# Living with Water Stress in the Hills of the Koshi Basin, Nepal*

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**Key messages**

- Decentralised systems, such as rainwater harvesting, offer incremental solutions to addressing emerging water stress but require larger policy shifts to scale up and acheive a significant impact.
- Access to and flow of information, goods, and services into and out of an area is a necessary condition for being able to respond to stresses.
- Social capital and the presence of multiple institutions help to support adaptation.
- Diversification and access to alternative sources of livelihood emerged as a central strategy for helping people adapt to stress, whether induced by climate change or other ongoing change processes.
- The variety of income sources, not the level of income, seems to be important for adaptation.

## Introduction

The study in the Koshi Basin of Nepal examined both wet and dry sites and the mosaic of vulnerability that leaves people coping with the effects of climate-induced stresses and hazards. Although the study examined the impacts of both flood and extended drought – too much or too little water – people generally consider that water availability has declined overall in the last decade.

The people of the hills and Terai of Nepal's Koshi basin are already experiencing climate-related hazards, such as erratic monsoons, floods, and extended periods without rainfall. They recognise that with changes in the climate, they will need to diversify their crops, agricultural practices, and livelihoods to cushion the impacts.

Study area – The Koshi is Nepal's largest river system draining almost a third of the country (Figure 4). It encompasses a great diversity in topography, climate, vegetation, demography, and culture (Table 1). The inhabitants of the Koshi basin face multiple hazards, such as droughts, floods, landslides, and earthquakes. In Nepal, the Koshi basin is home to about five million people living in eighteen districts, four of which are in the Terai. The area is contiguous with the Koshi area of Bihar, India.

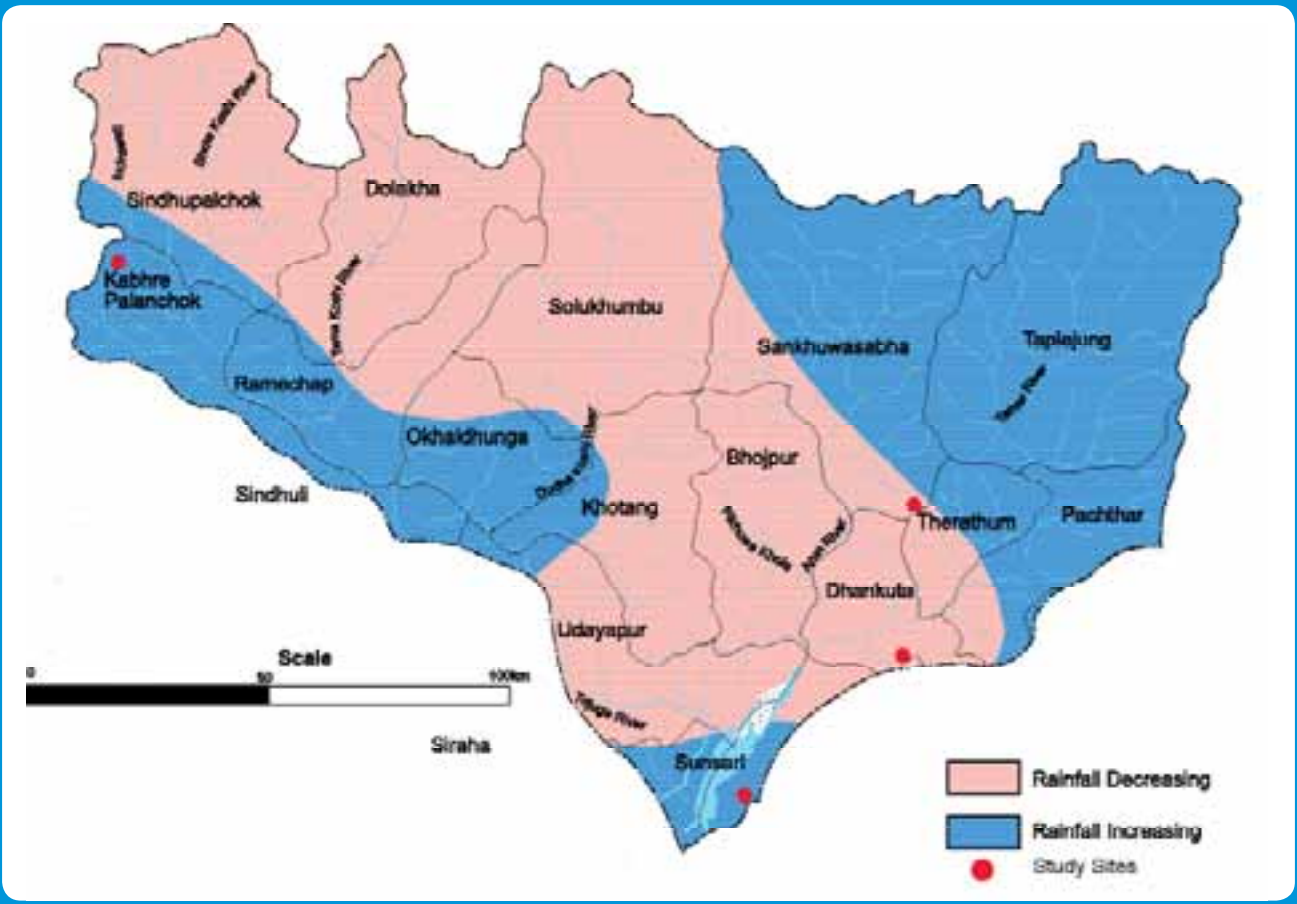
Study Sites – The study was conducted in three districts in the hills of the basin: Sankhuwasabha, Dhankuta, and Kabhre. A fourth district, Sunsari in the Terai, could not be visited during the study period due to severe flooding. The study sites were the four villages of Okharbote in Sankhuwasabha, Maunabudhuk and Danda bazaar in Dhankuta, and the dry valley of Panchkhal in Kabhre. Okharbote in the High Himal physiographic region of Nepal is typical of an area receiving high rainfall (>5,000 mm/year). Maunabudhuk in the High Mountain region receives moderate rainfall (~2,000 mm). Danda bazaar and Panchkhal in the Middle Mountain region receive low (~1,000 mm) rainfall.

The sites had different accessibility. Okharbote village is about a seven-hour walk from the Dhankuta-Basantapur; Maunabudhuk and Danda bazaar are on the Dharan Dhankuta road; and Panchkhal is located about 50 km northeast of Kathmandu.

Precipitation and replenishment of springs – Precipitation patterns in the Koshi basin are directly associated with the South Asian monsoon, with about 80% of the annual precipitation falling between June and September. Due to the great variation in the topography, the spatial and temporal complexity of

* A documentary film '**In the Grip of Drought**' on this case study is available on a separate DVD from ICIMOD.

Figure 4: **The part of the Koshi basin located within Nepal**




Basin area: 60,400 km$^2$
Elevation range: 100 to 8848 masl
Population: 5,081,463

Male female ratio: 1:1.02
Person/km$^2$: 37 (high mountains) – 498 (Terai)
Literacy rate: Male: 65%; Female: 35%

Access to potable water: 46%
Sanitation coverage: 30%
Energy: electricity - 30.9%; kerosene - 67.4%; biogas - 0.2%; other - 1.5%

Table 1: **General features of the Koshi Basin**

| Features | Vegetation | Crop | Fruit and vegetables | People | Industry | Transport |
|---|---|---|---|---|---|---|
| Middle Mountain | Pine forest + mixed hardwood and oak | Rice, maize, wheat, millet barley, pulses, sugarcane, radish, potato, ginger, cardamom and tea | Mango, papaya, banana, orange, lime, lemon, peach, plum, potato, cauliflower | Gurung, Magar, Tamang, Newar, Bahun, Chhetri, Damai, Sarki, Sunar, Kumal, Rai, Limbu | Rice, flour and oil mills, cement factory, cottage industry handicraft, curios, hosiery, metallurgy, furniture, plastics, hotels and lodges | Road linkages to major centres, suspension bridge, trails |
| High Mountain | Fir, pine, birch and rhododendron | Oats, barley, wheat, potatoes, buckwheat, yams, amaranths, medicinal herbs, cardamom, tea | Chestnut, walnut, apple, peach, plum, apricot, potato | Khas Chhetris, Tibetan related groups, Thakalis, Bhotiyas, Sherpas, Tamangs, Ghales | Cottage industry, carpets, blankets, hand woven cloth, trekking | Limited roads, some suspension bridges, trails |
| High Himal | Open meadows + tundra | Grazing (June-September) | Apple, walnut, vegetable seed, potato | Occasional herders, Sherpas and Bhotiyas | Mountaineering and trekking | Trails, no road linkages |

rainfall is large within short distances. The annual arrival of the monsoon rain results in the emergence of springs at various elevations. Stable, perennial springs are often located at the footslopes of the hills; springs at intermediate elevations start to flow a few weeks after the monsoon begins; and springs at higher elevations flow later during the season.

Specific hazards in the study area – The inhabitants of the Koshi basin face multiple hazards. In the hills, landslides, gully erosion, and debris flows are common; while in the valleys, sediment deposition and bank cutting are common. The Terai suffers from floods, riverbank erosion, and sand deposition on fields. Drought conditions are common in both the hills and Terai and affect rainfed agriculture.

Current livelihoods – All the respondents interviewed have multiple sources of income: 83% have agriculture as a source of income (49% say it is the primary source). Farmers produce cereals, vegetables, and fruit. Livestock are an important source of income for 74% of the surveyed households and a secondary or tertiary source of income for the remainder.

There were a significant number of wage earners – about 20% earn their income within the district, 4-5% outside the district, and 21% outside of Nepal. About 14% of respondents have teaching as a major source of income, 11% rely on business or other secondary sources, and 3% are students or engaged in industry. Some rely in part on a pension, about 10% from the British or Indian armies, and 5% from the Government of Nepal. About 47% of the households earn income from small business and trade, including the running of local teashops and general stores. Three families (5%) reported that trade and business is their main source of income. For 20%, service is the major source of income. A few families sell firewood to survive.

Water and irrigation systems – Drinking water systems generally tap spring sources, store the water in a tank, and distribute it via community tap stands. All three villages studied have gravity systems to supply drinking water. Users' committees manage the systems, but institutional, technological, and social issues are resulting in dysfunction of the existing schemes and adding to the emerging water stresses. For irrigation, farmers divert streams using temporary dams as at all four sites, agriculture is mostly rainfed.

## Impact of Water Stresses and Hazards

Worsening water availability in the hills and mountains has affected local livelihoods and daily life in the villages in many ways.

Water for domestic and irrigation uses – Both upland and lowland villages suffer from inadequate water for domestic use and irrigation. As discharge in upland sources declines, villagers require more time to fill their water vessels or must travel to sources at lower elevations to meet their needs. It can take 30 minutes to reach the source and about an hour to return, and several trips per day may be required. Consequently, they use more time and labour getting water, and pay with their health because the water quality of some lower sources is worse. Children have to miss school

**Woman and girl in the dry Jikhu Khola riverbed, Panchkal, Nepal. Securing water for agriculture and household use is an increasing challenge, especially for women**

and studying to spend 3-4 hours per day collecting water. The hindrances to education will affect future capacity to adapt. Smaller or affluent families and those living near the bazaar areas hire porters to fetch water.

Health and sanitation – The lack of adequate water has worsened sanitation. Many toilets, built with support from external agencies, have become redundant due to the lack of water. Occasionally people flush the toilets using grey water left over from washing clothes. Personal hygiene is affected visibly as people cannot wash their clothes, hands, and feet frequently or take regular showers. The lack of water makes it hard for women to wash dishes. At all three sites, villagers worry that the condition is ripe for occurrence of epidemics.

Agriculture – Continuing drought conditions have caused rainfed agriculture to fail in some villages, while in others the effect is moderate. In Dhankuta, the maize yield has decreased and the topography limits expansion of the area under maize cultivation. Discharges from sources have declined, so even farms with irrigation facilities are producing lower yields. Disputes about sharing water have increased, affecting the social relations already under stress in the aftermath of the decade-long insurgency and political turmoil. Since agriculture is the main source of income for about half the population, the loss of crops is gradually weakening the economy.

Livestock raising – Although livestock is the major source of income of a quarter of the population, families are increasingly unable to maintain the same number of animals as before. The local dairy enterprise, developed over the past two to three decades, has suffered as a result.

House construction – The shortage of water has also affected the construction sector. A few families engaged in building construction for contractors, but the work has ceased to function in winter when there is no water available to make concrete mixes. Construction work usually takes place in market areas where increasing demands for water have already put stress on the existing supplies.

**In Danda bazaar in Nepal's mid hills, households may only collect two pots of water per day.**

## Response to Water Stresses and Hazards

Himalayan herders and farmers have a long history of responding to environmental uncertainties, whether through seasonal migration, shifting land use patterns, or livelihood diversification. They have lived with and survived hazards, such as flash floods, and droughts for centuries. Today, farming is still a main livelihood, so people must find alternatives when floods, droughts, or pests destroy the crops.

Generally, people who were not dependent on ecosystem services, such as wage earners or service providers, were affected less by the immediate impacts of droughts, hailstorms, and heavy downpours.

Temporary migration – Following each crop-destroying disaster, people would historically borrow from local moneylenders so they could travel to seek temporary work as migrant wage labourers in other places. Being able to borrow money from local moneylenders provided a safety net during hard times, but the interest was very high.

Today, during the agricultural slack season (November to February), people continue to take loans to travel to work as wage labourers in cities, India, or abroad and return after earning some money.

People now migrate to wage-labour sites, such as urban centres and construction areas. They might stay for a year or two or just a season. If the migrants succeed in landing a relatively permanent job, they normally visit their families and villages once every two to three years. If they do not secure such a job, they may return to the village in a few months. Unlike permanent migration, it is both internal (within the country) and external (outside the country).

Permanent resettlement – Relocation and permanent resettlement began in the late 19th century, and has mostly occurred within Nepal from the highlands to the Terai. Uncertainty and difficulties associated with hill farming motivated a majority of hill dwellers to move to the foothills and the Terai. In the 1960s, the Nepali state also promoted resettlement in the Terai forests.

**Domestic water use** – People try to obtain water for domestic use through both structural and non-structural means. In water deficit areas, about half the population travels to sources at lower elevations when the supply from regular water sources declines. Communities may devise local rules for collecting water. For example, in Danda Bazaar, the local rule stipulates that one person can collect water in two containers for one family for one day. The community enforces the rule and those violating the rule face social boycott. Some families take advantage of the rule by using containers that are almost twice the size of regular ones. Men go to carry the heavier containers of water for the two-hour round trip. Some families have installed electric pumps to lift water from streams.

**Rain water harvesting** – Ponds were once a common method of harvesting rainwater in the hills, but many have been lost to other land uses in recent decades. Villagers in Maunabudhuk have continued this traditional method of harvesting rain by building multi-purpose ponds close to their homes to collect rain. Water remains in the ponds for 4 to 5 months to be used for livestock and irrigating fruit trees. In Danda bazaar, collecting rainwater is popular and the village has been the site to pilot a fog water collecting system. Although its performance is not very satisfactory, this system still provides water for a small section of the population that cannot get water from the main system of the village.

**Efficient irrigation systems** – Since large irrigation channels are expensive and necessitate external inputs like technology, resources, and skills, some families use sprinklers and drip irrigation systems. Others have started using pumps to lift water for irrigation from streams. Introducing non-structural changes to make irrigation more efficient also requires investments in new skills and community support because, rather than individualistic family responses, collective community decisions will be necessary. However, the study sites have not yet employed such changes.

**Change in crops** – According to the respondents, water shortages have caused about half the population in the study areas to shift their production from cereals to cardamom or from rice to maize. Some have adopted cultivation of tea or cardamom because it fetches a higher price than rice. Cardamom requires less water and less labour input for a limited period. Tea requires a regular supply of large numbers of labourers during the picking season. Both tea and cardamom require less water than cereals or vegetable crops. Other families have shifted their crops to rice varieties that require less water or that can be sown at a later date if the rains are delayed. Those unable to make such shifts abandon farming altogether, move to a different location, change occupations, or rely on different sources of income.

**Changes in the livestock system** – Due to water shortages, farmers have problems keeping the same number and size of animals as before. About two-thirds of the population use less water to make khole (boiled liquid feed) for livestock. The decline in water availability is forcing about a third of the population in the study sites to reduce the number of their animals by two-thirds – an economically and culturally difficult decision. An even harder choice for farmers is to reduce the variety of animals. About a fifth of the farmers who had both cows and buffaloes have sold either all the cows or all the buffaloes to keep only one species of cows, buffaloes, goats, or pigs. Some farmers sell milk and buy water to maintain their dairy business with the hope that the next year will be better.

**Changes in sanitation practices** – The majority of the respondents in the study area reported that due to reduced water availability, they have changed their sanitation behaviour by cleaning, showering, and washing less frequently.

**Shift in periods for construction** – In the past, people constructed their homes during the winter, the dry agricultural off-season. Since construction requires water, most locals now build houses during the rainy season when water and labour are available.

**Occupational changes** – When water shortages are acute, people tend to make the hard choice to change

**In the dry Jikhu Khola riverbed, wealthy farmers use heavy machinery to dig trenches to get groundwater for irrigation.**

or abandon their occupation, or move from a water scarce area to a place where water is available. They also gradually shift their livelihoods from farming to the service sector or trades. Continued water problems force many people without these alternatives to leave the village.

## Factors Influencing Local Responses

Various factors influence the choices people make to cope with water stresses. They include mobility and access to information, markets, services of institutions, technical support, technology, and tools and equipment.

Support systems – Electricity and communication facilities are available in the study areas. Access to both has helped local trade, including the use of cold storage facilities and the operation of small businesses. Farmers use cooperatives and other agricultural and livestock services to improve production and sell milk and vegetables in local markets. All three sites in Sankhuwasabha and Dhankuta districts have educational establishments and health centres. These facilities and cash income, from the sale of farm products, has helped people obtain their immediate needs.

Mobility, transportation, and communication – The ability to move in and out of an area allows people to respond to stress successfully. For example, the shift to tea and cardamom would not have been possible without access to roads that allowed local producers to secure inputs and reach the markets. Making a decision to move requires family support, initial investments, access to information, and the liberty to leave home for long periods and to take risks. Such strategies help a family shift from farming to a non-agricultural source of income outside the area, and to diversify the household's income basket.

Services – Various services; such as transportation, markets, communications, and technical backup for agriculture and livestock are important for enhancing local resilience, so the absence of these services and their unreliability can make local adaptive responses very difficult. For example, the chemical fertilisers and pulse and vegetable seeds that are available in local markets are often of inferior quality because there are no institutions to regulate and ensure quality. They are also often not available when farmers need them during the cropping season.

Infrastructure development – Road building on mountain sides can damage springs. Bus stations, public buildings, or sports fields often encroach on the flattest ground available – the traditional ponds near villages. The lasting impact of roads on water springs is only evident when erosion of the roadside slope causes the water channels to crumble. Villagers find it difficult to demand that road construction not destroy springs because the immediate benefits of a road seem to outweigh the loss of a spring. In the long term, the loss of the spring adds to local water stress while the road improves mobility, helping villagers to avail of alternative livelihoods.

External factors – The study site communities are affected by the larger global and national context; they face the negative impacts of rising oil prices, which increases the transportation costs of trading goods. Frequent strikes and road closures prevent farmers from transporting their products to market, which is making many farmers wary of investing in agriculture.

Political instability – Political stability is often a prerequisite for individual or community responses to succeed. During the decade long insurgency, many people left their villages because the remittance money and even salaries had to be shared with rebels. Other people left because they did not want to be pulled directly into the conflict. The educated and those with some economic base and influence in the village were asked to leave. In such circumstances, people had few incentives to grow more food.

Changing demography – As a consequence of migration, the absence of able-bodied men in the villages has changed peoples' perception of life and farming. So many men must seek alternatives that the local economic systems have weakened. The opportunities provided by improved mobility and access to information then become irrelevant as strategies to adapt to the emerging water stresses.

Notion of 'development' – In Nepal, development has always been equated with the availability of electricity, roads, and telephone services. Yet, even when these services are available and reliable, people are still moving from their homes and traditional livelihoods because these services do not help them to adapt to water stresses. This question requires much deeper inquiry.

Gender perceptions on water – Men and women expressed different perceptions regarding the impact of water shortages. When the definition of the problem is different, a solution will be different too. These nuances need consideration in the design of adaptive strategies.

## Conclusions and Way Forward

The people of the hills and the Terai of Nepal's Koshi basin are already experiencing the stress of climate related hazards, such as erratic monsoon behaviour, floods, and extended periods without rainfall. They are coping with the effects, but need to develop effective adaptive strategies. The information collected clarifies people's perceptions about adaptation. Clearly, they recognise that the diversification of crops, agricultural practices, and livelihoods can cushion the impacts of changes in frequency, intensity, and duration of rainfall (flood or extended drought).

Although the team selected study sites to represent dry and wet areas based on rainfall data, the respondents at all four sites reported water shortages. There is almost a consensus that water availability has declined in the last decade. Danda Bazaar is on a ridge and has always had physical limitations on water availability but the periods without water are becoming longer.

Although respondents say that rainfall has become erratic in the last five years, precipitation records do not show distinct trends. This could indicate increased local variability. Increases in variability affect the recharge of local springs, reducing the amount of water available in existing drinking water systems. This is particularly so if water sources are situated at higher elevations.

Responses to the emerging conditions of too little water often need to adhere to principles like catching the rain where it falls. Decentralised systems using rainwater harvesting for household water needs or storing water in ponds to promote recharge, offer incremental solutions. Scaling up these activities to make a significant impact would require large policy and behavioural shifts. However, behavioural change is not automatic and depends on factors such as access to information and knowledge. It also depends on the appropriate husbanding of water stored in the reservoirs, ponds, soil moisture, and watersheds. Adaptations, such as the use of drought tolerant seeds, can help farmers to adapt but must be suited to local specificities within the economic, social, and political landscape.

Diversification and access to alternative sources of livelihood emerged as a central strategy to help people adapt to stress, whether induced by climate change or other ongoing change processes. People with diverse income sources adapt more easily than people with few income sources. The variety of income sources, not the level of income seems important for adaptation.

People suggest that the state and government agencies must focus on providing an enabling framework for them to pursue their strategies rather than micromanaging all their activities. Under a facilitative structure, many of the locals argued that they could respond to disruptions at local level. Many villagers suggested that the stress posed by the Maoist insurgency and current insecurity was more serious than drought, though the long-term effects may add further to the mosaic of vulnerability.

A flow of information, goods, and services into and out of an area is a necessary condition to respond to stresses. Likewise, social capital and institutional checks and balances are helpful in supporting adaptation. The limits to adaptation depend upon the nature of the physical infrastructure and access to secure sources of water. When physical infrastructure and water sources are absent or limited, people will find it hard to adapt.