

CASE  
STUDY

# Ecosystem Services contributing to nature based solutions for disaster resilience





**The value of ecosystems to human wellbeing has long been recognized. People's lives are intrinsically linked and dependent on their ecosystem, as it provides many life-sustaining benefits to them. Recently, ecosystem services have been widely discussed to describe the different benefits people derive from them, both directly and indirectly.**

Living in a healthy ecosystem has many tangible benefits. Every person relies on ecosystem services in some way, but the degree of dependence varies from place to place and person to person. Those communities whose livelihoods and resilience are based on primary sector of the economy such as farming, fishing, and forestry heavily depend on ecosystems. The ecosystem services are capable of providing nature-based solutions for resilience to shocks and stresses. In areas affected or sensitive to disasters or climate variabilities, such contributions are prominent. On the one hand, these nature-based solutions are capable of dealing with emergency situations while at the same time they help in reviving and sustain life support systems. However, in recent times, human actions have adversely affected ecosystem services, making communities more vulnerable to weather- and climate-induced disasters. Many parts of the world have been facing climate and disaster risks due to poorly planned development activities that neglect natural ecosystems and their contribution to livelihood and resilience.

Kosi river basin area was once rich with biodiversity and ecosystem services. The case study documents ecosystem services and nature-based solutions that the Kosi basin provided, specifically to the villages that are close to Kosi embankments. The study conducted in five villages of Nirmali Block in Supaul District provides an account of how the local ecosystem services provided protection against natural hazards and were able to cope with shocks and stresses arising from climate variability, thus providing socio-economic resilience to the local population.

## Introduction

Supaul district lies adjacent to the flood plain terrain region of Nepal. During the past three decades, Supaul district has faced severe impacts of climate change. The climate trends indicate there is a significant change in precipitation and temperature indices of the district, which is exacerbating floods and other natural hazards. Floods brought immense sufferings to villages inside the embankments, which were trapped in floodwaters a number of times and were forced to abandon their land. Thousands of them had to resettle in nearby areas with limited land availability.

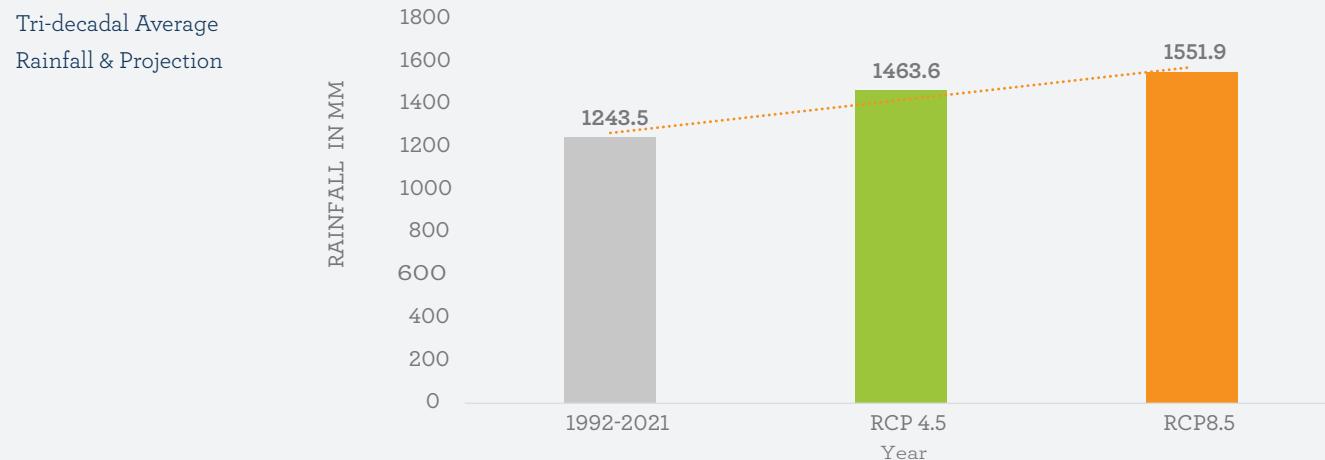
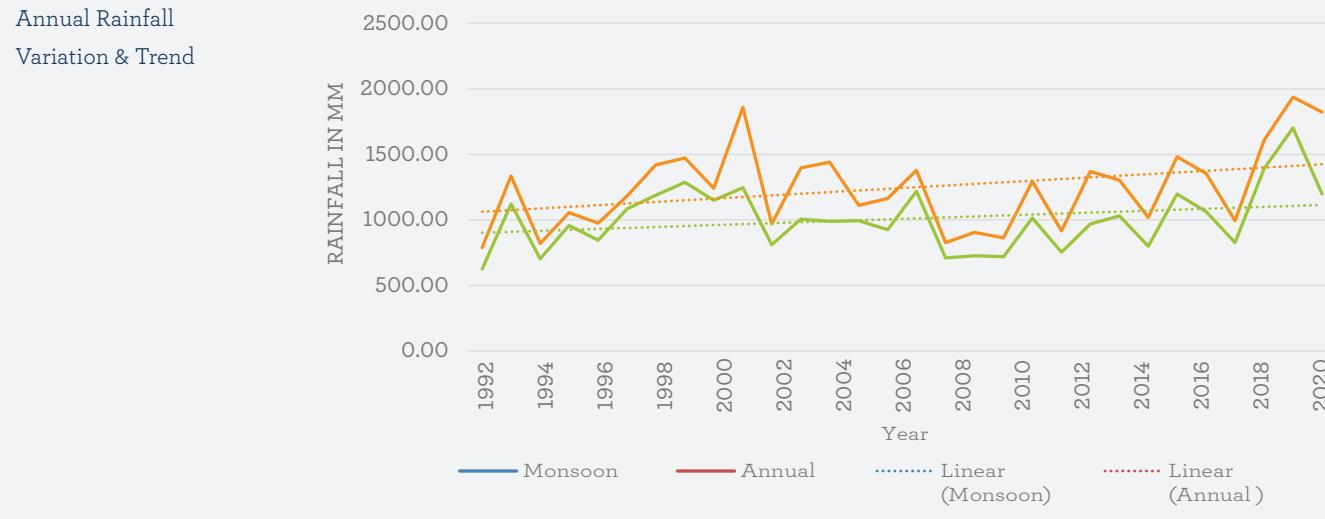
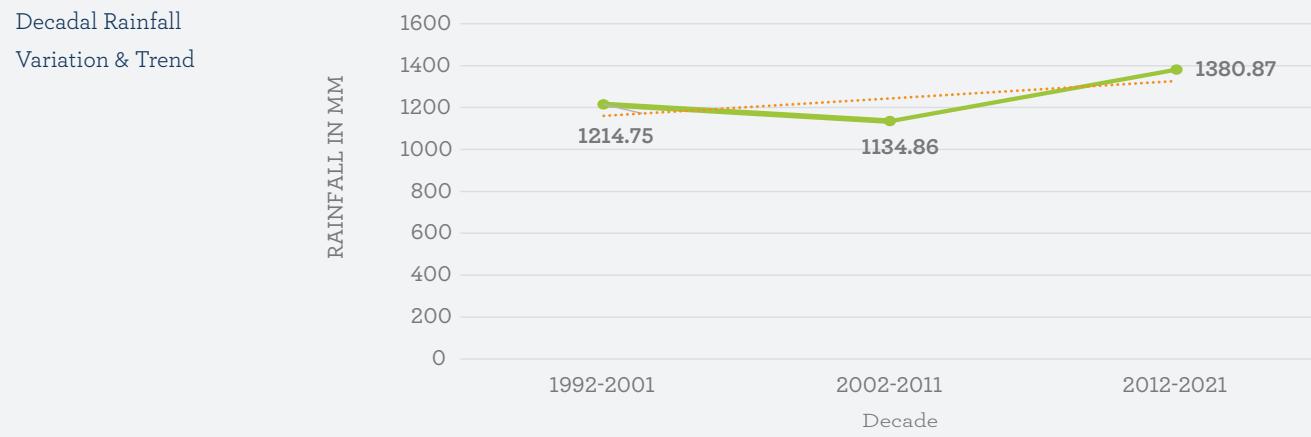
With the support of Asia Foundation, Gorakhpur Environmental Action Group (GEAG), a resource organisation, is implementing a project on Community Engagement for Climate Resilient Villages in five selected villages in Nirmali Block, Supaul district. All five villages represent communities relying on agriculture for their livelihood and have been significantly affected due to recurrent floods in the Kosi River.

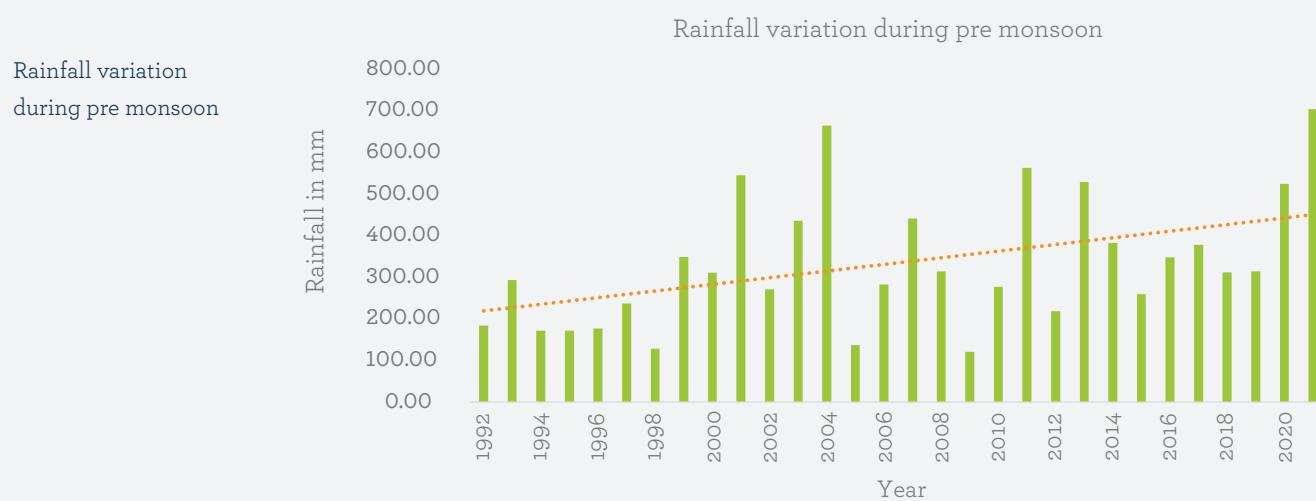
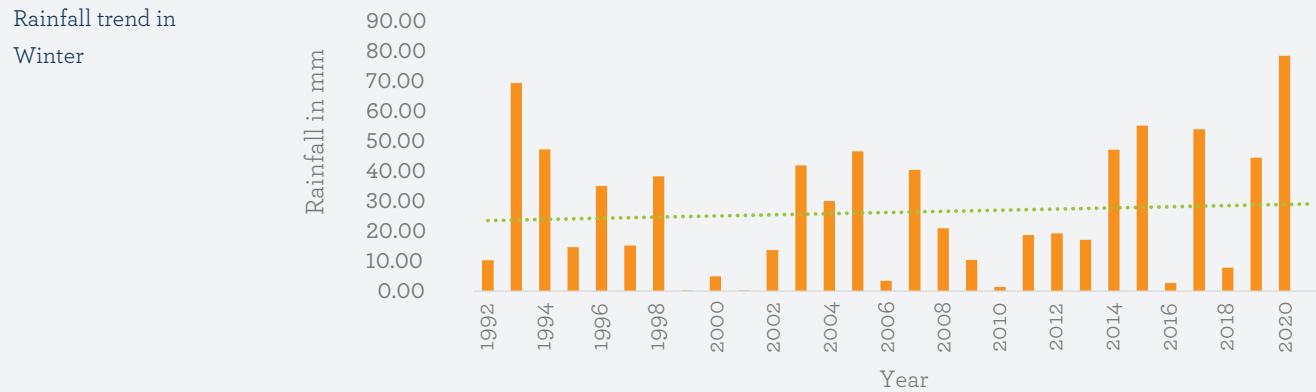
## Climatic Profile of district Supaul

To understand the climatic variability and the emerging vulnerabilities in district Supaul, which are often multidimensional and interlinked, a detailed climate data analysis is presented below sourcing data from the last 30 years:

### Time series of rainfall in mm for the southwest monsoon season and annual and trends

- Average Annual rainfall of the district is 1243 mm. The last decade 2012-2021 has experienced significant increase trend in annual rainfall .
- By the mid of 21 century , the tri-decadal rainfall is projected to increase significantly from 1243 mm to 1551.9 mm





#### Seasonal Rainfall Variation and Trend

- Annually the district experienced increasing rainfall trend with highest rainfall in July. But in last 30 years average rainfall in pre-monsoon has shown significant increasing trend
- In last 30 years, the contribution of pre monsoon (April–June) rainfall has increased from 21.14 % (1992–2001) to 28.76 % ( 2012–2021)

#### Frequency of Heavy Rainfall Days and Trend

- In last 30 years ( 1992–2021) the frequency of heavy rainfall is increasing.
- The years 2020 and 2021 have highest extreme rainfall events
- During 2021–2050 the frequency of heavy rainfall days is projected to be increased to 51.2 and 55.9 days in two different scenario i.e RCP 4.5 and RCP 8.5 respectively.

#### Temperature profile and Trend

- In comparison to other parts of the state , the district Supaul is experiencing significantly declining trend in maximum and Average temperature
- In last 30 years, the Maximum temperature has declined from 34 degree centigrade to 31 degree temperature.
- It is also important to note that in the district the frequency of warm days has also declined from 68 days to less than 20 days in last 30 years

#### Temperature Projection and Trend

- Both Maximum and Minimum temperature is projected to decline in both the scenario i.e RCP 4.5 and RCP 8.5 by mid-century (2050).

## Natural resources in the region that provided ecosystem services

### Kosi River

Kosi is a trans-boundary river which flows through high mountains in north eastern Nepal into the mid hills and the terrai plains of the Indo-Gangetic plains in North Bihar. For decades the landscape and the physical structure of Kosi River have provided settlements to people, various means of sustenance as well as a place where culture, practices and social interactions have evolved. Carrying a heavy sediment load, the Kosi river in Bihar is known for causing floods and due to the frequent flooding and devastation it creates, the river is being referred to as River of Sorrow.

Floods have submerged large portions of the villages under the project. Despite experiencing a range of devastations, people living here have a very positive attitude towards the river. Sri Ramcharit Pandit, a school teacher and farmer in Bathnaha village, shares that community had a mutual relationship with the Kosi River. Kosi nurtured life and was the primary source of food, water and livelihood. Most importantly, Kosi's landscape was such that it had a natural ability to control flooding and soil erosion.

Srimati Sarita Devi, a local resident of Bathnaha village says that she has been staying in the village for more than 35 years. Her village was never free from flood. Incidences of flooding occurred but were less volatile and of short duration. She further added that before the embankments were constructed, Kosi followed a distinct course. After

**“Kosi nurtured life and was the primary source of food, water and livelihood. Most importantly, Kosi's landscape was such that it had a natural ability to control flooding and soil erosion.”**

**RAMCHARIT PANDIT,**  
a school teacher and farmer in  
Bathnaha village

**“...village was never free from flood. Incidences of flooding occurred but were less volatile and of short duration. Before the embankments were constructed, Kosi followed a distinct course. After running eastward for the first 12 years, it shifted its course to a westward path. The run off from the river used to spread across its large width, without causing much damage to the land.”**

**SRIMATI SARITA DEVI**  
a local resident of Bathnaha

running eastward for the first 12 years, it shifted its course to a westward path. The run off from the river used to spread across its large width, without causing much damage to the land. The river could distribute sediments along the 200-kilometre stretch. Over thousands of years, Kosi has provided fertile land suitable for human habitation by providing the life-giving silt.

In Sikarhatta village, villagers shared the ecological benefits connected with the Kosi river, including irrigating the plains with water flowing down from



the Himalayas. The agricultural and fallow land that was available was also a potential source of fodder for livestock. By virtue of its inherent property of water purification, the river water also nourished the soil and maintained the quality of the water. However, seepage and water logging have severely deteriorated the quality of water. In addition to being contaminated, the water contains iron.

In August 2008 massive flood struck the region and thousands of people who owned land inside the embankments were displaced from their ancestral lands. Due to limited land availability, the people displaced still have a connection to the land they lost years ago. The land still provides sustenance, as the portion of it which did not submerge in floods is being utilised for farming, though on a small scale. Part of the land is also used for livestock grazing. The situation is even worse for the people who have relocated to the other side of the embankment as they have to cross the river every day to visit their

Palar area (Palar is the local name for the land inside the embankment). During the early morning hours, you can see them crossing the river with their cattle.

Residents of the project village shared that their forefathers knew how to live with Kosi. They had a very comprehensive understanding about Kosi's cyclic phases of flood and its courses. They could calculate when Kosi would run across their village. Farming practices were based on this understanding and the community made necessary preparations beforehand to respond to the flood-like situation. But Kosi river basin at present is witnessing the impacts of climate change such as increased days of intense rainfall. The seasonal pattern of monsoon rainfall and period of floods are changing. Sri Ramcharit of Bathnaha village says that earlier floods used to stay for ten to fifteen days but now they stay for four months.



**Silt:**  
Soil fertility,  
farming



**Natural  
Drainage**



**Irrigation**



**Water holding  
capacity**



**Commuting**



**Ground Water  
Recharge**



Cattle coming back from palar area in the evening, near Dagmara village

## Tiljuga River

Tiljuga is a tributary of the Kosi River, which originates in Nepal. Flowing through Bathnaha village in the project area, it takes an eastward course after touching Sikarhatta/Chutiyahi village. During the monsoon, the river acts as a natural drainage channel, taking in excess runoff from the Kosi River. However, its drainage capacity is affected due to the sandy deposits and siltation, which comes along with the Kosi river. Despite this, the river is capable of mitigating the flood effects. Residents of Sikarhatta and Bathnaha reported that there was a breach in Grameen Bandha/village bund during the monsoon of 2021. Water was flowing profusely in the Kosi river, creating panic among the inhabitants. However, no major damages were caused since the Kosi river followed the course of the Tiljuga river, allowing the floodwaters to flow downstream.



## Natural water streams in Nirmali block

Nirmali Block in Supaul district once had several small and large natural water streams. It was common for every village to have one or more ponds adjacent to the water streams. These water bodies provided regulatory ecosystem services to the people and the region. By acting as natural barriers, they mitigated floods and prevented waterlogging. Moreover, they helped recharge the groundwater and thereby provided the resources for livelihood.

In the project villages, there are a total of five water streams, locally known as Nala. However, due to encroachments and unplanned development activities, these natural water structures have been degraded and their ecosystem services have been significantly diminished. The natural water streams also served as channels for river water to flow off without causing much damage to people and their properties. However, there has been a reduction in the flow of these natural water bodies in most places, and some of them are completely stagnant. The following is a brief description of how various human activities have degraded the ecosystem services that these natural water streams provided:

## Natural water stream near Bathnaha Village

A wide natural water stream is located in Bathnaha village, which flows along the Pachchimi Tatbandh (Western Embankment). The stream flows one and a half kilometers downstream. While acting as a water reservoir, the stream helped control seepage caused by embankments. During heavy rainfall, it absorbed excess runoff to prevent floods in adjacent areas. The community members of Sikarhatta village shared that the water stream protected them by draining excess flow from the Kosi river. Eventually, the stream merged with the Tiljuga river, and together they helped dissipate floods.

The stream is now in a degraded state with a significantly restricted flow. There is a large patch of land along the stream that has been encroached upon by the displaced people and the stream itself is filled with waste. Moreover, silt deposition from the Kosi river has reduced the natural capacity of percolation, resulting in water logging in nearby villages. During heavy rainfall, the water level in the stream rises and inundates the surrounding areas.



Kosi river is on the left side of Paschimi Tatbandh and the natural water stream which flows along



The village situated close to the stream faces water logging throughout the year



During heavy rains, water submerges the government school building

### Natural water stream in Thariya Village

In the past, a natural stream which crosses through the Thariya village boundary benefitted the local communities by providing various ecosystem services. The community members describe it as a small river that has dried up. Once an integral part of the village landscape, it helped recharge groundwater and irrigated agricultural land nearby. During monsoon, it used to drain the excess floodwaters and prevented soil erosion. It

is one of the longest streams in the region, which crosses five to six villages, and was also used as a communication channel. As the locals traversed the stream by small ferries, they were easily able to reach the Nirmali market, located around 15 kilometers away.

Unfortunately, poor maintenance and encroachments have led to the loss of this ecosystem structure. In addition, poor urban planning contributes to its degradation. The construction of a training infrastructure along the

river has altered its landscape and permanently blocked its flow. Several years have passed since Thariya village has been affected by unplanned urbanisation. People who depended on the stream for agriculture and other allied activities have also been affected by this modification. The stagnant water also leads to seepage that causes agricultural land to be waterlogged for a long period of time every year.

Another stream of water can be found at Bela Singar Moti, which is seven to eight kilometers long and covers five to six Gram Panchayats. Due to poor maintenance and blockages, the stream is in a degraded state as invasive aquatic plants and weeds choke it. Along with this, the stream has also become a source of seepage, which



Farm land which is adjacent to the stream is water logged in the month of May 2022. During rainy season the land gets inundated in flood water.

has significantly impacted crop production in the village. According to residents, the stream is now a breeding ground for snakes.

### Village Ponds

The Kosi basin is home to a variety of water bodies that are part of a larger ecosystem with which communities have been living for centuries. The majority of villages have two to three ponds and depression areas that hold water throughout the year. These ponds provide both ecosystem services and nature-based solutions for resilient livelihoods. While providing livelihood services through makhana (Euryale) farming, fisheries, aquatic food, irrigation water, bathing livestock, providing fodder, extinguishing fires, recycling liquid waste, and so on, these water bodies have also created a microclimate in the village.

Temperature regulation, water storage capacity, drainage and irrigation during dry spells are some examples of how these natural water bodies enhance climate resilience. However, owing to neglect and being used as a dumping grounds of waste, currently the village ponds are in a poor condition. Local authorities, villages, and panchayats must protect and maintain these ponds for the immense environmental value they provide.



Natural Water Stream at Bela Singar Moti Village

## Way Forward

The Kosi River basin has a diverse and rich ecosystem. This case study describes the ecosystem and the services it provides in the operational villages, which includes services of provisioning, supporting and regulating. Below is a summary of the key services available to the people in the region:

Manmade activities have caused an imbalance in the region's ecosystem, which has negatively affected the economic and social status of the community. Based on the study of the project villages, it was confirmed that when ecosystem structures are disturbed due to imbalanced human actions, the services offered also degrade rapidly. Climate change is affecting the entire landscape in and around the project villages. The mass displacement has altered the social structure of

the community; affected the education of children who provide support for the economic activities, disappearance of religious and cultural structures, as well as the local wisdom.

The following are some measures that should be implemented on a priority basis in order to enhance the resilience of the region:

- A better understanding of the impacts of climate change on water resources in the region is urgently required;
- Protecting and conserving lakes and ponds in the region as living entities;
- Water streams and smaller rivers need to be revived and conserved;
- After mapping vulnerable areas like river banks and fallow fields, afforestation drives of water tolerant varieties need to be conducted in order to maintain green areas.

| Ecosystem/Services     | Provisioning   | Supporting   | Regulating   |
|------------------------|--|--|--|
| Ponds/Lakes            | Fishes, Singhara (Trapa) cultivation, Makhana (Euryale) cultivation, Irrigation, drinking water for livestock, water for extinguishing fire in dry days* | Biodiversity, maintaining seeds of aquatic plants, cooling     | Act as water reservoirs during floods, groundwater recharge, recycling of domestic waste water |
| Smaller Rivers/Streams | Fishes, irrigation, Bathing-human and cattle   | Silt deposition, bio-diversity, soil bunding -checking erosion | Drainage of excess storm water, water recharge   |
| Green Areas/Vegetation | Food, Fuel, Fodder,  | Reducing heat impacts (cooling), soil bunding                  | Water holding capacity, water recharge   |

\*Fire accidents are very common in the areas close to the embankments. The thatched houses, built by adding layers of straw, catches fire especially during the peak summers when high velocity wind blows throughout the day.



