; in the Ramche VDC only 5.4 % of females are literate, whereas the Bangesaal VDC of Pyuthan district has the highest female literacy rate of 35.1 % (refer to Table 15.8). These data show that the women in the study districts are less privileged than men in terms of access to education and other support services.

The majority of the households in the study areas are dependent on climate-sensitive sectors such as agriculture. The survey data show that 79 % of the total population in the study VDCs is dependent on agriculture for their livelihood. The dependency is highest in the Bhorle VDC, where 93 % of the population is dependent on agriculture. Only 67 % of the population in the Holiya VDC of the Banke district is dependent on agriculture, as there are alternative livelihood sources in this district compared to Rasuwa. It should be noted that the average

Table 15.8 Socio-economic features of the study sites

VDCs	Education (%)		Food sufficiency (month/year)	Land size (ha)	Income per annum (rupees)	Agriculture dependency (%)
	Male	Female				
Bhorle	46.10	24.40	5.00	0.35	50,145.00	93.00
Ramche	14.30	5.40	5.50	0.32	44,816.00	82.00
Dhugegadi	57.00	43.00	9.00	0.73	120,000.00	70.00
Bangesaal	64.90	35.10	7.00	0.71	132,000.00	74.00
Bethani	33.52	24.60	5.40	0.67	74,699.00	88.00
Holiya	26.01	4.84	5.80	1.26	78,600.00	67.00

Table 15.9 Human development index of the study areas

District	HDI	GDI	HPI	HEI	Below poverty line (%)
Rasuwa	0.39	0.376	54.5	0.439	46
Pyuthan	0.45	47.9	0.41	0.01	38
Banke	0.46	34.4	0.579	0.01	40

Source: DDC-Banke (2004), DDC-Pyuthan (2004), DDC-Rasuwa (2004), UNDP (2004)

household size in the study area is 6.5, which is higher than the national average. The findings indicate that the large household size in the study areas has placed enormous pressure on the limited land for food supply and production.

Access to land is one of the major issues for food security. The average land size is 0.67 ha in the study areas. The Rasuwa district has only 0.33 ha whereas the Banke district has an average of 0.97 ha. The average food sufficiency status was 6.28 months indicating that a household can have sufficient food for only 6 months. In the Rasuwa and Banke districts, 20–30 % of the population has food sufficiency, while the rest of the population has to either consume less or seek alternatives. Comparatively, households in the Rasuwa and Banke districts have a lower annual average income (refer to Table 15.8). Likewise, according to the national census data, 15.7 % of Nepali households do not have adequate food to eat (CBS 2011).

An assessment of the socio-economic conditions of the populations at each of the study sites reveals that most of the households live below the poverty line and are food insecure. Based on UNDP (2004) data with regard to the Human Development Index (HDI), Gender Development Index (GDI), Human Poverty Index (HDI) and Human Empowerment Index (HEI), the Rasuwa district can be considered the most vulnerable. Rasuwa has a HDI of 0.39, which is lower than the national average of 0.463. Further, 46 % of the population in Rasuwa is living below the poverty line, i.e., under one dollar of income per day. The HDI and poverty ratios in the other study districts are also very low (Table 15.9).

The findings show that the poor and women suffer most from the impact of climate change. The majority of the respondents (92 %) with a low income perceive that they are experiencing significant impacts of climate change on their water resources compared to respondents with a better income. During focus group

Table 15.10 Impact of floods on the well being of different categories of respondents

Impact of loss	Non-poor (household %)	Poor (household %)	Total (household %)
Male	10.5	3.3	5.0
Female	15.8	19.7	18.8
Children	21.1	18.0	18.8
All	52.6	59.0	57.5
Total	100.0	100.0	100.0

Source: Interview with households, Banke

Table 15.11 Impact of climate change on women households

	Year	
Time needed to collect water (min/day)	2009 (%)	2012 (%)
Within house or no time needed	19.1	10.0
Less than 15 min	50.1	27.1
15–30 min	18.0	20.6
More than 30 min	22.8	42.2

Source: VDC-Dhungegadi (2009)

discussions, the participants shared that more than 70 % of the victims of flooding and landslides were from poor households. For example, ward number 5 of the Bangesaal VDC reported that the outbreak of water-borne diseases (cholera and diarrhea) in 2008/2009 took the life of two people belonging to poor families. Similarly, the household survey of the Banke district indicated that children and females are equally vulnerable to the effects of floods. Moreover, poor females are more vulnerable than non-poor females (Table 15.10).

Women's vulnerability to climate change and variability is strongly influenced by their socioeconomic status and gender roles (Figueiredo and Perkins 2012). A comparison of the data generated from the focus group discussion and secondary sources in the Pyuthan district indicate that between 2009 and 2012, there was a reduction in local water availability. In recent years, 42 % of the women have had to travel more than 30 min to collect water compared to only 23 % in 2009 (Table 15.11). Similarly, according to the majority of the female interview respondents in the Banke district, their workload has also been increased with intensive agriculture practices required due to the impact of climate extremes like drought and land degradation.

Capacity to Cope and Adapt

This section discusses the existing capacity of communities to cope with and adapt to climate change in the study areas. The field information shows that there are limited traditional coping practices available to deal with climate change at the

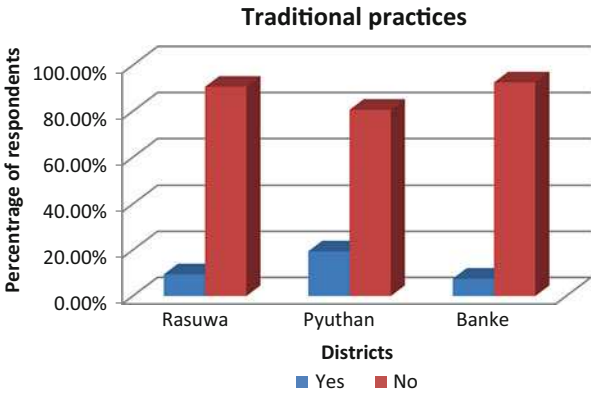

Fig. 15.1 Household perception on the use of coping practices

local level. The household survey indicates that more than two thirds of the respondents (above 80 %) in all the districts lack sufficient traditional practices to deal with climate change. This is because they have limited access to knowledge and technology on climate change adaptation. Some households have adopted very few local practices. For example, at the time of the study, in the Banke district less than 5 % of non-poor households had initiated construction of physical infrastructure such as drainage canals or water storage tanks around their house/land. Likewise, only around 10 % of households had opted to change their crop patterns to include mixed crops, or changed their cropping system or fertilizer (Fig. 15.1).

It was found that most of the traditional practices adopted by the communities are ineffective to deal with climate disasters. The household survey of all three districts revealed that more than two thirds of respondents argued that their practices are ineffective and inadequate to mitigate climate change impacts, often due to the scale and magnitude of the impacts. For example the use of vegetative check dams proved ineffective during massive flooding in the Holiya and Bethani VDCs. Almost 89.1 % of the respondents in the Bangesaal VDC of Pyuthan district perceived that the existing adaptation options were ineffective because they lacked information, knowledge and technology on dealing with climate change risks and impacts (refer to Fig. 15.2).

The findings reveal that the external support from the government and non-government service providers on climate change was limited. More than 90 % of respondents in the Rasuwa district indicated that they had not received any support from the government to deal with climate change, and more than 50 % of respondents in the Pyuthan and Banke districts perceived that there was no support. For example, around 32 % of the households in the Banke district perceived that the government was doing nothing to mitigate the vulnerability of the flood impacts, whereas around 27 % of households responded that they did not know anything about the governments' initiatives on climate change.

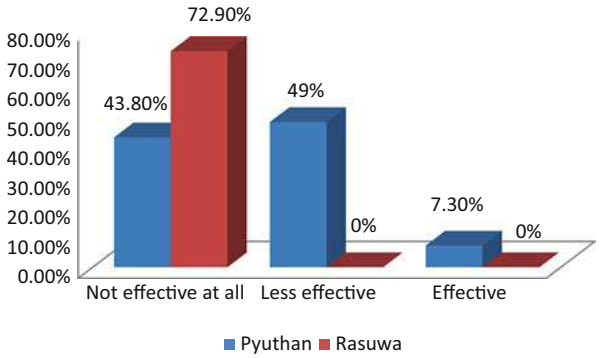

Fig. 15.2 Household perception on effectiveness of current traditional practices

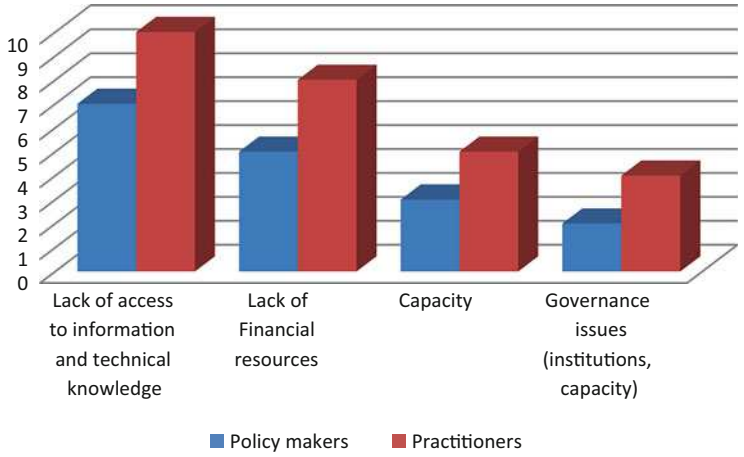

Fig. 15.3 Perception of respondents on challenges in promoting climate change adaptation

Challenges to Implementing an Adaptation Programme

There are gaps in information, knowledge and technology on climate change at both local and national levels. The interviews with communities in the Rasuwa and Pyuthan districts revealed that more than 80 % of the respondents were not aware of climate change and related issues. Likewise, at the local level the government and NGO practitioners also revealed that they had limited knowledge on climate change and that technology transfer is not occurring. Most of the policy makers and practitioners revealed a lack of access to knowledge and technology as one of the major barriers preventing them from taking affirmative action on climate change. The policy makers and practitioners also identified that a lack of financial resources and capacity, as well as governance issues, are challenging progress to promote climate change adaptation in Nepal (see Fig. 15.3).

Another challenge in promoting climate change adaptation at the local level concerns governance and institutions. According to the majority of the practitioner and community respondents, the local government is weak, has insufficient capacity and is under resourced. Government respondents reported a lack of information and knowledge on climate change as a major obstacle in decision making. In addition, the political instability and lack of a local election in the last 15 years has made the local government weak and fragile. The local government officials in an interview revealed that the current capacity and resources of the local government are insufficient to support additional services for climate change adaptation.

Discussion

The findings of this study indicate that climate change will make the achievement of development goals in Nepal more complicated by adding an extra burden to the poor, marginalized and vulnerable households. The data clearly show that communities in all three geographical locations studied have a high degree of exposure and sensitivity to climate change and a low adaptive capacity to deal with climate extremes. It was found that the poorest and most excluded were the most vulnerable to the impacts of climate change, both because of their high dependency on climate-sensitive resources and their lack of access to material, social, political and economic resources.

One of the major constraints to climate change adaptation for the districts identified in this research is a lack of information and data on climate change. There were constraints observed in this study in accessing meteorological data which affected the analysis. In addition, there are issues with the availability and access of districts to scientific and meteorological data related to climatic variables. This can be attributed in part to the relatively short length of records, about 30 years (Shrestha and Aryal 2011). Similarly, the precipitation and temperature data, used earlier, are constrained by locality since they were taken at a different altitude, aspects and geographical location from the study area. Although local information is useful in understanding local contexts and climate change impacts (Berkes and Jolly 2002; Byg and Salick 2009), it is limited by lack of access to technology and specific knowledge required to deal with climate extremes.

The findings in this research support earlier findings which indicate that unsustainable development has resulted in poor and inequitable distribution of adaptive capacity (Yohe et al. 2006). Traditional responses and the existing local governance structure alone are not sufficient to address contextual vulnerability. Existing resources and practices often fail to address the uncertainties and scale of climate change impacts. Yamin et al. (2005, p. 9) also argue that the complexities of climate change necessitate addressing the *structural* causes of vulnerability that cannot be dealt with in a piecemeal, project-by-project fashion.

The findings in this paper demonstrate that, to deal with climate extremes, local responses must be supported with technology transfer and knowledge and skills.

The findings support the notion that effective adaptation measures in development-deficient situations require 'transformational' approaches that necessitate adaptive co-management and joined-up actions. Co-management can be considered a knowledge partnership between organizations, from local to international (Berkes 2009). In addition, joint working or a 'joined-up' government strategy is useful in bringing together a number of public, private and voluntary sector bodies to work across organizational boundaries towards a common goal (Kavanagh and Richards 2001; Ling 2002; Wilkins 2002).

The most suitable adaptation response strategy specific to Nepal and other LDCs, as argued earlier, is to adopt an adaptive co-management approach where the government and stakeholders identify a common local and national-level mainstreaming strategy for knowledge management, resource mobilization and institutional development. The evidence from this research argues that a governance structure that is inclusive and owned by multiple stakeholders has the potential to overcome institutional, technological and financial barriers.

Conclusion

This study aimed to explore the existing challenges of managing climate change in Nepal.

The findings show that climate change has emerged as an additional burden to the existing problems of socio-economic underdevelopment, inequality and lack of access to sufficient services at the study sites. The weak socio-cultural context necessitates that interventions consider adaptation and development together in order to address both poverty and vulnerability. It also implies that stand-alone climate change adaptation interventions are not sufficient for addressing the root causes of vulnerability, because a fragmented approach will further marginalize households.

This chapter has identified several challenges for implementing climate change adaptation responses in Nepal and other LDCs. The gaps in information, knowledge, technology and financial resources are already undermining the local and national-level responses on climate change adaptation. In particular, the findings showed that adaptation responses at the local level are currently ineffective because of limitations within local knowledge and practices to deal with climate extremes as well as inadequacies in government and NGO services and support for the local communities.

The findings clearly demonstrate that, in order to strengthen climate change adaptation in Nepal, an integrated interventions and technological support might be required at different levels, which could include the individual and collective responsibility of the international community, national-level government, development agencies and the local communities. Specifically, there is a need to place a greater emphasis on information and knowledge management that can help poor and vulnerable households to

(continued)

access information and technology to adapt to the adverse impacts of climate change. This could happen if local, national, regional and international actors and agencies collaborate with each other in devising policies and establishing knowledge and technology sharing mechanisms and systems. This highlights an urgent need to identify tools and methods to practically facilitate these collaborations in Nepal and other LDCs.

References

Berkes F (2009) Evolution of co-management: role of knowledge generation, bridging organizations and social learning. J Environ Manag 90(5):1692–1702

Berkes F, Jolly D (2002) Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. Conserv Ecol 5(2):18

Bolch T, Kulkarni A, Kääb A, Huggel C, Paul F, Cogley JG, Frey H, Kargel JS, Fujita K, Scheel M (2012) The state and fate of Himalayan glaciers. Science 336(6079):310–314

Byg A, Salick J (2009) Local perspectives on a global phenomenon—climate change in Eastern Tibetan villages. Glob Environ Chang 19(2):156–166

CBS (2011) Preliminary findings of the national census 2011. Nepal Centre Bureau of Statistics, Kathmandu

Intergovernmental Panel on Climate Change-IPCC (2013) Working Group I contribution to the IPCC fifth assessment report climate change 2013: the physical science basis summary for policymakers. IPCC WGI AR5, Intergovernmental Panel on Climate Change, Sweden

DDC-Banke (2004) District profile Banke. District Development Committee (DDC), Nepalgunj

DDC-Pyuthan (2004) District profile Khalanga. District Development Committee (DDC), Pyuthan

DDC-Rasuwa (2004) District profile Rasuwa. District Development Committee (DDC), Dhunche, Rasuwa

Devkota K, Manschadi A, Devkota M, LaLamers JPA, Ruzibaev E, Egamberdiev O, Amiri E, Vlek PLB (2013) Simulating the impact of climate change on rice phenology and grain yield in irrigated drylands of Central Asia. J Appl Meteorol Climatol 52(9):2033–2059

Figueiredo P, Perkins PE (2012) Women and water management in times of climate change: participatory and inclusive processes. J Clean Prod 60:1–7

Gilbert RO (1987) Statistical methods for environmental pollution monitoring. Wiley, New York, NY

Helvitas (2011) Nepal's climate change policies and plans: local communities' perspective. Nepal Helvitas-Swiss Intercorporation, Kathmandu

Intergovernmental Panel on Climate Change-IPCC (2007) Climate change 2007: impacts, adaptation and vulnerability. Contribution of the Working Group II to the fourth assessment report. Intergovernmental Panel on Climate Change, Sweden

Jones L, Boyd E (2011) Exploring social barriers to adaptation: insights from Western Nepal. Glob Environ Chang 21(1):1262–1274

Joshi P, Rawat A, Narula S, Sinha V (2012) Assessing impact of climate change on forest cover type shifts in Western Himalayan Eco-region. J For Res 23(1):75–80

Kavanagh D, Richards D (2001) Departmentalism and joined-up government. Parliam Aff 54 (1):1–18

Kumar P (2012) Assessment of impact of climate change on Rhododendrons in Sikkim Himalayas using Maxent modelling: limitations and challenges. Biodivers Conserv 21(5):1251–1266

Ling T (2002) Delivering joined–up government in the UK: dimensions, issues and problems. Public Adm 80(4):615–642

Manandhar S, Pandey VP, Ishidaira H, Kazama F (2012) Perturbation study of climate change impacts in a snow-fed river basin. Hydrol Process 27(24):3461–3474
NCVST (2009) Vulnerability through the eyes of vulnerable: climate change induced uncertainties and Nepal's development predicaments. Institute of Social and Economic Transition (ISET), Kathmandu
Pant D, Gautam K (2013) Policy provisions and local response on climate change adaptation in Nepal. Regional climate change adaptation knowledge platform for Asia. Stockholm Environment Institute, Bangkok
Regmi B, Bhandari D (2012) Climate change governance and funding dilemma in Nepal. TMC Acad J 7(1):40–55
Shrestha AB, Aryal R (2011) Climate change in Nepal and its impact on Himalayan glaciers. Reg Environ Chang 11(1):65–77
Sönke K, Eckstein D (2013) Global climate risk index 2014: who suffers most from extreme weather events? Weather-related loss events in 2012 and 1993 to 2012. Germanwatch, Berlin
UNDP (2004) Human development report (HDR) Nepal. United Nations Development Programme, Kathmandu
Village Development Committee (VFCC)-Dhugegadi (2009) Local adaptation plan of action (LAPA). Village Forest Coordination Committee (VFCC)-Dhugegadi, Pyuthan
Wilkins P (2002) Accountability and joined-up government. Aust J Public Adm 61(1):114–119
Yamin F, Rahman A, Huq S (2005) Vulnerability, adaptation and climate disasters: a conceptual overview. IDS Bull 36(4):1
Yin RK (1994) Case study research: design and methods. Sage, Los Angeles
Yohe G, Lasco R, Ahmad QK, Cohen S, Janetos T, Perez R, Ebi K, Lankao PR, Malone E, Malone T (2006) Perspectives on climate change and sustainability. Change 25(48):49