

# Life in the Shadow of Embankments – Turning Lost Lands into Assets in the Koshi Basin of Bihar, India

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## Key messages

- Past flood control measures have changed the agro-ecology of the Koshi basin and increased the intensity and frequency of floods, droughts, and other water-related stresses and hazards.
- The communities have mainly responded by adjusting the cropping cycle; introducing new and improved varieties of crops, such as sunflower, wheat, and maize; using water-logged land for makhana (foxnut or water lily) cultivation and sand-covered land for vegetable cultivation; using cheap, local technologies, such as bamboo tube-wells and movable pumping sets for irrigation; and applying better cultivation methods.
- Off-farm seasonal migration has become an important adaptation strategy. Temporary migration in search of jobs has increased with the increasing scale of water hazards and has helped offset losses incurred from floods, droughts and water-related hazards, facilitated by improvements in transport and communication and better access to credit and banking facilities.
- The state machinery's limited reach, corruption, and an inefficient bureaucracy have led to poor delivery of government programmes, which otherwise hold potentials to improve communities' capacity to adapt to water-related hazards and stress.
- Non-state actors such as markets and NGOs, to some extent bridge the 'knowledge gap' created by poor government extension and information delivery services. Bridging this gap could enhance the adaptive capacity of the people to respond to floods, droughts, and other water-related hazards.
- Autonomous 'adaptive' strategies in the region have at best helped community groups cope. These strategies provide a blueprint of what needs to be done.

## Introduction

This study in the Koshi River basin in India examines the relatively long history and ramifications of human intervention to manage and control the river in this region. The extensive flooding on the flat terrain of northern Bihar results from huge variations in water volume and the deposition of large amounts of sediment during the monsoon.

As the Koshi River loses momentum on the plains, it deposits sediment and shifts course, causing devastation along its path. In the past, the government constructed structural measures, particularly embankments, to deal with floods. These measures have had significant impacts, both positive and negative. Although they

limited the area of flooding, those areas inside the structures get longer and more intense flooding and sediment deposition while areas beyond the structures are waterlogged as water cannot drain. The areas prone to flooding or waterlogging have increased 2.5 times over the years (GoB 2009).

The impact of climate change now frequently affects large areas of the basin with droughts as well, creating an urgent need to identify and encourage measures to address it. Communities living in or along the basin have developed their own strategies to deal with both floods and droughts. The Koshi basin supports a huge population that both benefits from its waters and suffers from its hazards.

## Geographical context

As the third largest state, Bihar in north India borders Uttar Pradesh and Maharashtra to the west, West Bengal to the east, and Jharkhand to the south. To the north is the international boundary with Nepal. Most of the population of Bihar (83 million) live in rural areas with only 10% living in urban areas.

North Bihar receives about 1,300-1,700 mm of rainfall each year (GoB 2009), mostly during the four monsoon months. The rainfall can be uncertain in terms of both quantity and timing. Most farmers have only rainfed crops, so they face drought and crop failure on a regular basis. Especially for autumn crops, a lack of rains during critical phases in the crop cycle can mean the loss of three-quarters of the expected harvest.

A comparison of the records of 1966-67 and 1986-87 reveals that the flood-prone districts of north Bihar are as or more susceptible to droughts than the districts of south Bihar and Jharkhand. Even Khagaria district, known as 'the submerged district', suffered drought conditions in seven of the 20 years.

## Past flood responses and management

Prior to the construction of the embankments, people in the floodplains had adapted and adjusted to the agro-ecological setting, by planning to avoid river flooding during the monsoon from July to September. The annual monsoon overflow of the rivers did not allow the villagers to grow crops harvested in the autumn close to the rivers.

Each village had its own system of floodplain zoning and flexible land-use with different categories of land depending on the soil and altitude (lowland or highland). Specific lands were put to use for different purposes and crops (Singh 2003). For example, people living close to the river mostly grew crops sown in May and harvested in June or sown in November and harvested in March. Those living further from the rivers mostly grew crops sown in June-July and harvested in October.

Many of these traditional land-use systems have disappeared with population growth, extension of cultivation, flood protection measures, and other infrastructure developments in the region.

After considerable deliberations on how to lessen the impacts of the shifting Koshi River, the Koshi project

was launched in 1955. It involved the construction of embankments, which were completed by 1959. The construction of a barrage across the river in 1963 was to facilitate irrigation. Massive construction activity followed in other river basins in Bihar.

Despite additions to the total length of embankments, Bihar has the highest number of flood-affected people per capita in India. The area threatened by floods has grown continuously from 2.5 million ha in 1952 to 6.9 million hectares (ha) in 1993 (GoB 1994). Within Bihar, 74% of North Bihar plains are flood-prone. Since 87% of the population depends on agriculture for livelihoods, survival in such a large area flooded for much of the year has become difficult. The state that used to enjoy food surplus now suffers chronic food deficits.

## Study sites

As the impact of the Koshi project varies in different villages, the team selected the study sites with reference to their location on the embankment and canal in order to observe differences. Table 2 briefly describes the study site villages.

## Socioeconomic context and livelihood patterns

In all the villages in the study, only 20-30% of the people own land, the rest are landless, working as labourers. The upper caste and, to some extent, the middle caste people own most of the land.

**Governance** – The local people have little or no role in the governance of day-to-day issues despite decentralisation through the Panchayati Raj Act. Elections of local level bodies were held only recently after decades. Even these bodies have caste politics and are a battleground for state and national level political parties. Bihar has a poor record implementing poverty alleviation programmes and government services.

**Health and education** – The region and study villages are characterised by poor indicators of human development. Although registering an increase of 10% in the last decade, the literacy rate in the Koshi districts is still significantly lower than national standards and state averages. Health services are poor, especially in inaccessible villages. This creates serious hardships for the people with a prevalence of water-borne diseases like malaria, kalaazar, and Japanese encephalitis brought by the floods and waterlogging.

Table 2: Basic characteristics of the study sites

Village, district	Location relative to the embankment and river	Accessibility before and during the rains	Water-related Stresses
Chandrain, Saharsa district	0-2 km outside the left embankment	Accessible by all-weather roads; road condition bad	Waterlogging; not completely recovered from sand deposition due to 1984 embankment breach; fields within embankments suffer from massive and widespread sand deposits; villagers live in fear of embankment breach
Dhamara, Saharsa	Between embankment and river on island between two channels of Koshi	Accessible only by boat; boat service bad	River floods and erosion; village lives in constant fear of embankment breach
Tilathi, Saharsa	0-2 km outside the western embankment	Accessible by all-weather roads; road conditions bad	Severe waterlogging
Sarsauwa, Khagaria district	Not protected by any embankment, riverine site between the Koshi and Bagmati rivers	Accessible only by boat and rail; problems transporting agricultural produce	Erosion and river floods; lack of transportation
Rahuamani, Saharsa	8-10 km from embankment and in the command area of the Koshi canal	Accessible by all-weather roads	Canal not working for last few years

**Agriculture** – Despite sluggish growth in agriculture, most of the workforce is employed in this sector. There are four cropping seasons in the study area. Maize, millet, and paddy rice are the main crops grown during the hot months (May-June) paddy rice is the only crop grown during the early monsoon (June-July). The main crops grown during the winter (November-March) are wheat, legumes, lentils, mustard, potato, and vegetables. Extensive areas in all villages are cultivated with maize, pulses, and vegetables in the hot pre-monsoon season – sown in February-March and harvested in May and June.

**Migration for employment** – Migration has become a way of life and an important livelihood option for many people, except in Rahuamani. Migration in most cases is temporary; people migrate during the lean agricultural months. Most migrate to the agriculturally dynamic regions of north-west India and to urban and industrial sites for jobs. The majority work as labourers; those with some education or skills land in better jobs. Depending on duration of migration, remittances constitute about one-third to two-thirds of household income.

**Animal husbandry** – The dairy business is not an important source of livelihood in the study villages, except in Rahuamani, which is close to a town, and Sarsauwa, which has a long tradition of cattle rearing. Poor women in all the villages raise small ruminants, mostly goats, to supplement household income. Fisheries

are not an important livelihood option in this region; even the fishing community, the Mallahs, have moved to other occupations for their livelihood.

### Impacts of Water Stress and Hazards

The impacts of floods and droughts on the changing landscape, and the increasing intensity and prolonged nature of the floods on the general well-being of the people have been immense. Increased waterlogging, sand deposition, and soil erosion have affected people's livelihoods, especially related to agriculture.

The impacts have been different in the four different zones that emerged after the construction of the embankments – zones trapped between the

**In some areas in Bihar high iron content causes damage to teeth.**



embankments, protected by the embankments, unprotected, or a distance from the embankments.

In areas trapped between the Koshi embankments, erosion and sand deposition on fields is intense. Nearly a million people live in the 380 villages in this zone, including Dhamara, one of the study sites. Villagers of the area still hope that the floodwaters will bring silt, rather than sand, to fertilise their land. Agriculture within the embankments did improve considerably and Dhamara has experienced agricultural growth.

In protected countryside close to the embankment, a significant portion of agricultural land remains waterlogged most of the year making agriculture virtually impossible in villages such as Chandrain and Tilathi. The villagers live in constant fear of embankment breach, as the Koshi embankments have breached eight times (Mishra 2008). They keep vigil at night during the rainy season as they would have very little time to move to higher ground in case of a breach. This problem is particularly acute in a strip of land about five km wide along the embankment.

Areas that have been in the direct path of the Koshi flood after an embankment breach take years to recover and return to normalcy. For example, Chandrain was in the direct path of the waters during the 1984 breach and has yet to recover fully 25 years later.

Large populations living along unprotected stretches of the river experience the adverse impacts of upstream embankments. Beyond Ghonghepur, the Koshi is free to wander on its western side where rivers, like the Kamala and the Bagmati, join it. However, the combined waters make life difficult for unprotected villages like Sarsauwa.

Communities further away from the embankment and the river have benefited from the Koshi project and have not had to deal with the river's swelling or changing course. Many came under the command of the Koshi irrigation canals. Despite government promises, the canals created irrigation potential that has been massively underutilised (Gol 1973) in villages such as Rahuamani. The experience of the floods of 2008 also shows that even this zone is not safe from the devastation caused by embankment failures.

In the first three zones – between the embankments, protected by the embankments, and in unprotected areas – agriculture is impossible from June to October or December, depending on village location and the duration of waterlogging.

The perennial flooding has affected the availability of clean drinking water, and other aspects of human well-being including livelihoods, education, and health. Prior to the embankment construction, animal husbandry and pisciculture (fish farming and aquaculture) supported large sections of the population. The construction of embankments, barrages, and other infrastructure has diminished vast open grassland areas causing a significant reduction in the cattle population. The livelihoods of the Mallah fishing community declined as the obstruction of the river's flow and neglect of ponds and reservoirs reduced the fish stock and variety.

## Adapting to Water Stress and Hazard

People have adapted to changes brought by floods and droughts in different ways. Many parts of North Bihar have witnessed the development of alternate land-use and cropping systems to adjust to water-related stresses. Most adaptations in agriculture aimed to cultivate land intensively during the short period land can be cultivated. Some of these strategies are analysed in the next section.

### Non-structural responses

Communities have adapted to water-related stress and hazards by making small changes and adjustments in livelihood practices, institutional arrangements, and social relations. Most non-structural measures and strategies adopted by the communities require little or no investment except adjustments in cropping season and practices.

**Adjustments in the cropping cycle** – In the villages of Dhamara and Sarsauwa, which suffer river floods almost every year, farmers still take the risk of planting monsoon season (June-July) paddy, even though the fields get flooded during these months. Farmers living between the embankment and the river or in unprotected areas broadcast paddy in the field hoping that the crop might survive if the floods are low. This risk-taking becomes worth their while once every three years, when the fields actually produce a bumper harvest.

The same categories of land support a good crop harvest in the dry, winter season (November-March) depending on where the river is flowing. If the river deposits thick layers of sand, there will be low crop yields or no crops at all; but if the floods deposit a good layer of silt, as has happened in Dhamara village in 1990, the fields will produce good harvests of wheat, maize, and pulse.

Cultivation of crops in the hot pre-monsoon season (sown February-March and harvested May-June) is a new response to acute waterlogging in lands close to or outside the embankment. Farmers in Tilathi and Chandrain do more cultivation in this pre-monsoon season as both villages suffer from long periods of acute waterlogging. In Tilathi, where waterlogging is more acute, only a small portion of land is cultivated in June-July. Farmers cultivate areas with winter (November-March) and spring (February-March) crops in Chandrain village where most of the village is within the embankment.

Farmers irrigate crops from November to March, when two to three watering times are required for wheat, maize, and rice. In all the villages, farmers irrigate fields through privately owned bore-pumps. Although farmers in Rahuamani are in the command area of the Koshi canals, they have not received water from the canals for the last five years.

**New and better crop varieties** – The area planted with a new rice variety has increased in recent years especially in Tilathi and Chandrain villages. This coarse

rice is grown mostly for household consumption to address food security for poor households as it does not command a good price in the market compared to other rice varieties.

Farmers have started to use other new varieties of wheat, maize, and vegetables that are better flood or drought adapted and higher yielding. Since the late 1990s, they have also cultivated an early variety of maize that is harvested by May before the first floods occur. Private seed marketing companies introduced the new crop varieties and tried them first with big, entrepreneurial farmers.

Other new crops, such as sunflower, have been introduced in the flood-prone villages of Dhamara and Sarsauwa. In the latter village, farmers plant sunflower on lands completely under water for four months of the year. Sunflower is a profitable commercial crop, which destroys weeds, improves soil productivity, and costs little to cultivate.

Water lily (*Euryale ferox* Salisb), called makhana locally, is now a major aquatic crop cultivated in waterlogged

**In some areas of Bihar, water lily (makhana) cultivation is providing an alternative use for waterlogged land next to embankments.**



fields. It is a nutritious non-cereal food commonly used in the preparation of sweets and other recipes. Its cultivation requires standing water (maximum one metre deep), the right soil type, and favourable climatic conditions. Large areas of waterlogged land and other water bodies in the Koshi basin are now under this crop. With the decline in fish stock, the Mallah fishing community depends on this crop for its livelihood. The crop is demanding to cultivate but commands a good price in the market. The growing demand for makhana is evident from the increased number of private companies cultivating it commercially.

On land within the embankments, sand deposition poses a serious problem. Here, several Muslim vegetable farmers lease these lands for vegetable farming. Some sand-covered land is good for vegetable farming, especially for the cucurbit family of plants. Vegetable farming is widespread in Rahuamani due to its proximity to markets in Saharsa. New, high-yielding vegetable varieties have increased the profitability of vegetable farming and helped landless Muslims improve their lives.

**Better cultivation methods and techniques** – Farmers have developed practices to reduce the degradation of land or soil fertility even though the land available for intensive cultivation is already declining and the time period available for cultivation is short. They use mixed cropping and rotational cropping to maximise crop yield yet keep the soil fertile. Common practices are to mix the cropping of maize with summer rice and maize with lentils and/or millet. In many places, farmers use the field bunds to grow teak trees or manajera<sup>1</sup> plants. They also use the same water body for water lily cultivation and fish farming. Manajera and lentils, apart from their other uses, are nitrogen-fixing plants sown especially to reclaim soil fertility.

**Animal husbandry** – In most areas of Bihar, farmers have decreased cattle rearing or changed the cattle breed because the spread of waterlogging has reduced common grazing land. Meanwhile, the rearing of small ruminants, mostly goats, has increased especially among poorer castes and classes, such as the Musahars and Muslims. Goats are easier to manage and feed even during floods. A practice similar to sharecropping, share rearing of goats is widespread in the region. Goats command a good price in the market – an adult year-old male goat can be sold locally for Rs1500.

<sup>1</sup> Manajera is a kind of shrub that helps in nitrogen fixing and reclaiming soil fertility. It generally grows along the boundary of the agricultural fields and is often used as fuel during floods and prolonged waterlogging.

**Migration and remittances** – Off-farm seasonal migration has always been a livelihood option for people living in the floodplains, especially those who are resource-poor. It has increased since the construction of the embankment has increased stresses caused by floods and droughts and changed the agro-ecology. The disruptions to agriculture have forced both landed and landless labourers to seek employment outside their villages.

For example, in Chandrain, Tilathi, and Dhamara villages, about 80% of adult males migrate during the non-agricultural season. Most leave their villages at the end of May or beginning of June after they complete the hot season farm activities. They return when the land is ready for cultivation, either in the beginning of the cool, dry season (early November) or the hot season (February). While the men are away, women, children, and old men do not have much farm work except for labour on some government-sponsored rural schemes. With improvements in transport and communication, finding work in far-off places has become easier. Each household has its own social network which refers them to outside work opportunities.

**Access to loans** – Although the traditional money-lending castes do not operate in this region, people in the village who are relatively better-off provide small loans without collateral, but at high interest rates. Work migrants often need this small cash to cover the cost of their travel and the upkeep of the family they leave behind. Small farmers also need petty cash to buy seeds and fertilisers before the planting season. Local shopkeepers sometimes provide goods on credit and charge interest for deferred payment. With improvements in rural banking, workers can more easily send remittances to families.

Overall, migration has been a very important adaptation strategy to adapt to the changing nature of hazard and stress in the basin. It is expected that migration will increase further with growing population pressure on land resources and more employment opportunities in economic growth centres in other parts of India. However, the introduction of employment guarantee schemes in rural India could lessen dependence of temporary migratory work.

## Structural responses

Without much external support, communities in north Bihar have developed several autonomous responses to deal with water stresses.

**Bamboo bore wells** – In the early 1970s, bamboo bore wells were introduced in north Bihar. Their cost is low using locally available bamboo materials and expertise. It costs a farmer about INR 7,000-8,000 to bore a bamboo tubewell about 25 metres deep – the cost of a regular tube boring is at least 5-6 times more. Bamboo bore wells last for about 10 years and can easily be used to irrigate about one acre of land. The increased use of bamboo tube wells has increased the intensity of land use by small and marginal farmers and contributed to addressing the wide income disparity in the villages.

**Movable pump sets for hire** – Movable pumping sets can easily be rented at Rs 60/hr (of pumping) in order to obtain sufficient water. The sets are mounted on small bamboo carts that are moved from field to field to service bore wells and fields. The pump owner provides diesel or kerosene for the pump and plastic pipes to transport water. Those who do not own bore wells pay another Rs 5-10 for pumping water from a private bore well.

**Food and fuel storage systems** – Households make cylinder-shaped silos (storage towers) of mud, cow dung, and bamboo strips that are elevated several inches above ground to store food (mainly maize and rice) and fuelwood (cow dung cakes, maize stubs, dried manajera plants, bamboo roots, and so on). They make the cow dung cakes round and bigger for easier storage and transport in times of emergency. They also make long cow-dung cakes of dung and mustard stalk as a wood replacement.

**Flood-adapted housing** – Most households in the project areas used local materials to construct their houses. Bamboo frames hold bamboo screens plastered with mud and cow-dung. The roof is thatched with locally available dried grass or crop residues. Households in all the villages build houses on a plinth. Villagers in Dhamara and Sarsauwa build houses on even higher plinths over the debris of old homes to be above the maximum flood level. Dhamara residents are confident that the river will have to flow over the embankments before flooding their homes.

Most households, especially those that can afford it, construct a tube well as part of the raised homestead. In villages suffering from perpetual waterlogging, the plinth

level is not so high, but new houses made of bricks and cement, are constructed at higher plinth levels. In these villages, remittances are used mainly to build brick and cement houses with flat roofs that can serve as points of refuge during big floods.

## Factors Influencing Local Adaptation

### Absence of a rehabilitation and resettlement policy

The study sites experience a loss of access to their productive assets, especially agricultural land, when floods breach an embankment or a river changes course and during prolonged periods of waterlogging. Floodwaters breaching an embankment also deposit sand on fertile agricultural land.

The government does not have a policy to encourage reclamation of land damaged by sand deposits and waterlogging. It considers all land outside the embankments to be protected. In reality, these lands have lost their productive capacity temporarily or even permanently, due to the poor drainage caused by these conventional flood control structures. Various drainage schemes have failed to improve the situation. The state has not compensated Bihar residents for this loss in land productive assets.

### Increase in green revolution technology and packages

Nevertheless, two factors have revived agricultural growth – access to agricultural credit and penetration of the market by private seed and fertiliser marketing companies. Through aggressive marketing, new and improved hybrid seeds have been made available in nearby towns. The assistance of some NGOs has popularised new methods of cultivation, such as rice intensification or SRI. The increases in remittances have promoted investments in agriculture.

### Portable water pump used for irrigation in some areas of Bihar, India.



Most innovations happen at the local level without outside help because state extension services are effectively absent, extension officers are overworked, government seed distribution centres hardly function and even if they do, do not provide seeds on time. The quality of seeds distributed by private traders is not monitored.

### **Access to markets and food storage facilities**

Inadequate roadways and improper transportation facilities have a direct impact on access to markets. In most cases, producers are forced to sell their products within the village or in nearby villages. Thus, they have little opportunity to negotiate for better prices. Although the community has its own household food storage system, there are no cold storage facilities at the study sites for long-term storage. Therefore, poor access to markets and lack of adequate long-term food storage facilities constrain market potentials, and adaptation.

### **Improvement of road and railways facilitate migration**

The rural infrastructure has improved during the last three decades. The improved transportation system has facilitated labour mobility to areas with potential labour demand and has increased access to markets and other facilities. However, despite increased investment in infrastructure, large areas of the region remain inaccessible.

### **Rural banking and easy transmission of remittances**

Banking in the rural areas has improved greatly. Households have used remittances to develop their assets in certain sectors, which has improved their capacity to adapt to floods and droughts. However, some problems remain. Those individuals who are poor and illiterate have difficulty opening bank accounts. They have no option but to depend on sending remittances through people holding bank accounts. Sometimes, this leads to pilferage of their hard-earned income. Despite the growing reach of nationalised banks in rural areas, they have often failed to benefit poor and marginalised communities. Most poor people have had to depend on informal village moneylenders to obtain credit.

### **Rural telecommunication system**

In the study areas, improvements in telecommunication have brought access to a mobile telephone network that enables the population to keep in touch with potential

employers. Access to telecommunications has helped in early warning about floods.

### **NREGS and other poverty alleviation programmes and schemes**

Various poverty alleviation and environmental management policies and programmes could increase the resilience of people in disaster-prone areas. The National Rural Employment Guarantee Scheme (NREGS) is one of the largest social security programmes in the world. It provides 100 days of employment locally to households in all the districts of India. Besides alleviating poverty, this scheme creates community and household assets that can be used in dealing with floods. However, in practice in the study villages, inefficiency and corruption in the bureaucracy has prevented the scheme from being implemented fully and from achieving its ultimate objective. Some structures being built through this scheme lack the quality that could enable adaptation.

The implementation of other programmes, such as the distribution of subsidised food grains for families below the poverty line through the public distribution system and a housing scheme, happens in ways at the ground level that defeat their purpose. A possible cause is corruption and inefficiency in the bureaucracy.

### **Lack of adequate infrastructure for education**

People with education and skills get better jobs when they migrate, while others only get opportunities for manual labour and are more prone to exploitation. Illiteracy is the main cause of low adaptive capacity of the people in the area.

Large sections of the population in the study sites do not have access to education despite increased budgets and spending on education and the introduction of literacy programmes. The situation is worst in the flood-prone areas of north Bihar. In a large number of inaccessible villages, absenteeism among teachers is common.

### **Conclusion and Way Forward**

Conventional flood control structures changed the agro-ecology of the Koshi basin, increased the frequency and intensity of water related stress and hazards, and increased the area that is flood-prone or waterlogged. Erosion and sand deposition have put huge areas out of cultivation temporarily or permanently. The embankment

structures are not failure-proof as evidenced by eight failures in the past. Considering the projections for future climate change, these conventional structures could cause further distress and destruction.

Communities have been experimenting and innovating strategies to deal with water stress and hazards in their own ways. These innovations include

- making adjustments in the cropping cycle and better cultivation methods;
- introducing new and improved crop varieties and use of waterlogged land for water lily cultivation and sand-covered land for vegetable cultivation; and
- using cheap, locally available, and appropriate technologies for irrigation, such as bamboo tube-wells and movable pumping sets.

These 'softer approaches' devised by the people themselves compensate many of the losses incurred from floods, droughts, and other hazards. They are based on the approach 'get away from the flood rather than prevent it', which is an ecologically sound way of dealing with rivers in flood plains.

There is a need to rethink the way we deal with rivers and other natural resources in floodplains as reflected in policy instruments and in a structural change in governance at the local and national levels. The delivery of government programmes and schemes will improve

with the involvement of communities and civil society in environmental governance and in the development process.

To the state's credit, it has helped communities respond to water-stresses through improvements in transport and communication networks in the region, huge investments in rural development, present (albeit weak) law enforcement, and working democratic political systems. These enabling measures need to be further strengthened and streamlined.

Communities have their own autonomous responses to cope with excessive floods or droughts. The promotion of these autonomous measures and other measures could improve the communities' general well-being. This study could not determine the extent of these practices and their effect on the overall well-being of the people. Further studies and detailed analysis are needed to understand the benefits of these measures.

Finally, community-initiated responses provide a blueprint for scaling up and strengthening an adaptation strategy for the region. There can be no permanent or fixed adaptation strategies as a resilient system or community requires flexibility to change strategies according to the demands of the situation. Better governance must provide the enabling structure for this flexibility. Increased investments should focus on improving the capacity of communities to adapt.

