

# Assessment of the Land Use Change and Economic Transition Under the Impacts of River Course Alteration in Rural Areas Rajshahi: A PRA Framework-based Analysis

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## Abstract

The intricate and interdependent relationship between rural communities and rivers has long been recognized as a crucial aspect of rural livelihoods, providing essential water, food, transportation, and recreation sources. However, with its annual course changes, the mighty Padma River poses a formidable challenge to these communities, transforming landforms that can create new land (Char) or disintegrate existing land. Inevitably, these changes can have a profound impact on farmers, fishermen, and migrant communities, leading to significant shifts in their livelihoods and occupational patterns. The GIS and RS-based method provides visual information about the land use change in Yusufpur along with river course change and PRA (Participatory Rural Appraisal) helps in understanding the community, and promotes active community participation, resulting in more relevant and impactful research outcomes. In light of these challenges, this study aims to investigate the course changes of the Padma River over time and explore the effects of these changes on the socio-economic landscape of the Yusufpur union. The study area encompasses a range of communities, including Kakra Mari hat, Yusufpur Bazar, Yusufpur Primary School, one high school, a fishermen community, migrant communities, and an agricultural community, with a significant portion of land dedicated to agricultural use along with identifying and analyzing the causal mechanisms underpinning the socioeconomic changes in the study area. Ultimately, this analysis provides valuable insights and strategies for fostering socio-economic development and resilience in these rural communities facing river course alterations.

**Keywords:** River course alteration. PRA, Landform Changes, Economic transition.

## 1. Introduction

Rajshahi, one of the influential cities of Bangladesh has a prominent impact on the northern region of Bangladesh in terms of economy and development. The influential change in the landform over the period in the rural areas of Rajshahi had been a major factor in the development and economic transition. Landform change involves any type of morphological alteration to a landmass, including soil erosion, deposition, landslides, and other geological activity that can alter the shape of the land. In rural places, changing river channels significantly impacts how landforms evolve and the economy develops. One such area, Rajshahi, Bangladesh, has undergone major changes as a result of altered river courses. River course alteration can lead to a significant loss of habitat. When a river is altered, pollutants can be brought into the ecosystem, affecting the water quality and potentially causing health issues for local wildlife and people. It can also cause soil erosion, leading to the loss of valuable agricultural land and increasing the risk of flooding. The PRA framework operates as a thorough instrument that includes the knowledge and viewpoints of regional communities, subject matter experts, and stakeholders, promoting a full comprehension of the effects of river flow alteration. This investigation tries to pinpoint the primary forces and mechanisms underlying landform change and economic transformations in Rajshahi by interacting with the impacted community. The rural life of Bangladesh is vastly dependent on the river-based economy. As for the analysis of the major vulnerable section over the last decade, Yusufpur Union at Charghat

Upazila (Rajshahi district), is located between 24°14' and 24°22' north latitudes and in between 88°46' and 88°52' east longitudes for its river-based location and agricultural influence in the regional economy having river interdependence. With its annual course changes, Padma River poses a formidable challenge to these communities, resulting in a transformation of landforms that can create new land (Char) or disintegrate existing land that opens agricultural opportunities for the locals. But the major concern occurs with the course change that causes land erosion and people's migration. The paper aims to attain geographical change of Yusufpur by the **river course change along with land use** over some time and analyze livelihood and occupational **patterns** change in **farmer, fisherman, and migrant** communities. The research emphasizes the community-based assessment and development of the rural community and economy of the Rajshahi.

## 2. Literature Review

The literature review includes objective planning and information collecting for each chapter or section of the report. The use of GIS and RS is often followed by an emphasis on the broad idea, causes, and effects of the historical flood and its impacts on the landform change considering the economic section of the people's livelihood.

### 2.1. Causes of River Course Alteration

River course changes pose persistent challenges to rural communities in Bangladesh, with future rainfall increases expected to exacerbate surface runoff and trigger severe nationwide flooding (Asaduzzaman, M., 1994). To address this issue, implementing strategies to protect lives, livelihoods, and economic productivity is essential. This includes safeguarding populations from floods, developing resilient crops, and optimizing irrigation and fertilizer practices (Brammer, H., 2010). While uncertainties surround the immediate effects of sea-level rise and temperature changes, climate change management should be integrated into broader development agendas (Brammer, H., 2009). Predictions indicate that climate warming will accelerate global hydrological cycles, resulting in heightened river discharge due to increased precipitation and reduced evapotranspiration, thereby increasing flood frequency in regions worldwide, including Bangladesh. So, flood events have a huge impact on river course alteration.

### 2.2. Flood Events in Bangladesh

BHOLA (11/1970): According to the World Bank's assessment, two million of the 4.8 million people in the cyclone's path resided in the worst-hit districts. One million acres of crops were also lost, and another million were damaged. Up to 400,000 homes and 3,500 schools were damaged, 280,000 animals and 500,000 birds perished, and 9,000 sea and 90,000 river boats, or 65% of all fishing capability, were destroyed.

RAJSHAHI (1987): In 1987, Bangladesh had its most recent and severe flood, which many people consider to be the worst disaster to hit the country in the previous 70 years. The damage caused by this unusually deep flood was significant. According to estimates, the cost could reach US\$1.3 billion nationally. to calculate the harm caused by the 1987 flood at the home (micro) level.

GAIBANDHA (6/1993): Damage Statistics, As Reported in the latest official update (23 June 1993) from the Ministry of Relief, have increased with more detailed assessments coming in from the affected areas: number of confirmed Deaths:15, the population affected: 2,633,436; houses Damaged: 37,787 Fully, 128,464 partly; educational institutions damaged: 122 fully, 800 partly; roads damaged in Km.: 907 Fully, 2,841 partly; number of bridges/culverts damaged: 786. These incidents lead us to many major issues to deal with which impacts can be measured through layer base assessment.

### 2.3. Assessment of Landform and River Course by GIS & RS

In Bangladesh's northeast, flash flooding is common with this country's main grain crop. The major objective of this study was to describe the impact of the 2017 flash flood (which began on March 27, 2017) on boro rice using multi-temporal Landsat-8 OLI and MODIS data. first chose to use Landsat-8 OLI data to map the damage. So, Using GIS-based modeling to analyze agricultural output ensures economic benefits and reduces costs. GIS and RS have a big impact when identifying sensitive places. The study divided mapping the damaged boro into two primary segments using MODIS images taken before and after the flood. Another relative study has suggested the following adaptation alternatives to deal with the challenges of climate change: retreat, accommodation, and protection. The frequency and severity of tropical cyclones, storm surges, coastline erosion, and backwater consequences were given particular attention (Ali, A., 1999). So eventually GIS and RS in used in the in-depth analysis of the flood hazard cause and effect.

### 3. Methodology

The study area selection was based on the prominence of the river-based economy in Yusufpur. Various PRA tools were utilized, including cause-effect diagrams, trend analysis, timeline exercises, matrix ranking, Venn diagrams, resource mapping, pair-wise matrix ranking, and dream mapping for the analysis of livelihood and occupation. These tools facilitated the collection and analysis of data interactively, enabling the identification of key issues and resources, visualization of problem causes and effects, exploration of historical contexts, and prioritization of community needs. Moreover, the land use change assessment is conducted through GIS-based modeling to identify the change in landform along with the river course alteration. The analysis is done based on the sources and the following process.

Table 1: Data Source for Land-use Classification (Data source for Land use Change Analysis)

Sources	Row/Path	Date of Acquisition	Resolution (Meter)	Projection/Datum
Landsat 1-5 MSS C2 L1	138/034	1975/11/17	60	BUTM/ WGS84
Landsat 4-5 TM C2 L1	138/034	1988/11/08	30	BUTM/ WGS84
Landsat 4-5 TM C2 L1	138/034	1990/10/29	30	BUTM/ WGS84
Landsat 8-9 OLI / TIRS C2 L2	138/034	2022/10/21	30	BUTM/ WGS84

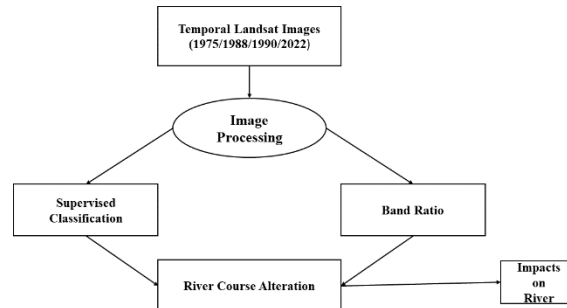


Figure 1: Image Classification Method for River Course Change Detection

### 4. Data Analysis and Discussion

The data analysis portion of the research includes the PRA and GIS-based tool application analysis to enrich the information of the existing scenario and delineate proper recommendations for the development of the community.

#### 4.1 Water Course Analysis at Yusufpur

The research is focused on the left bank (at the bank of Yusufpur) of the Padma River which has constantly shown frequent and aggressive erosion trends in recent years. In the image of 1975, erosion occurred along Yusufpur, Sarah, and Charghat unions only and then the southern end of the Gargari Union of Bagha Upazila.

### WATER COURSE CHANGE COMPARISON

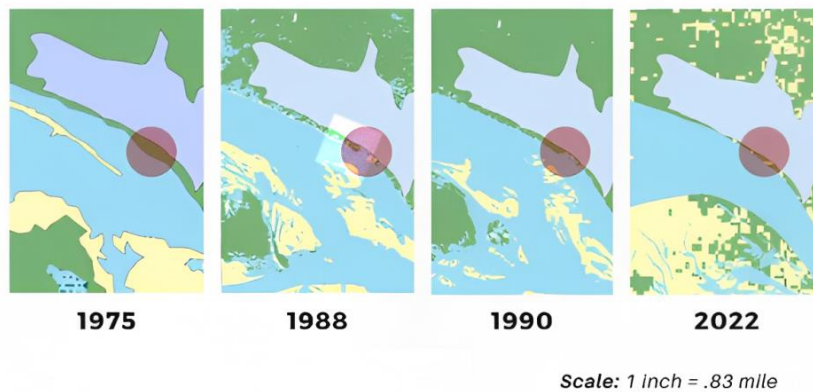


Figure 2: Water Course Change at Yusufpur from 1975-2022 (Source: Author, 2022)

The affected areas are observed in a site visit and social surveys, Sahapur (Purbapara), Tangoan (Fisherman Area), and Char area (Bangladesh- India). The changes in river course drastically affect land loss, people’s migration, and dams. The timeline exercise gives a broad look at this scenario. About 586 hectares of bank lines were eroded during the period of 1975. Since 1975, about 1319-hectare new bank line was eroded maintaining a slowerosion process during these 34 years. The analysis shows a visual change in land use as the river bank gets close to the present Yusufpur Upazila.

### 4.2 Cause-Effect Diagram

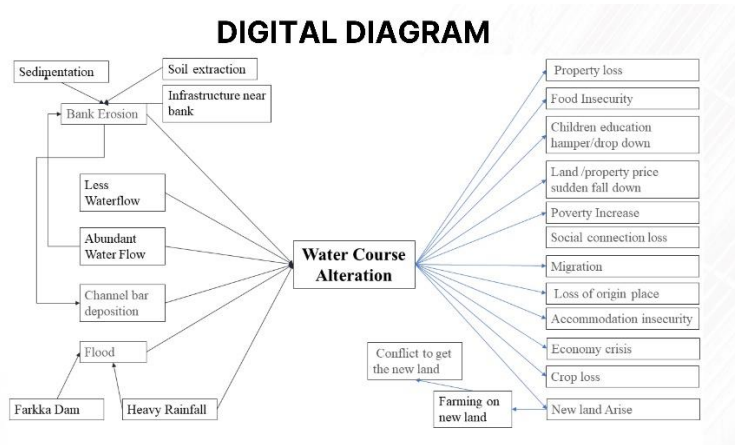


Figure 3: Cause-Effect Diagram for Yusufpur (Source: Author, 2022)

The cause-and-effect diagram identifies the impacts of water course alteration on rural communities from a participatory assessment perspective. This study investigates the cause-and-effect relationship of watercourse alteration, with a specific focus on the perspectives of rural communities. Through active participation, the local people identified bank erosion as a significant consequence of water flow variations. This erosion, in turn, leads to property loss and exacerbates food insecurity, impacting socio-economic conditions. To mitigate these effects, the deposition of bars along riverbanks has been proposed as a potential solution. Additionally, floods resulting from heavy rainfall and controversial overflow from the Farkka Dam were highlighted by the participants. The irregularity of heavy rainfall in the region contributes to recurring flood events, while the controversial overflow exacerbates flash floods. These floods have severe consequences, including property loss, food insecurity, disruptions to children's education, and social disconnections. Furthermore, the emergence of new land creates conflicts among villagers, as it holds significant value for agricultural purposes. This study sheds light on the multifaceted impacts of water course alteration on rural communities, offering valuable insights for sustainable development and effective resource management in the region.

### 4.3 Pair-Wise Matrix Ranking

PAIR WISE MARTRIX RANKING OF THE IMPACTS ON RIVER COARSE ALTERED AFFECTED COMMUNITY								
Impact Analysis	Agricultural land Loss	Economic Crisis	Food Insecurity	Property Price Fall	Loss of Origin Place	Crop Loss	Frequency	Ranking
Agricultural land Loss	X	1	1	1	1	1	5	1
Economic Crisis	0	X	0	1	1	1	3	3
Food Insecurity	0	1	X	1	1	1	4	2
Property Price Fall	0	0	0	X	0	0	0	6
Loss of Origin Place	0	0	0	1	X	1	2	4
Crop Loss	0	0	0	1	0	X	1	5

Figure 4: Pair-Wise Matrix Ranking for Impact Analysis at Yusufpur (Source: Author, 2022)

In terms of impact, the economic crisis was found to be less pronounced than agricultural land loss and food insecurity. Nonetheless, it remained a high-priority concern compared to property price fall, loss of origin place,

and crop loss. Similarly, food insecurity garnered greater importance than the economic crisis, property price fall, loss of origin place, and crop loss. Notably, property price fall was accorded less significance by the rural population, as their primary focus was on farming rather than property transactions. Loss of the original place received more attention in the impact analysis than property price fall and crop loss, reflecting the participants' concerns. Lastly, crop loss was ranked higher in terms of importance compared to property price fall. Based on the frequency analysis of the pairwise matrix ranking, agricultural land loss emerged as the top-ranked issue, underscoring its profound impact on the community. Following closely, food insecurity was ranked second, followed by the economic crisis in third place. Loss of origin place, crop loss, and property loss was ranked fourth, fifth, and sixth, respectively.

#### 4.4 Resources Map

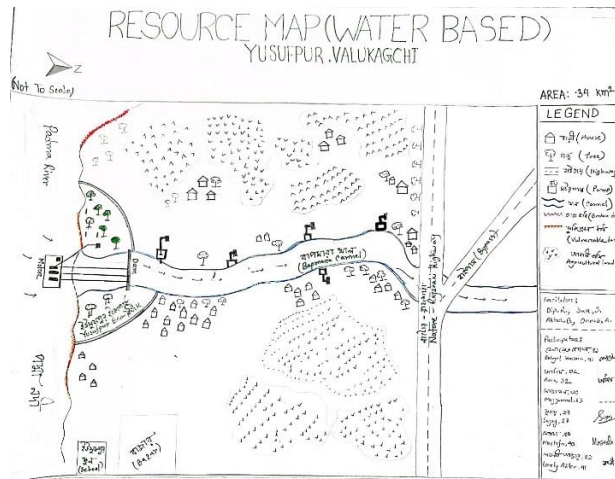


Figure 5: Resource map of Yusufpur Upazila (Source: Author, 2022)

The Yusufpur Bazar emerged as a central hub for socio-economic activities, with most farmers selling their agricultural products in this marketplace. Educational institutions, including Yusufpur Primary School, Yusufpur Higher Secondary School, and Mohila College, played a vital role in meeting the educational needs of the local population.

Transportation networks also shaped the community's dynamics, with the Natore-Rajshahi Highway located in the northwest corner of the union and the Bypass Road passing through the northeast corner. Notably, the construction of an artificial canal, locally known as "Bapmara Khal," played a pivotal role in ensuring the proper supply of irrigation water. Moreover, numerous motor pumps were strategically placed along the canal to contribute to the water supply for the cultivated land. The resource map also encompasses the Yusufpur eco-park, recognized as a significant natural resource that protects the riverbank. However, given the dynamic nature of resources in the area, including the emergence of new lands resulting from river damage.

#### 4.5 Dreamscape of Yusufpur: Unveiling the Potential and Possibilities

##### Dream Map Illustration of Yusufpur

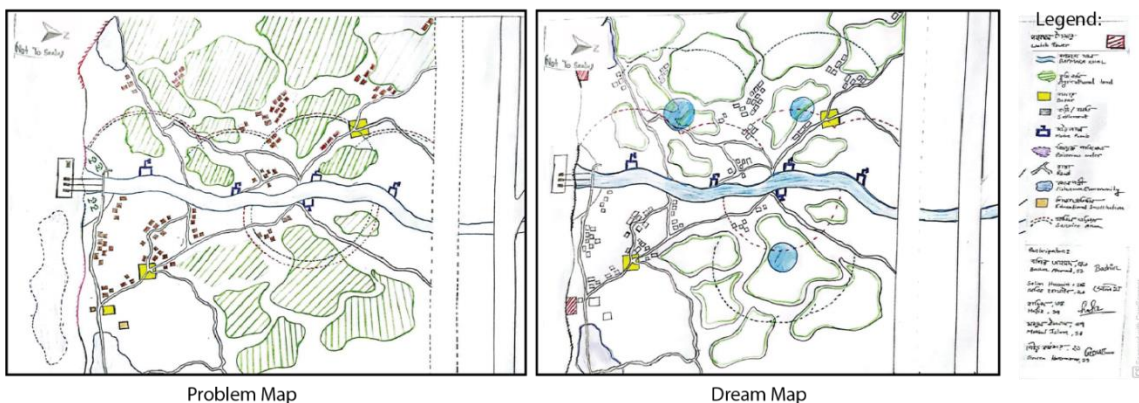


Figure 6; Problem map and Dream Map of Farmer and Fisherman Community (Source: Author, 2022)

**"Mapping Community Problems: A Glimpse into Dream Maps"**: To create a dream map, the initial step involves understanding the problems faced by the communities involved. This study focuses on three distinct communities and identifies their respective challenges, which are then illustrated on the dream map alongside their envisioned solutions. Participants highlighted the fragile condition of the river bank, with a specific section of the study area experiencing significant damage. The limitation of the suction pump's capacity emerged as another issue, leading to inadequate irrigation coverage for agricultural lands. Additionally, water poisoning emerged as a major concern for the fishing community, resulting in a decline in the river's fish population. The dream map visually represents these problems, marking the damaged river bank in red, insufficient irrigation coverage in blue, and the impact of water poisoning on fish in the river.

## 5. Recommendation

### 5.1 Authors' Recommendation

According to the in-depth analysis considering sustainable SDGs goals, some recommendations have been considered. Like, well channelization of water supply from the Khal, embankment of the river, proper supply chain maintenance in agricultural and fish production, and policy formation including people.

### 5.2 Dreamscape of Yusufpur

Increasing the capacity of the suction pump is not feasible since it was a one-time project by the BMDA, with no plans for capacity expansion. Therefore, the suggested alternative is to create an intermediate reservoir for temporary storage. The reservoir, marked by the blue boundary on the map, would provide water for irrigation purposes. This solution requires acquiring land for digging the channel, and the maintenance of the canal would be entrusted to the local people.

Informal conversations with the authority of BMDA (Barinda Multipurpose Development Board) indicate that the Water Development Board (WDB) has a plan for the reconstruction. However, administrative difficulties may cause delays in the process.

To address another problem of poisoning the water, the proposed solution involves establishing a watchtower in front of the fishermen's community. Two patrol teams would be responsible for monitoring the river during nighttime.

## 6. Conclusion

Rural life and rivers are the heart of Bangladesh. The development process for a rural area vastly depends on the river-based economy. Rajshahi, being a river-based area has a huge impact on the life of rural people. A PRA framework-based analysis has been used to evaluate the assessment of landform change and economic transition in rural Rajshahi areas under the consequences of river course alteration. The research demonstrates the important effects of river course modification on landforms, including adjustments to soil fertility, water availability, and erosion patterns. Traditional agricultural methods and resource-dependent livelihoods have been put in jeopardy by these changes. Furthermore, changes in agricultural methods and means of subsistence have been indicative of the economic transition in rural areas. The results highlight the need for comprehensive policies and sustainable land management techniques to reduce the adverse effects of river course alteration and enhance the economic well-being of rural residents in Rajshahi. This will eventually help the development of the farmer and fisherman community and in the long run a sustainable economy in Yusufpur, Rajshahi.

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