Research Report

Issues and complexity in assessing adaptive capacity:

Experiences from the field in Chitwan and Nawalparasi districts of Nepal

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By

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Summary: This report presents the results and analysis of research that was carried out in Chitwan and Nawalparasi in 2010. The research was conducted within the remit of a participatory vulnerability assessment, within which vulnerability is defined as a function of exposure and sensitivity to climate change and adaptive capacity. The focus of this report is on adaptive capacity. Following a situation analysis of climate change and its impacts on livelihoods in the research sites, evidence of previous adaptation strategies is presented before an adaptive capacity assessment is made, drawing attention to common areas of adaptation. This is followed by a critical discussion of some key issues faced in adaptation and building adaptive capacity. The report concludes with a discussion of how the complexity of adaptive capacity can be built into its assessment.

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1 Introduction

This report documents research carried out in Nepal to investigate the underlying factors of adaptation and adaptive capacity. The research was conducted from within a field-test of a Participatory Vulnerability Assessment (PVA), developed by Practical Action Nepal. The PVA was designed as part of a collaborative project, entitled "Strengthening Capacity for Managing Climate Change and the Environment: Community-based Vulnerability, Risk Mapping, and Adaptation Planning". The project is funded by the Asian Development Bank (ADB), and the partners include WWF, the International Union for Conservation of Nature (IUCN), the Centre for International Studies and Co-operation (CECI), and the National Association of VDCs in Nepal (NAVIN). Practical Action has taken the lead in developing the PVA, which will be implemented in different altitudinal zones of Nepal by the partner organisations. In the PVA, vulnerability is conceived as a function of exposure to climate change, community sensitivity to change, and community adaptive capacity. Since exposure and sensitivity are relatively well understood concepts amongst practitioners in both theory and practice, focus in this report is placed on adaptive capacity.

2 Methodology

2.1 Participatory vulnerability assessment

The conceptualisation of vulnerability in the PVA methodology is consistent with definitions provided by the Intergovernmental Panel on Climate Change (IPCC). In the Fourth Assessment Report of the IPCC, vulnerability is defined as "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity" (Pachauri & Reisinger, 2007, p. 89). Thus, the PVA consists of three components (exposure, sensitivity, and adaptive capacity), which are assessed to provide an overall picture of vulnerability. For the purposes of the PVA and this report, exposure is defined as the experience of climate, which includes long-term (seasonal) changes, short-term/extreme events, and projected changes. Sensitivity is defined as the degree to which a system is modified or affected, either adversely or beneficially, by climate change; i.e. it is the *impact* of climate change. The data gathered in relation to exposure and sensitivity is presented below within section 3.2 of a situation analysis. However, exposure and sensitivity are well understood both in theory and practice by practitioners, and greater attention is placed here on the less understood notion of adaptive capacity.

For the purposes of the PVA, adaptive capacity was defined as the ability to implement:

> coping strategies in the short term and forward-looking adaptation (the ability to plan and implement adaptation decisions) in the long-term. Coping strategies reflect the ability of a system to adjust to and cope with climate change. It is the ability to respond to changes by drawing on available assets (Ensor & Berger, 2009). It is the capacity to cope with adverse consequences by substituting or re-strengthening existing livelihood strategies…Forward-looking adaptation is the ability to reform a system in response to (unknown) variability and change. This means transforming the relationship of the system to climate and potential change. It is the ability to shape and create changes in a system (Ensor & Berger, 2009). Adaptive capacity is determined by whether a community has sufficient assets to cope with climate change, and by whether they can combine those assets to plan for the future and implement adaptation decisions in order to create and shape change. It is the process of

change that must be understood. In short, an assessment of adaptive capacity should measure the quality and the adequacy of livelihood assets available for adaptation.

In order to assess adaptive capacity, the PVA methodology includes an analysis of livelihood assets (based on the sustainable livelihoods framework) and a capacity assessment, for which a series of indicators were developed (Table 2-1). The indicators informed the assessment of adaptive capacity, both in terms of evidence of past adaptation and capacity to plan and implement adaptive decisions in the future. The indicators were developed taking into account previous capacity assessments carried out by Practical Action Nepal (Bhandari & Malakar, 2009) and the framework for understanding adaptation presented in Ensor and Berger (2009). Specifically, the indicators pay attention to flows of knowledge and information regarding climate and alternative livelihood practices. Moreover, the political and institutional framework is conceived to be dynamic and co-constitutive of adaptive capacity, rather than as a static context as is often presented in assets-based analyses.

Table 2-1 Adaptive capacity assessment indicators

Capital	Indicator
Natural	Diversity of natural resources Conservation of natural resources
Physical	Infrastructure Hazard relief materials Climate/hazard warning systems
Human	Community awareness of climate change Access to information on climate change and livelihood options Access to education and training (technical support) Experimentation Ability to conceive and plan for future change Cultural norms and practices
Financial	Diversity of financial resources Diversity of financial services (e.g. co-operatives; micro-credit; savings schemes; etc.)
Social	Social networks and groups Evidence of learning from others (mutual/reciprocal learning) Equity and equality
Political framework	Awareness among political representatives of climate change and livelihood impacts Supporting institutions Supporting policies Access to and participation in the decision- and policy-making of supporting institutions (i.e. propensity and ability to engage) Equity and equality (i.e. competing or mutual/unified interests)

2.2 Methods

An objective the PVA field test was to establish which particular tools are effective at gathering the necessary information to assess each component. The majority of data was gathered during the semi-structured interviews with key informants and the focus groups discussions within community members. The interviews lasted between 50 and 75 minutes, and were guided by a series of questions designed to shed light on community dynamics, livelihood practices, past, current, and projected climatic conditions, previous adaptation measures, plans for future adaptation, and the policies, institutions, and community groups that exist in support of adaptation.

The focus groups lasted between 2 and 3 hours and were designed to more specifically address the three components of exposure, sensitivity, and adaptive capacity. The participatory tools and methods deployed included community and hazard mapping, seasonal calendars, hazard ranking matrices, hazard impact matrices, historical timelines, (informal) scenario building, and Venn diagramming. The participatory tools and techniques were supported with discussion on the prevailing issues; it was within these discussions that scenario building was included rather than through the application of a particular tool, as advocated by Bizikova, Dickinson, and Pintér (2009). In addition to the focus group discussions, community (transect) walks were carried out to place the data in context and gather further detail where necessary.

In addition to the above qualitative methods, secondary sources were consulted to verify information provided during the interviews and focus group discussions. Specifically, village development committee (VDC) records were consulted to verify the occurrence, frequency, and magnitude of impact of various hazards, such as floods; national and regional IPCC data was consulted to generate an overall picture of climate change, which was complemented by Practical Action data and projections at the district level.

2.3 Site selection

The research was carried out in the Chitwan and Nawalparasi districts of South-central Nepal. In Chitwan, the PVA was carried out in the villages of Laukhari and Swargadwari, both of which are located in ward 1 of Meghauli VDC. Chitwan is located in the south-western corner of the central development region of Nepal, and lies in the Narayani administrative zone. The district has an area of 2,218 km^2, of which

In Nawalparasi, the PVA was carried out in Kadampur Village, located in wards 8 and 9 of Divyapuri VDC, and Kirtipur village, located in ward 3 of Devchuli VDC. Nawalparasi district is located in south-eastern corner of the western development region of Nepal, and lies in the Lumbini administrative zone. The district has an area of 2,016 km^2, of which 16% is categorised as middle hills (1000 – 2500m above sea level (asl), 62% Siwalik (200 – 1000m asl), and 22% Terai (60 – 200m asl) (Pradhananga, Karmacharya, & Subedi, 2009). Kadampur is located in Siwalik, and Kirtipur in middle hills.

The two different regions were selected for the diversity of challenges that each faces; within the two regions the villages were selected as they are linked socially, politically, and/or biophysically. For example, the two villages in Meghauli both fall within the management of one particular VDC and they both face challenges from the same two rivers. In Nawalparasi, the two villages are linked by a watershed, where Kirtipur is an upstream community and Kadampur a downstream community. The villages were also chosen because they are *not* part of climate change projects managed by Practical Action, meaning that community members have not been saturated with climate change research and project implementation (which would likely affect their responses and enthusiasm). The three VDCs are, in fact, existing disaster risk reduction (DRR) project implementation sites, which aided in gaining access to and the confidence of community members.

3 Situation analysis

3.1 National context: climate change and policy responses

The annual mean temperature in Nepal increased by 0.4^{o}C per decade between 1975 and 2005, with average annual temperature increases of 0.05^{o}C in the western region and 0.02^{o}C in the central region (Gurung, et al., 2010). According to the IPCC, this trend will increase in severity, as warming greater than the global mean is projected for South Asia (3.3°C), particularly during the winter months of December – February (Christensen, et al., 2007). Future increases of 2-4°C in extreme daily maximum and minimum temperatures are also projected in Nepal, increases that are likely to occur faster in night temperature than in day temperatures. The likely implication is less severe cold extremes in the future, resulting in less frequent ground frosts and over-night dew (Christensen, et al., 2007). This is supported by projections from UNDP, which indicate that mean annual temperature for Nepal will increase by 1.3 - 3.8°C by the 2060s, and 1.8 - 5.8°C by the 2090s. It also projects some increase in the frequency of hot days (11-28%) and nights (18-28%), and considerable decreases in the frequency of cold days and nights (Regmi & Adhikari, 2007).

Precipitation in Nepal is influenced by or correlated to several large scale phenomena including EI Nino/Southern Oscillation, regional scale land and sea surface temperature changes, and extreme events such as volcanic eruptions. Mean annual precipitation is increasing, as is the occurrence of intense rainfall. This causes more erosion of soils and riverbeds and banks, as well as sedimentation on fertile land. Weather-related extreme events like excessive rainfall, longer drought periods, landslides and floods are increasing both in terms of magnitude and frequency (Regmi & Adhikari, 2007).

In response to climate change, Nepal signed the United Nations Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro in June 1992, and ratified it in May 1994. Since then, Nepal has been regularly participating in Conferences of the Parties (COPs) and other subsidiary meetings. Nepal also became part of the Kyoto Protocol by submitting its instrument of Accession on September 16, 2005. In the context of adaptation, the National Climate Change policy and the National Adaptation Programme of Action (NAPA) are currently being formulated, and different scales of government are working with INGOs to generate data and information on climate change related impacts and to raise awareness among local people (Climate Change Network Nepal, Undated). The Ministry of Environment, Science and Technology (MoEST) has set up Climate Change Network (CCN,) involving inter-ministerial departments/organisations, interested bi-lateral and multilateral agencies, NGOs, academia, and the private sector, to address information, coordination and communication issues around climate change in Nepal.

Administratively, Nepal is divided into development regions and administrative zones. District Development Committees (DDCs) co-ordinate development activities at the district scale, carried out by constituencies and within that Village Development Committee (VDCs). DDCs and VDCs are responsible for the implementation of any local projects relating to climate change aspects, such as the establishment of disaster management committees or the development of local meteorological stations. As a result of land reforms since the 1950s, VDCs also play a role in land administration. As a result of the land reforms, land in Nepal is now classified as public, private, or religious property. Public land is un-owned and un-ownable or *de facto* government land. However, in practice a distinction is drawn between national land and community land; public land within VDC areas is now held under the responsibility of the community (Wily, Chapagain, & Sharma, 2008). In this context, *de facto* land-use rights can be granted to households and villages to make productive use of the land, usually through agriculture.

3.2 Local context: climatic conditions and their impacts on livelihood practices

3.2.1 Chitwan

According to a study conducted by Practical Action Nepal into the temporal and spatial variability of climate change in Nepal from 1976 to 2005, Chitwan exhibits a high increasing trend in minimum annual temperatures and post-monsoonal temperatures (Marahatta, Dangol, & Gurung, 2009). These trends equate to warmer winters and less predictable rainfall, the impact of which has been felt in decreasing soil moisture, off-seasonal damage to crops, and the decreasing water level of the Narayani and Rapti rivers since 1963 (Gurung, et al., 2010). The research was carried out in Meghauli VDC, where the impacts of climate change and related hazards are not uniform. Ward 8 is deemed to be of a higher socio-economic status than the rest of Meghauli, while wards 6 and 2 are particularly poor and are frequently affected by flood, which reinforces their low socio-economic status.

Laukhari Village, Meghauli VDC

Laukhari village is located in ward 1 of Meghauli VDC and the majority of residents are of the Kumal caste. The village is flanked on two sides by the major Rapti and Narayani rivers (Figure 3-1). Infrastructure includes two culverts across flood-prone over-flow channels and a school. The predominant livelihood practice in the village is agricultural production crops and, to a lesser extent, livestock.

In Laukhari, the major climatic shifts that concern the community are hotter summers, warmer winters, erratic rainfall, and longer and more severe droughts. The village is also prone to flash floods during monsoon season, and until an electric fence was recently installed the community had been preoccupied by the increasing frequency of wildlife intrusion. Erratic rainfall has had a significant impact on agriculture as a reliable livelihood practice. In 2009, for example, they planned to sow their crops in the second half of May, when rain is expected. This is usually followed another period of rain, which enables them to cultivate their paddy. In 2009, there was no rain in the expected seasons, and many farmers suffered from the death of seeds and seedlings due to dry soils. Flash floods are also a major cause for concern, as they damage crops, infrastructure, and food stores, and increase the threat of water-borne diseases. During monsoon, both the Narayani and Rapti river flood, and inundate the entire village. The flood water enters via a natural overflow channel (Figure 3-1), which used to provide water for irrigation. The channel is now dry until monsoon, when irrigation is not necessary or possible. The erratic nature of rainfall and the increase in frequency of flash floods has also increased the impact of river erosion, which is decreasing the area of land available for the community forest and damaging natural flood defences.

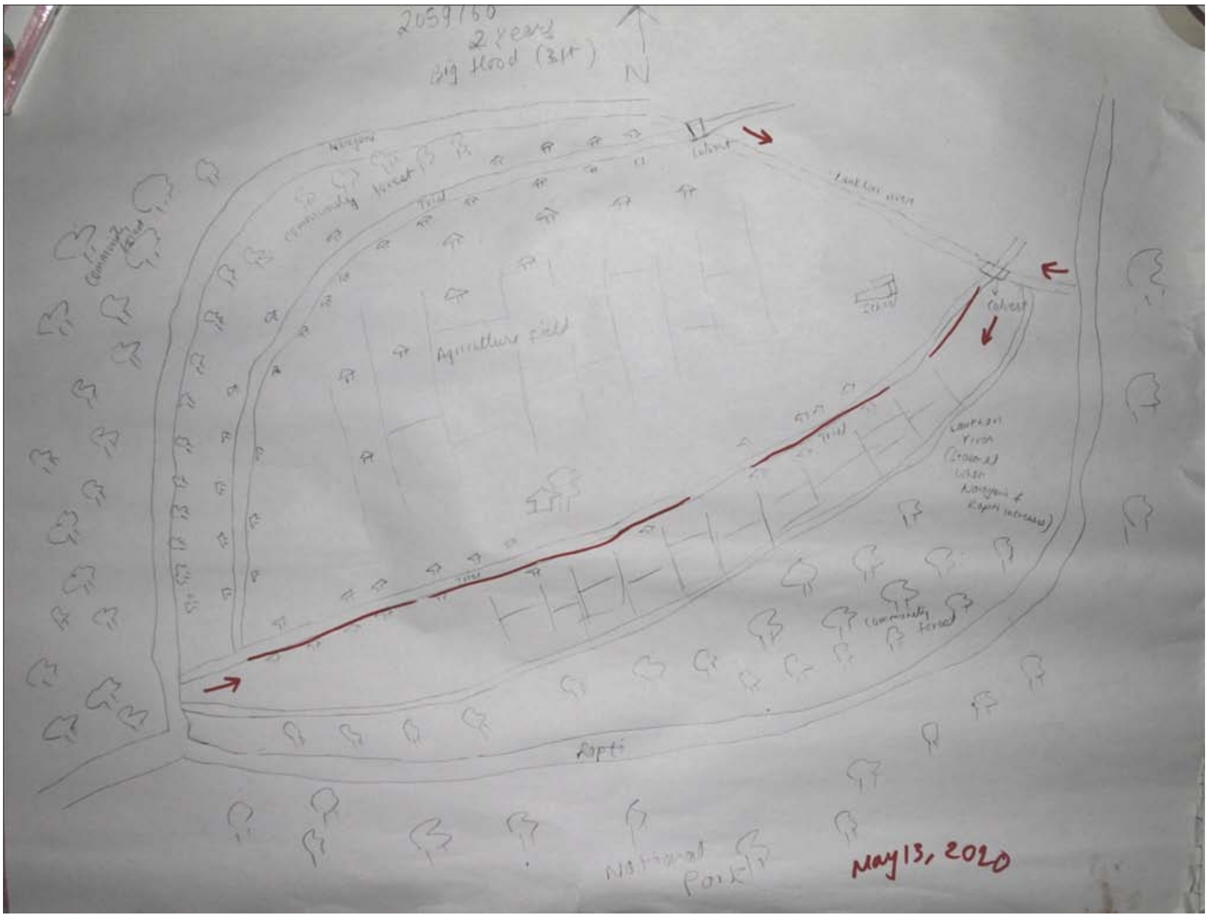

Figure 3-1 Community map of Laukhari

Swargadwari Village, Meghauli VDC

Swargadwari is located in ward 1 of Meghauli VDC, and the majority of the community belongs to Bote, Brahmin, and Kamal castes. Infrastructure in the village consists of an emergency disaster shelter, two shallow tube wells, and an early warning system tower. The major livelihood practices are daily wage labour in agriculture, agricultural production on their own land, fishing, and daily wage labour in the nearby town. Maize, rice paddy, and mustard dominate the agricultural landscape around the village. Daily wage labour in agriculture is the predominant livelihood practice due to the poor quality of land held by community members. The majority do not own their land, but in fact possess *de facto* use rights; it is public land at the community scale, which allows for local use. Since there is not a history of agricultural maintenance on the land, it is of poor quality, and the farmers are unwilling to invest heavily to improve the land due to the insecurity of tenure that results from the *de facto* system. Some households also have family members, particularly the youth, working in India and sending remittances.

The major long-term climatic shifts that worry village residents are longer summers and shorter winters, which has reduced the availability of irrigation water. The warmer winters have also brought new pests, and enabled pests to live year-round. Greenfly, for example, has recently been decimating mustard crops, forcing many to abandon mustard cultivation all together, while other pests are attacking maize, which is often seen as a replacement for mustard.

Although Swargadwari is also close to both the Narayani and Rapti rivers, the village is located on the shores of the Rapti river, which poses the greatest threat of flood. During monsoon season, the entire village in inundated with flood waters from the Rapti. Despite the increase in frequency of flash floods, the overall water level of both rivers has been decreasing according to community observations. This is observation is supported by data on river levels, which show continuous decreases in volume since 1963 (Gurung, et al., 2010), as well as a consultation held upstream in Pokhara (NCVST, 2009). Decreased water levels have had a significant impact on local fishers, who are now finding it hard to sustain fishing as a sole livelihood practice. The floods are also contrasted by the increasing frequency of severe drought during the dry months of the year, which have resulted in decreased agricultural production and at times total crop failure.

Despite the recent construction of an electric fence between the village and the community forest, the community remains concerned about the dangers posed by feeding wildlife, particularly rhinos. As a result of the proliferation of invasive plant species in the national park (which may be attributable to climate change), rhinos are more frequently crossing the Rapti River to feed in the community forest. This poses a threat to community members who rely on the forest resources for fuel wood and animal fodder.

3.2.2 Nawalparasi

Nawalparasi is one of the few districts in Nepal that exhibit a decreasing trend in annual mean maximum temperature as well as a decreasing trend in average winter and post-monsoon temperatures.

Kadampur Village, Divyapuri VDC

Kadampur is located in wards 8 and 9 of Divyapuri VDC, and lies adjacent to the Baulaha River. The majority of community members are of the Brahmin and Magar castes. Infrastructure in the village includes a water diversion canal and reservoir, two privately owned dig wells, and two schools. The major crop in the community is rice paddy, which they are able to harvest three times a year. Rice paddy is cultivated in June and July, followed by wheat and then maize. Livestock is not reared for commercial purposes, but most households keep a few goats, 1 or 2 buffalo, and some pigs are kept by the Magar community. A few households also cultivate vegetables for personal and commercial use.

Figure 3-2 Baulaha river bed

According to community members, the major challenge that they face is drought and the associated general unavailability and unpredictability of water for agriculture. Baulaha River used to flow year-round, but now only flows during monsoon rains (Figure 3-2). Frequent lack of rain has had a severe impact on agricultural production; maize has completely failed for the past three years, while the transplant of paddy seedlings has been delayed, causing many to die and subsequently lead to decreased production (Table 3-1). Agriculture has also been affected by the decreasing frequency of over-night due, which used to irrigate the lentil crops. The lack of dew has resulted in the abandonment of lentil cultivation. The community also identified floods during monsoon season as a hazard, along with the deteriorating quality of their agricultural soils due to the flushing of nutrients from the soil.

Table 3-1 Kadampur seasonal calendar

Community observed changes		Baisakh (Apr/Mav)	Jeth (May/Jun)	Asar (Jun/Jul)	Shrawan (Jul/Aug)	Bhadra (Aug/Sep)	Aswin (Sep/Oct)	Kartik (Oct/Nov)	Mangsir (Nov/Dec)	Poush (Dec/Jan)	Magh (Jan/Feb)	Phagun (Feb/Mar)	Chait (Mar/Apr)
Summer	Now	High temp.		Increased temp.									
	20 yrs ago	High temp.											
Winter	Now								Increasing temp.				
	20 yrs ago												
Flood	Now												
	20 yrs ago					Sometimes							
Drought	Now												
	20 yrs ago												
Rain	Now				Unpredictable								
	20 yrs ago					Regular							
Crops: paddy	Now		Sow	| transplant				Harvest					
	20 yrs ago		Sow | transplant					Harvest					
	Now								Sow				Harvest
maize	20 yrs ago								Sow				Harvest
	Now								No maize for past 3 years due to lack of rain				
wheat	20 yrs ago												

Kirtipur Village, Devchuli VDC

Kirtipur village consists of 114 households and is located in wards 2 and 3 of Devchuli VDC at approximately 1,000 metres above sea level. The majority of the community belongs to the Magar caste; infrastructure in the village consists of a primary school, a dam and irrigation canal, a newly installed water tap, a community centre, and a mill for the processing of maize and rice paddy. The village lies adjacent to a tributary of the Baulaha River, which runs to the downstream community of Kadampur. The major occupation is agriculture, and the primary crop is ginger. Previously they cultivated maize and millet via shifting cultivation (slash and burn); such practices have been replaced with permanent agriculture, including wheat and maize cultivation and vegetable farming. Livestock are also reared, including goats, pigs, chickens, and buffalo. The community relies on the surrounding community forest for a source of fuel wood and animal fodder. Since the village is located in the hills, land is a scare and there is no room for agricultural expansion.

The major seasonal challenges are hotter summers and shorter rainy seasons. Irregular and unpredictable rain has made it difficult to cultivate land that is up-hill from the established irrigation system, which sources water from the Baulaha tributary river. The rain that previously fell during March/April and November/December is longer dependable, and a lack of rain has often prevented agricultural production in these seasons. As a result, droughts are also perceived to be more common.

The major extreme event that affects the village is landslides, which still occur during the same time of year (June – September) as they did twenty years ago. Landslides are perceived to present the greatest threat to the village source of drinking water, but also damage crops, livestock, and infrastructure such as the irrigation canal and village buildings. Landslides are linked to erratic and intense rainfall, and as a result are perceived be more frequent. Extreme hailstorms are also perceived to be increasing in frequency; hailstorms damage infrastructure and threaten livestock.

3.3 Evidence of coping, adaptation, and planning

Table 3-2 Adaptation and coping strategies in Laukhauri

Aspect	Adaptation	Rationale	Effectiveness (constraints; sustainability)	Supporting factors
Infrastructure	Raised plinths	Protects possessions and food from floods; protects infrastructure	Houses and possessions remained undamaged by floods; does not protect livelihoods (i.e. crops and livestock)	Technical support from Practical Action; awareness raising and skills training
	Bridge construction taking account of previous flood levels	Provide an evacuation route and ensure bridges aren't damaged	Only effective if flood doesn't exceed previous levels - not tested in more extreme conditions	Technical support from Practical Action
	Dam construction	Prevents floods	Successfully reduced the impacts of floods, but has not eliminated them altogether	VDC implementation
	Early warning system	Provide some warning of floods, allowing for evacuation	Short term coping strategy; lack of resources to pay tower personnel; untested – no floods since implementation	Technical support and implementation by Practical Action and Disaster Management Committee
	Shallow tube wells	Provides water for irrigation	Only been established by better off farmers – poor still vulnerable and suffer during droughts	Supported (financially and with technical support) by VDC and DDC
	Reservoir	Water storage	Wards 1-4 (which includes Laukhari) remain vulnerable as cannot access water from the reservoir – still depend on rain-fed irrigation; damage to irrigation canal during floods, which subsequently damages crops.	Technical support from VDC and Practical Action
Agricultural practices	Use over flow river as irrigation source	Seasonal use of overflow channel to irrigate crops	Changes in climatic conditions mean that now the river is either dry or flooding during monsoon. During monsoon, the entire community floods, and there is no way of using the water for irrigation purposes; have not explored water storage.	Biophysical conditions; experimentation
	Vegetable farming	Requires less irrigated land area; added income-generation opportunity	Vegetable and fruit (watermelon) thieving (farmer constructed a watch tower, which he now sleeps in; so adaptation had negative knock-on effects, in some ways, although he is doing well from the watermelons.	Technical support from Practical Action
	Collect grasses from National Park	Decreased quantity available in community forest, so cross the river to collect.	Illegal, dangerous; not possible during monsoon as the river level is high.	Propinquity of national park; low water level in the river; lack of policy/law enforcement.
Ecosystem management	Plantations and forest conservation	To reduce impacts of floods and maintain source of forest products.	Flood destroyed bamboo plantation	Education and awareness-raising by community forest.
	Traditional climate	Likelihood of a rainy or dry	Unproven method	Reflects need for climate information, as

	projections	year is predicted using three pieces of soil and a bucket of water (moist soil/empty bucket = sufficient rain)		people are trying to find out information on rains.
Livelihood alternatives	Seasonal migration and daily wage labour in nearby town	Income generation	Dependant on local labour markets; does not address decreasing agricultural production or increasing frequency of hazards	Development of transportation routes to towns
Coping with hazards	Climb trees during flood	Saves lives during heavy flood	Extremely short term; only saves lives, not livelihoods; unsustainable even in the short term.	Biophysical conditions (climbable trees); last resort.
	Shelter and seed distribution	Short-term response to floods	No plans by VDC to provide more long-term support to seasonal variations; farmers still have to react as events occur.	VDC implementation

Table 3-3 Adaptation and coping strateiges in Swargadwari

Aspect	Adaptation	Rationale	Effectiveness (constraints; sustainability)	Supporting factors
Technology and infrastructure	Early warning system	Provide some warning of floods, allowing for evacuation	Short term coping strategy; lack of resources to pay tower personnel; untested – no floods since implementation.	Technical support and implementation by Practical Action and Disaster Management Committee
	Shallow tube wells	Water for irrigation	Provides water for the irrigation of 7 hectares of land. Does not cover enough area; cannot channel water from the river as it is at a lower altitude – think government has the capacity to do it, but they have shown no inclination for this; lack of capacity within community to invest in tube wells; restricted government budget for these activities.	Supported (financially and with technical knowledge) by VDC and DDC – 9 STWs funded from central source.
	Dam construction	Prevents floods	Successfully reduced the impacts of floods, but has not eliminated them altogether.	VDC implementation
	Installation of biogas facilities	Reduces burden on forest	Need for continuous technical support and access to replacement parts.	Community forest and national park buffer zone awareness-raising and financial support.
Agricultural practices	Accessed hybrid seeds and fertilisers	Higher yields	Loss of traditional varieties; dependency on the market (no seed saving); dependent on chemical fertilisers.	Gained access to agricultural extension services (*agrivets*)
	Diversifying livestock	Reduces burden on the community forest for fodder; more diverse production		Awareness-raising by community forest and national park buffer zone; education.
Ecosystem management	Plantations and forest conservation	To reduce impacts of floods and maintain source of	Flood destroyed bamboo plantation	Education and awareness-raising by community forest.

		forest products.		
Livelihood alternatives	Daily wage labour	Income generation	Dependant on local labour markets; does not address decreasing agricultural production or increasing frequency of hazards	They only have *de facto* use rights for their land, which creates insecurity of tenure and does not encourage investment in land improvements.
Coping with disasters	Banana plantation	Use trees as boats during the flood; eat and sell bananas when fruiting	Short-term coping strategy for floods; added benefit of an extra source of income-generation	Experimentation; ability to think of alternatives and plan ahead.
	Temporary relocation	Temporary living during flood emergency; receive compensation if in buffer zone	Short-term; insecure; requires valuation of land prior to flood	VDC initiative; National Park buffer zone compensates for land lost due to flood in the buffer zone (i.e. by Rapti River).

Table 3-4 Adaptation and coping strategies in Kadampur

Aspect	Adaptation	Rationale	Effectiveness (constraints; sustainability)	Supporting factors
Technology and infrastructure	80m+ deep bore well	Shallow tube wells not possible due to depth of water	Not yet found water; uncharted territory – experimental, and don't know if will get water; different geological conditions to other experiences.	Experimentation following success in private enterprise of community leader; visiting successful deep bores; INGOs and government for technical support
	Reservoir construction	Water storage	Baulaha River is no running dry most of the year, meaning that the reservoir level is dropping; uneven access to the reservoir.	Technical support from Practical Action
Agricultural practices	Switch from mustard and lentils to wheat and maize, respectively.	Mustard and lentils failing due to dearth of water and greenfly attacks; wheat is resistant to greenfly.	Effective at first, but now maize is also failing due to lack of water and no plans to change; lack of capacity to conceive of alternatives.	Experimentation; assumption that traditional knowledge and practices are inappropriate; reliance on knowledge of one community leader.
	Increased use of pesticides and chemical fertilisers	Increases production	Increases dependency on expensive inputs; fertilisers and pesticides not always available and farmers do not always have the income to purchase them, meaning that their crops suffer more than traditional varieties would.	Technical support and agricultural extension
	Collection and use of livestock waste	Use manure as fertiliser and transform urine into a natural pesticide	Unknown – in initial phase of awareness-raising and implementing cow shed for waste collection.	Community forest technical support and awareness-raising; ability to plan.
	Plant jatropha (for biodiesel)	Use of fallow land; requires less water than traditional crops	Too early to assess (a lot is not yet planted, but planned); need technical support for jatropha cultivation.	Community forest technical support and awareness-raising; ability to plan.
	Cultivation medicinal crops (planned)	Diversify agriculture; added medicinal benefits.	Need technical support on the cultivation of medicinal crops; need access to seeds and necessary inputs.	Community forest technical support and awareness-raising.

Ecosystem management	Bamboo planting	2,600 were planted to reduce flood impacts and provide additional income source (NTFPs)	Bamboo plantation failed due to lack of water – less than 50% survived; no plans for how to address this.	Planted due to technical support from Practical Action; lack of support for addressing failure.

3-5 Adaptation and coping strategies in Kirtipur

Aspect	Adaptation	Rationale	Effectiveness (constraints; sustainability)	Supporting factors
Technology and infrastructure	Irrigation system – water collection pond created by dam in the river, from which water is channelled through a 6 inch pipe into an irrigation canal to the village.	Provide reliable water supply	Increase from 2 to 3 harvests a year; does not reach a large proportion of the community that has land above the canal (they remain rain-dependant); doubts over longevity/sustainability (source will dry up).	Technical and financial support from Practical Action and VDC; voluntary labour from the community.
	Use stronger building materials for homes and livestock sheds	Prevents damage from hailstorms (which are increasing in frequency)	Planned	Need access to stronger materials, either locally or through improved transportation infrastructure; need technical knowledge and skills for building.
	Construction of community building	Strong, reliable infrastructure for community use.	Space for community meetings about future plans; storage for official documentation; emergency shelter.	Technical support from Practical Action
	Construction of a mill for maize and paddy	Enhance capacity to processes agricultural products	Improved income generation (selling processed not just raw products)	-
Agricultural practices	Switch to hybrid seeds	Higher production levels	Increases dependency on expensive inputs	Agricultural extension (*agrivets*) in downstream community.
	Vegetable and fruit (lemon, lychee, mango) cultivation, instead of shifting cultivation (slash & burn)	Diversified agriculture; extra source of income; improved ecological management	Providing good income; deceased deforestation; using previously fallow land.	Technical support and awareness-raising from Practical Action
	Grow yams instead of failing maize (planned)	Reduces irrigation demand, maintains production.	Not implemented yet, as cannot transport (too heavy to get downstream); need to the road for access to markets in downstream.	Experimentation; local/traditional practices
	Switched from	No rain in winter and aphid	More reliable production, but still prone to failure if lack of rain;	?

	mustard to maize,	attacks; maize is more resilience to both problems	uneven benefit (those uphill from the irrigation canal still rely on rain, whereas those with irrigation can grow maize effectively).	
	Started bee keeping	Income diversification; Increased income	Efficient production due to natural foraging space for bees; organic honey; selling honey in downstream community – enhanced income.	Technical support from Practical Action; demand for honey from downstream.
Ecosystem management	Plantation in forest	Reduce landslides and hazards; reduce dependency on the forest for fodder; and reduce burden of collection (source closer to home)	Landslides have decreased in frequency; deforestation has decreased.	Awareness raising by community forest; capacity to think ahead;
	Plantation around drinking source	Prevents drinking water contamination; slows run-off to prevent the source drying up	Landslides have decreased in frequency.	Education in downstream community of one community member who has ideas and plans; sharing of those plans in community meetings.
	Prevent/control wildfire	Reduce forest destruction; prevent landslides.	Greater awareness amongst the community; landslides have decreased in frequency.	Community forest awareness-raising; education.
	Plant grasses (planned)	Demand less water, prevent over-land run-off, and provide an extra income-generation opportunity	Not implemented: Risk of failure (lack of insurance mechanisms, which limits entrepreneurial capacity) – fear of taking the blame; lack of access to supporting service providers and technical support to help implement plans; lack of access to advanced education (in downstream community); symbolic participation in planning processes (e.g. participate in VDC meetings etc, but it is not effective in getting projects in the community) – access but no effective support.	Idea: education of one community innovator; awareness-raising through group meetings and forums.
Livelihood alternatives	Tourism development	Diversified income sources; increase off-farm income; catalyse infrastructural development projects.	Not implemented due to lack of infrastructure.	Entrepreneurialism of community leader

4 Adaptive capacity assessment

The aspects and supporting factors of adaptation, presented in tables 3-2 – 3-5 , indicate some of the key themes of adaptive capacity in rural areas of Chitwan and Nawalparasi. These themes are explored below, first through the identification of common areas of adaption and followed by a discussion of the issues that arise in deploying or drawing on adaptive capacity.

4.1 Common areas of adaptive capacity

As Bhadwal et al. (2003) point, out adaptive capacity in agriculture is considered to be an outcome of biophysical, socio-economic, and technological factors; to this we can add political and institutional dimensions.

4.1.1 Biophysical factors

The biophysical factors that influence agricultural production include soil conditions and groundwater availability (Bhadwal, et al., 2003), factors that were frequently discussed and often at the centre of adaptation activities in the research communities. Bhadwal et al. (2003) assume that areas with more productive soil and more groundwater available for agriculture will be more adaptable to adverse climatic conditions. However, the capacity to effectively source groundwater and improve soil conditions also reflects a community's adaptability. In Laukhari, for example, irrigation measures have transformed over recent years in response to the drying up of an overflow channel that links the Narayani and Rapti rivers. Previously farmers in the village used the overflow channel to irrigate their crops, but now the river only flows during the floods associated with monsoon season (when irrigation is neither necessary nor possible). In response, and with the support of Practical Action and the VDC, shallow tube wells have been developed along with a water reservoir; reflecting a capacity to affect the biophysical factors that support agriculture. However, the shallow tube wells have only been implemented by relatively well-off farmers, while farmers in wards 1 – 4 are unable to access the reservoir and remain vulnerable and dependant on rain-fed irrigation. Those who do have access to the reservoir remain vulnerable during times of flooding due to the damage that is often caused to the irrigation canal, which subsequently damages crops. In Swargadwari, similar measures have been implemented, but the effectiveness of shallow tube wells is also in doubt due to the small area (7 hectares) of land they are able to irrigate. In Kirtipur only those who farm downhill from the irrigation channel are able to benefit, there are also doubts as to how long the source of water will continue to flow. In Kadampur, meanwhile, they also have a reservoir, but the level is dropping due to the drying of the Baulaha River that feeds it. In an attempt to manage this situation, they are experimenting with a deep bore well that is over 80m deep. Experimentation is being driven by a community leader whose private enterprise already has a deep bore well. However, at 80m they are yet to hit water and the effectiveness and efficiency of the initiative remains unknown.

Farmers in three of the villages also demonstrated the capacity to affect the productivity of their soil. In recent years, the introduction of chemical fertilizers has helped to improve productivity. In Kadampur they are also combating the increased use and dependency on chemical inputs by experimenting with natural fertilizer and pesticides derived from livestock waste. In Swargadwari, however, there is a lack of capacity to affect the productivity of their soils. Local farmers only have *de facto* use rights over the land, which creates insecurity of tenure in the long term. As a result, farmers are reluctant to invest in land improvements and would rather sell their labour to farmers in neighbouring villages, where the soil is of better quality and the land rights secure.

Another common aspect of biophysical adaptive capacity exhibited in the communities was *ecosystem management*, often in the guise of forest conservation and tree planting. Three of the communities have experimented with bamboo planting to reduce the impacts of floods as well as provide an extra source of animal fodder and an income generating opportunity (from the sale of NTFPs). However, in Kadampur the bamboo plantation failed due to a lack of water and in Swargadwari floods have destroyed the bamboo. Such experimentation reflects a capacity to proactively transform the ways in which the ecosystem functions; however, the ability of these communities to conceive of alternatives to bamboo will be a test of their capacity to face unexpected adversity. In Kirtipur they have had more success with plantations, as they have reduced the frequency of landslides and reduced the burden of collection by bringing a fuel and fodder source closer to the village. They have also planted grasses on previously fallow land, which provides an added income-generation source and reduces the overland flow of water. They are also planning a plantation around the drinking water source to protect it from damage and prevent it from drying (by slowing water flows). While the four communities are being supported in ecosystem management practices (usually by the community forest scheme), there remains a lack of information on future climate, which would help in ecosystem management planning. This is reflected by the traditional practice in Laukhari, where they place a bucket of water on top of three piles of soil; if the soil is saturated with water when they return, then a year of plentiful rain is forecast. The reliance on such unproven methods illustrates the lack of scientific data being generated and disseminated to local farmers, who are clearly looking for climate information.

It is important to remember that biophysical adaptive capacity is relative, and some communities may appear to be well endowed with adaptive capacity because many opportunities for adaptive capacity remain. These opportunities may serve well in the near future, but once they have been explored, biophysical adaptive capacity may decrease. Thus, areas that possess many options in biophysical adaptation may have the capacity to adapt to a 2^{o}C warming scenario, but if the biophysical adaption options are exhausted in this process they may not possess the capacity to adapt to more severe changes such as a 4^{o}C warming scenario.

4.1.2 Socio-economic factors

For Bhadwal et al. (2003), the socio-economic factors that influence adaptive capacity relate to employment in agriculture, the proportion of landless labourers in the agricultural workforce, human capital (as represented by education and access to information), and gender discrimination. In addition, socio-economic adaptive capacity requires a diversity of income sources, dynamic links to markets, supportive and equal social networks, and the presence and accessibility of financial support mechanisms such as micro-credit and savings schemes (though this last aspect will be explored below in relation to the institutional context). Broader inequalities are also important, particularly given the caste system in Nepal.

In the four communities, socio-economic adaptive capacity is evident in the diversity of their agriculture and sources of income. All four communities have substituted between different crops, either in response to particular challenges (e.g. more frequent droughts) or as part of a continuous process of experimentation and agricultural improvement. Many farmers are also maintaining year-round production of a variety of crops, including rice paddy, maize, wheat, vegetables, and fruits such as lemon, mango, and watermelon. Other avenues of income-generation being explored are bamboo plantations for the production and sale of NTFPs, bee-keeping (which has been successful in Kirtipur), and in Kadampur the cultivation of medicinal plants and jatropha for biodiesel. Jatropha requires less water than any other major crop (such as wheat) and is able to grow in poor-quality soil that is often left fallow. Given the rapidly expanding market for biodiesel, the planting of jatropha in Kadampur reflects an imaginative and entrepreneurial approach to agriculture. The difficulty, however, may lie in establishing good links to markets. For the major crops grown in all four communities, strong and stable links to markets have been established. In Meghauli, a key informant went so far as to state that the farmers were in a strong bargaining position and have the upper hand over traders who come to purchase their products. All of the communities also have good links to seed markets, which has allowed them to increase their use of hybrid varieties and experiment with different crops.

Beyond agriculture, the major sources of income are daily wage labour and seasonal and long-term migration. Laukhari, Swargadwari, and Kadampur benefit from propinquity to labour markets, and many community members are engaged in daily wage labour in nearby towns. Kirtipur, however, is at least two hours walk to the nearest town, which reduces the lure of wage labour. In Swargadwari, the majority of farming actually occurs via daily wage labour in neighbouring villages. Although this reflects a diversity of income sources, the fact that *de facto* land use rights have driven farmers to daily wage labour reveals the vulnerability of the community – insecurity of tenure, coupled with dependence on insecure daily wage labour, does little to enhance the capacity of a community to successfully adapt to future changes. The other three communities, however, use seasonal migration as an adaptive strategy during times of hardship, usually when floods destroy their crops. Some households also have members in India sending remittances.

However, the human capital to support income diversification is limited in the four communities. This is particularly the case in Kirtipur, where the nearest secondary school is in the downstream community 3 hours away by foot. Few sources of information and education exist for the four communities, and many rely on the influence of agricultural extension and representatives of the community forest programme or national park. Moreover, access to such services is unequal. In Kadampur, for example, the community leader interviews belongs to the Brahmin caste, which has enabled Brahmin farmers to gain access to knowledge and information about alternative agricultural practices, while the Magar caste remain ignorant to these alternatives. In Kadampur gender dimensions also affect community dynamic, as reflected by the fact that only men of the Brahmin caste attended the focus group discussion; there were no women or members from any other caste. In the other three communities, in terms of absolute numbers participation in the focus group discussions was dominated by women. However, the male participants frequently took control of the proceedings, illustrating that equal attendance does not necessarily reflect equality of social and gender relations. While the strength and depth of social networks was not fully explored as part of this research, the discussion of adaptation ideas during community meetings in Kirtipur offers an example of how knowledge and information can be made mobile by supportive social networks.

4.1.3 Technical factors

According to Bhadwal et al. (2003), the technical and technological factors that influence adaptive capacity include irrigation and infrastructure. Irrigation was explored above in relation to the capacity a community possess to alter biophysical factors in favour of sustaining livelihoods. Such adaptation is not possible without the technical, technological, and infrastructural support necessary to implement and sustain the changes. In Kirtipur, for example, the irrigation system consists of a river dam, from which a 6 inch tube leads to a concrete canal. This infrastructure was developed by Practical Action and with a financial commitment from the VDC. The community did, however, voluntarily provide their labour for the construction of the irrigation system, which reflects their recognition of the importance of such measures. In Kirtipur the community as a whole was successful in securing support for the irrigation system, but access to irrigation is not so uniform in other villages. In Kadampur, there are two dig wells, which are privately owned and were privately developed. Similarly, the community learned of deep boring due to the development of an 80m deep bore by a private corporation. In Kadampur, it appears that financial wealth determines access to infrastructure for irrigation. In other areas, irrigation is simply not effective enough, such as in Swargadwari, where the shallow tube wells do not cover a large enough area and the community lacks the technical and technological capacity to source water from the nearby Rapti River.

Beyond irrigation, the infrastructural capacity in the four villages is generally low, and relies on sporadic technical and financial investment from the respective VDC and NGOs such as Practical Action. In Laukhari, two bridges and a temporary shelter were built for flood evasion, and houses were redesigned with raised plinths to protect against damage from floods, all of which was achieved with the added technical capacity provided by Practical Action. Similarly, the early warning system in Swargadwari was the result of a partnership between Practical Action and the DDC to create a disaster management committee. In Kirtipur, the community building that houses the information sharing meetings about adaptation options was also built with the technical and financial support of Practical Action. However, in Kirtipur they have also recognised the need to build with stronger materials so as to withstand hailstorms; the limiting factor here is access to stronger materials, which is restricted by the lack of transportation infrastructure. Indeed, a road is currently under construction, and the community are looking forward to its completion as it will improve access to markets and enable the easier transportation of building materials and heavier types of crops, such as yams. The cultivation of yams is a strategy identified by the community for addressing the decreasing availability of water, as yams grow in conditions that wheat and maize will not. However, the strategy has not been implemented because they are unable to transport yams to the downstream community. While the completion of the road will solve this problem, it is being built across landslide prone areas with erratic and intense overland flow of water, making it a vulnerable piece of infrastructure on which to rely.

Finally, the technical aspects of adaptive capacity also relate to human capital in the form of technical know-how. For example, links to agricultural service providers, locally known as *agrivets* (agricultural and veterinary services), has helped to build technical knowledge in terms of the combinations of hybrid seeds, fertilisers, and pesticides that are available to and beneficial for farmers in particular contexts. Similarly, in experimenting with alternative crops such as medicinal plants and jatropha, farmers in Kadampur require the technical capacity to effectively cultivate these crops and sustain the agricultural system to suit them. Whether such capacity exists in Kadampur remains to be seen, but in Kirtipur the technical knowledge for growing fruits and vegetables has been provided by Practical Action.

4.1.4 Political and institutional dimensions

Lacking from Bhadwal et al.'s (2003) account of adaptive capacity in agriculture is an appreciation of how the above factors are co-produced and mediated by a complex web of political actors and institutions. Such an appreciation goes beyond a broad policy perspective, some aspects of which were presented in section 3.1. It is necessary to gain an understanding of the ways in which institutions connect at a variety of scales to support and/or restrict the adaptive capacity of a community. In the context of agriculture in rural Nepal, the common institutions and structures of governance include: government bodies at a variety of scales (VDC, DDC, national government,); government and non-government agriculture-specific institutions (such as district agriculture offices and *agrivets*, respectively); government and non-government ecosystem management organisations (such as the Chitwan National park and community forestry initiatives); CBOs; local and international NGOs (e.g. Sahamati and Practical Action, respectively); local co-operatives (farming, dairy, financial); local savings and micro-credit groups; community social groups (e.g. women's groups); and community decision-making committees. The influence of these institutions over adaptive capacity often extends beyond their strict remit or the practices with which they would usually be associated. Micro-credit and savings groups for example, do more than provide financial security.

In all of the communities investigated, the VDC has played a role in previous incidences of adaptation (as the tables in section 3.3 illustrate), and has been most active in developing flood defences (dams), warning systems (viewing towers), and response plans (evacuation routes; temporary shelters; temporary relocation). In Meghauli, these activities have been subsumed within the newly formed disaster management committee. However, the role of the VDC is perceived differently in each village; in Laukhari the VDC was perceived to be effective in infrastructure development and yet almost completely ineffective in disaster relief. In Swargadwari, the same VDC was perceived to be proactive in developing flood defences and warning systems, but less important than the community forest scheme in terms of ecosystem management and general development. In Kadampur, the VDC has even been sidestepped by a community that has close links with the community forest scheme. The rationale behind such a strategy is the bureaucracy involved in pursuing projects through the VDC, as the project must be approved centrally, before being administered through the DDC to the VDC. In Kirtipur, physical distance plays a large role in the perceived absence of the VDC and its reluctance to implement the projects that community members demand. In all villages, there is perceived to be a lack of communication between the VDC and the communities; even when participation in meetings is possible, this is restricted to symbolic rather than substantive participation - i.e. participation in the meeting does not affect the outcome or the development plans that emerge. It has been shown that symbolic participation of this kind significantly hampers to implementation of equal and sustainable development projects (Yates & Gutberlet, 2010).

Although many of the VDC projects are linked to other scales of government through funding (they are funded from a central pot, which is then distributed by DDCs to VDCs), there is a lack of co-ordination between VDC and DDC activities. In the focus group discussions of all four communities, participants agreed that the DDC appeared to have no bearing over local development initiatives, and that any DDC activity was channelled through the district agriculture office, which is itself too distant to be effective. Indeed, the majority of respondents confessed to not knowing where the district agriculture office is located or to having never been despite being registered with the office. In Chitwan, the office moved to the district capital of Bharatpur, further away from Laukhari and Swargadwari, thus limiting its accessibility and potential effectiveness in enhancing adaptive capacity in the two villages.

Local and district government, then, is regarded as reactionary, relatively inaccessible, and rather reactionary. By contrast, community forest schemes have been active at the ground level and are regarded by community members and key informants as transparent and accountable. Community forest schemes are most active in awareness-raising and education on issues of forest conservation, biodiversity, and broad ecosystem management. However, they have also proved to be a rich source of technical knowledge in areas as diverse as alternative fuel technologies (biogas and briquettes), agricultural diversification (jatropha), flood management (tree plantations), and alternative technology development (cow sheds for manure and urine collection). Importantly, the community forest is an independent local organisation that is managed by an elected committee of local representatives. Projects, policies, and budgets are frequently reviewed by the committee, and community members encouraged to participate in committee meetings. Similarly, the buffer zone of Chitwan National Park is an independent body with its own budget, and is seen as a relatively effective mechanism for communicating between communities and government. The buffer zone also offers a degree of insurance; in Laukhari and Swargadwari, if a household is forced off their land by the flooding of Rapti River, which divides the National Park from the community forest, the buffer zone organisation will reimburse the household for the value of the land.

At the local level, all four communities are also actively engaged with local co-operatives, particularly agriculture and dairy co-operatives. The co-ops are locally formed and locally run, meaning that the communities and community members retain ownership over their management and activities. The co-operatives not only provide a mechanism for the purchase and selling of agricultural products, but also provide small-scale loans and savings schemes and are a rich source of information regarding new or alternative agricultural practices. The co-operatives act as a catalyst to knowledge and information sharing, while also providing the financial and social security required for farmers to experiment with new ideas and practices. In Kirtipur, until recently there was no local co-operative, which is why community members are reluctant to experiment with new and unproven techniques or livelihood practices. However, they have recently started as credit and savings co-operative, which they are hoping will provide them with financial security. In Kadampur, it is an agricultural group that is providing this security, as well as the information sharing and networking that has led to the accessibility of and adoption of new seed varieties.

It is also clear that local and international NGOs play a prominent role in building adaptive capacity through the input of technical knowledge and expertise, financial support, awareness-raising, and information dissemination. Since all four locations are Practical Action project sites, it was inevitable that Practical Action would be identified as an important organisation in local development. While the presence of organisations such as Practical Action helps to build adaptive capacity, the limit lies in questions of permanency. Although Practical Action has a long history as an organisation, the Nepal office is relatively young and since projects are usually funded on a limited term by donors such as DfID and the EU, there is no guarantee as to how long Practical Action projects will remain in any one community. While projects exist, Practical Action is able to help build technical and technological capacity, awareness of agricultural alternatives and sustainability, and provide links to other service providers. However, if Practical Action projects come to an end, the financial and technical support that the organisation provides will suddenly be withdrawn. While the community will be left with enhanced capacity in some areas, the withdrawal of a key organisation in the community may leave a hole that hampers future adaptation.

Finally, it is important to recognise that institutions are not simply organisations, but consist of systems of rules, practices, decision-making procedures, and programmes that (re)produce social practices and cultural norms; "institutions are not equivalent to organisations, as institutions also refer to underlying ideological values and norms" (Gupta, et al., 2010, p. 2). In Kadampur, for example, the key informant that was interviewed is a prominent and influential actor in local society and politics, and therefore wields influence over the community. Thus, it is important that he places blame on the community for their supposed inability to develop. When asked what could be done to positively shape the future of community development and adaptation, the informant responded by describing a dream for the community in which there should be no leisure period for the people; all community members should be working up to their potential, with no complaints, and no conflict. Most importantly, in his opinion, local people are excessively gambling and drinking, and if these things were to be controlled then everybody would be working for themselves and struggling to support their family. Such an Othering of community members not only reinforces a divide between community 'leader' and community 'followers', but also entrenches a belief in the community that their everyday lives are somehow inadequate. This was reflected by the almost *verbatim* repetition by focus group participants of the leader's discourse that their traditional knowledge and practices are insufficient and only western scientific knowledge and practices can help improve their situation. The fundamental political and ideological role of community leaders is further explored below.

4.2 Issues in adaptation

From the above analysis of adaptive capacity, some key themes can be identified. Although these themes add complexity to an analysis of adaptive capacity, they should not be ignored. Being able to overcome this complexity and the associated contradictions will ultimately determine the success or failure of adaptive strategies.

4.2.1 Adaptation is not always good, sustainable, or legal

In Laukhari, the demand for grasses has outstripped supply in a community forest increasingly frequented by rhinos at dawn and dusk in search of the same grasses. In response, villagers have begun crossing Rapti River to get the grasses they need to feed their livestock. The community forest is on the village side of the river; across the river is the national park where it is illegal to enter without a permit and illegal to forage for plants. It is also a dangerous practice; as rainy season approaches, changes in river levels occur rapidly, and in monsoon the river is prone to violent floods. Given the illegal nature and the danger involved, why are they crossing? The availability of grass in community forest has decreased in part because rhinos have been forced to look beyond the national park by inedible invasive species. While the rhinos used to continue through the village to feed elsewhere, they are now blocked by an electric fence that was erected as part of a multi-stakeholder initiative to prevent wildlife intrusion into the village. With the rhinos squeezed from both sides, the community forest is struggling to supply for all. This case illustrates two points: 1) adaptation may not conform to broader social rules or even laws; 2) adaptation may have negative consequences, forcing re-adaptation – in this case, the erection of an electric fence has negatively affected the availability of grasses in the forest, forcing villagers to adapt by illegally crossing the Rapti River into the national park.

Contradictions in effectiveness and sustainability were also evident elsewhere; in Swargadwari, they built a reservoir and an irrigation canal, but in monsoon the reservoir overflows and damages the canals and their crops. So, positive adaptation in one scenario (drought) has caused a problem in another (monsoon). In Kadampur, meanwhile, they stopped growing mustard and lentils due increased frequency and intensity of pest infestations and a lack of dew for irrigation, respectively. They replaced both crops with wheat. Although this is technically an example of successful adaption, their agriculture is now less diverse, which in the long term is likely to reduce the flexibility and adaptability of their system (Ensor, 2009). So, adaptation, in this sense, is not always positive or sustainable. In Kirtipur, due to constraints on many forms of adaptation, they have to rely on adaptation options that they know are not sustainable. Villagers are aware that the existing irrigation scheme is unlikely to be sustainable in the long term, as the river source will eventually dry up completely. But their ability to implement other adaptive decisions is constricted by a) the need for the road to transport yam (a crop with decreased need for irrigation), b) technical support to develop irrigation alternatives. This brings us to a second issue frequently encountered in the analysis of adaptation in the four villages.

4.2.2 The recurring debate of traditional practices (experimentation) versus modern 'scientific' knowledge (technical support)

In Swargadwari, people have completely abandoned traditional seeds in favour of improved varieties, to the extent that they have forgotten about the traditional seeds and the genetic resources have been lost. Is this really positive adaptation? While production may be higher now, the new crops require more inputs in the form of water and chemical fertilizers and pesticides. The widespread adoption of the same improved varieties also results in decreased biodiversity, which reduces the ability of the system as a whole to adjust to future changes. Moreover, the increased adoption and reliance on imported seeds and agricultural inputs reduces local capacity to develop alternatives and locally produce the necessary inputs. In Kadampur, farmers are continuing to call for more scientific knowledge and technical assistance to help resolve the problem of the repeated failure of maize. Farmers are not experimenting with other solutions or brainstorming about possibilities. The answer to their problems, however, may lie in the upstream community of Kirtipur, where they know that yams are a good substitute for maize during dry periods and when irrigation is not available. The knowledge that yams grow well in these conditions was passed down by forefathers who experimented with yam cultivation. Paradoxically, it is the traditional knowledge and practices renounced by farmers in Kadampur that may hold the solution to their problems, not an increased reliance on external knowledge and standardised inputs.

4.2.3 Dependency on technical support

As the above example illustrates, farmers in Kadampur have run out of ideas on how to solve their problem of unproductive maize crops. They have no plan to attempt to replace maize or search for alternative sources of income; rather, they say they need to update their practices to a Western scientific level and need more technical support. The fact that the answer to their problems may lie in the nearby community of Kirtipur begs the question of whether a reliance on external knowledge and technical support create a degree of complacency and a lack of willingness to experiment and think of alternatives. Indeed, attempts to diversify do exist in Kadampur; in recent times they have explored bee keeping as an alternative income source, they have planted jatropha to tap into the growing market for biofuels, and some farmers are exploring ways to use livestock waste as both a fertiliser (manure) and pesticide (derived from urine). However, these ideas and alternative practices have been instilled in the community from without, not as part of a vibrant process of reinvention from within. Practical Action introduced the notion of and the technical skills for bee keeping; the community forest scheme introduced jatropha and livestock waste recycling practices. Elsewhere, Practical Action and the community forest scheme have also been behind adaptations, including the construction of irrigation infrastructure, from canals to large reservoirs, and the introduction of alternative agricultural practices, such as fruit and vegetable cultivation. While NGOs such as Practical Action and local schemes such as the community forest are good sources of information and technical knowledge, dependence on these organisations may not help to stimulate a form of adaptive capacity that is independently responsive to new stimuli. Adaptive programmes may become determined more by the agendas and areas of expertise of the facilitating organisations, rather than by autonomous and community-driven adjustments.

4.2.4 The role of political leaders and community innovators

The case of farmers in Kadampur demanding scientific knowledge also reflects the influence that well connected and powerful individuals can wield over the broader community. In the Kadampur case, one particular community leader has been able to drive forward adaptation options, such as experimentation with deep bore drilling and effectively side-stepping the VDC to implement projects more quickly through the community forest scheme. However, his main concern appeared to be a supposed over-reliance on traditional knowledge and practices; successful adaptation in the future, in his opinion, could only be achieved through the introduction of scientific knowledge and methods from the outside. When combined with his derogatory comments about community members (explained above), one individual has constructed an ideology that has taken hold in the community. During the focus group discussion, farmers repeated almost *verbatim* his claims that local practices were inadequate and should be supplanted by external scientific ways. Such an ideology strikes against philosophies of participatory, bottom-up, or endogenous development, and instead promotes a form of soft Imperialism implemented by the capillaries of power associated with influential and knowledgeable institutions and individuals.

Figure 3-1 Mining the Baulaha River

Moreover, in documenting the positive effect that the community leader can have over the implementation of adaptation options, it is also necessary to explore who gains and who loses from these options and where his interests may lie. For example, the deep boring project stemmed from a successful deep bore well that was implemented by a mining corporation, with which the community leader has a vested (financial) interest. His connections to the corporation are, however, not only beneficial, as the company is involved in mining the Baulaha river for stones that are used as building materials (Figure 3-3). Such mining processes have led to the damming of the river in places and have changed the dynamic of the river bed, causing the river to dry at a faster rate than before. The knock-on effect has been the decreased water level in the Kadampur community reservoir. However, the community leader placed blame for a damaged river ecosystem on the upstream community that supposedly overexploits and poorly manages the river as a resource.

There is a need, then, to explore both the benefits and conflicts that emerge from the influence that key individuals can have over decision-making processes, project implementation, and local ideology. The silk that holds together the web of local institutions and policies is made up of a series of actors that mobilise and direct resources. Thus, it is the strength and dynamism of networks between key political players and institutions that is capable of making or unmaking sufficient adaptive capacity. This supports Moser's (2009, p. 317) argument that "[t]he centrality of the decision-maker cannot be overstated…beginning with the decisionmaker(s) provides a revealing diagnostic entry point into the structural governance context that channels adaptation planning and implementation".

4.2.5 Constraints on adaptation

The above four points illustrate that adaptation is seldom straight forward and usually faces a series of constraints that must be overcome if its effectiveness is to be fully realised. These constraints include legal barriers, biophysical limitations, the need for continuous technical support, the danger of losing traditional practices, resources, and lifeways, control by the wealthy and the powerful, the need for financial investment in adaptation, existing social inequalities, and the need to effectively balance the trade-offs between different and often competing adaptation paths. The last point reflects the fact that adaptive capacity cannot necessarily be addressed through a typical livelihoods framework. The sustainable livelihoods framework presents livelihoods in terms of five different capitals or assets (social, financial, natural, physical, and human), and a livelihood with extremes in the capitals may be as sustainable as one that is equally endowed with all five. The above analysis has shown that this is not the case for adaptive capacity. For example, while famers in Kirtipur are well endowed with the human and natural capital to cultivate yams, such cultivation is severely constricted as an adaptation option by the lack of physical capital in the form of a road that will enable transport of the yams to the point of sale. Thus, a high capacity in one aspect does not necessarily equate to high levels of adaptive capacity more broadly, and adaptive capacity does not directly translate into adaptive action. Adaptive capacity requires that constraints to adaptation can be overcome by a range of factors that span the different livelihood capitals. The resolution of the problem of failing maize in Kadampur is unlikely to lie simply in increased agro-technical support; the resolution of the problem of decreasing water availability in Swargadwari is unlikely to lie simply in the implementation of more shallow tube wells. Rather, it is the deployment of a diverse portfolio of livelihood strategies that will stimulate a creative process of exploring alternative strategies and adaptation options. It is the ways in which the portfolio of strategies comes together to produce adaptation that is of central importance.

5 Conclusion: Complexity in assessing adaptive capacity

The analysis in this report has shown that adaptive capacity is spatially contingent, relying on a particular combination of factors that produce adaptation in place. In Laukhari and Swargadwari, biophysical conditions have given rise to adaptation to floods and droughts, with an emphasis on protection and evasion of floods during the monsoon and the provision of a reliable water supply during dry seasons. The supporting factors are largely VDC implementation supported by technical expertise and advocacy from organisations such as the community forest scheme, Chitwan National Park, and Practical Action. In Kadampur, floods have diminished due to the drying of Baulaha River, which now only runs during monsoon. Thus, adaptive practices largely focus on water provision, supported by private investment and experimentation (for the deep bore and private wells), and technical expertise from Practical Action (for the reservoir). Other adaptive practices are being explored, largely through the influence of the community forest scheme. In Kirtipur, emphasis is placed on decreasing the frequency and impact of landslides, protecting water resources for both irrigation and drinking water, protecting against hailstorms, and diversifying agriculture to reduce dependency on irrigation. The supporting factors include intra-community dialogue and planning, technical expertise from Practical Action, awareness-raising by the community forest scheme.

In exploring these issues, the complexity of adaptive capacity was revealed, which has implications for how researchers and practitioners go about assessing, building, and supporting adaptive capacity and adaptive practices. First, at a functional level, the research revealed the lack of methods that are dedicated to climate change issues and/or adaptive capacity. The tools and methods deployed during the focus group discussions were based on common PAR techniques and methods that had previously been deployed by disaster risk reduction (DRR) projects in the area. Seasonal calendar for example, often resulted in an over-emphasis on hazards, rather than broader climate change. This also reflects the context of the research locations; being DRR project site, participants gravitated to familiar subjects and were keen to report on the successes of Practical Action DRR work. This makes it difficult to assess whether the hazards discussed are in fact the main challenges and causes for concern in the community, or whether other important challenges were over-looked in the name of trying to provide the information that they thought Practical Action researchers were looking for. There is a need, therefore, to develop methods that effectively tackle climate change and adaptation issues, without over-influencing the community and the responses.

Second, the research faced challenges in addressing adaptive capacity. The forward-looking and abstract nature of adaptive capacity makes its assessment complex. The implementation of static livelihoods analyses or DRR capacity assessments is unable to cope with the complexity of the forward-looking aspects of the concept (planning; conceiving change; gaining access to information about alternatives and change; etc.). For example, there is a need to distinguish between adaptive capacity and disaster resilience. Early-warning systems may enhance disaster resilience, but do not necessarily reflect the increased capacity of a community to change their (agricultural) system in response to more frequent and more severe floods. Similarly, using previous adaptation as a proxy for adaptive capacity is dangerous. First, the more adaptation options are explored, in theory the more adaptive capacity is eroded (as options run out). Second, as contexts change, the ways in which previous adaptation options were explored may not reflect success in the future. For example, the relationship between institutions, organisations, local policies, and community innovators can radically change (e.g. as a result of formal party politics), which subsequently affects how adaptation can occur in the future. The abstract nature of adaptive capacity also makes it difficult to acquire tangible evidence (without using previous adaptation as a proxy). When asked about future plans and responses to climate change, it is difficult for respondents to give concrete answers that lead to conclusive evidence. This makes it difficult to address the future uncertainty of climate change – how can we assess adaptive capacity in relation to a 2^oC or 4^oC warming scenario if communities are unable to distinguish between these. In reality they may not develop different plans for each scenario, but may just implement plans with different intensity. These difficulties reiterate the need for the development of methods specifically tailored to adaptive capacity and climate change.

Third, the above analysis was permeated with examples of how politics (both formal and informal) affects adaptive capacity and the everyday practices of adaptation. While attention to the institutional dimensions of adaptive capacity is increasing, a more refined conceptual framework is required to address the complex political and institutional dynamics at the community level. It is not simply the ability of institutions to support adaptation, or the ability of institutions themselves to adapt that should be the focus, but the ways in which a web of political and institutional players are brought together through the actions of powerful and influential individuals. Key decision-makers mobilise the resources available in the political and institutional framework, the effects of which are likely to be positive for some but negative for others. There is a need to turn attention to these aspects.

Presenting an overall picture of community adaptive capacity, therefore, requires an unravelling of the layers of effectiveness, sustainability, and equality. This is a complex task that cannot be reduced to a static livelihoods analysis or pre-existing models of how to assess capacity. There is a pressing need for conceptual frameworks that seek to unravel the complex layers of adaptive capacity through the deployment of methods specifically tailored to climate change issues. This requires a systematic procedure that teases out the different dimensions of adaptive capacity and then re-assembles them to identify the variables that construct or constrict adaptation and the capacity to adapt.

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