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Assessing Anthropogenic Drivers of Riverbank Erosion Along the Bhagirathi-Hooghly River Using Land Use and NDVI Analysis

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Abstract

Now a day's riverbank erosion is burning issue in the world. Riverine dweller suffers from the hazards. Rapid rate of population explosion is the main factor of the hazards. Due to increase built-up area deforestation occur which leads riverbank erosion. The main purpose of the study is to identify between LULC change and riverbank erosion in Nadia and Purba -Burdwan district using LULC map and NDVI map. To assess the change of landuse, four LULC maps were generated such as year of 1993, 2003, 2013 and 2023 and to detect the changes of vegetation cover, NDVI maps of 1993 and 2023 were made. From the comparative study of the maps it is clear that built-up area is increased and vegetation cover decreased and riparian vegetation also decreased day by day. Loss of riparian vegetation indicates rapid erosion. To overcome the problem people needs to plant trees along riverbank and protect bank from erosion.

Keywords: Riverbank erosion, Riverine dwellers, Land use, Population Exploration, and NDVI.

Introduction

Riverbank erosion acts as a killer which displace millions of people, destroy their livelihood as well as economic loss (Miah et al., 2025). It become a common phenomena and major natural hazard. Due to rapid growth of population causes agricultural expansion which increase riverbank erosion. Human activities like deforestation and over farming acts as a important factor to increase riverbank erosion.

LULC (Land Use Land Cover) investigation play a important role for sustainable development of natural resource (Pandey et al., 2023). It helps to assess the status of socio- economic condition of people aa well as livelihood of people also. (Das et al., 2021). The study of LULC change detection may help to assess the rate of riverbank erosion. Rapid change of LULC such as increase builtup area and decrease vegetation cover accelerates riverbank erosion (Chakraborty and Saha, 2021). Flood plain continuous struggle with land use change. River course always is an equilibrium condition between erosion and accretion. Erosion and accretion together play vital role to change shape and form by creating new features like meanders, bars and braided channel (Hasan et al., 2024). Erosion, Acieration and river shifting help to change the LULC of an area. But when river fails to maintain the equilibrium then its negative impact will fall in society.

NDVI is a vegetation index which indicates vegetation cover of an area. Comparison of NDVI map of different year a complete scenario of vegetation status is identified. As there is a relation between vegetation cover along riverbank and riverbank erosion so NDVI is a vital index to study riverbank erosion of any area.

West Bengal is a deltaic plain formed by sediment deposited by rivers (Hasan et al., 2024). Mainly lower part of West Bengal is highly vulnerable to riverbank erosion because mainly rivers continuously changes their course overtime. Agricultural expansion, sand excavation and another human activities change land use pattern of the area which increases the erosion rate. As a result rate of land loss, property loss, displacement of riverine dwellers increase due to rapid rate of Riverbank erosion (Deb and Deore, 2025). LULC change has impact on environmental services, Urban growth, Erosion rate and many other issues. The study of LULC change detection is important for understanding the dynamism of human activities (Hu et al., 2023).

Remote sensing and Geographic Information System (GIS) helps us to detect the changes of Land use and Land Cover and also detect changes of vegetation cover using NDVI indices time and space (Yohannes et al., 2025).

This aim of the study to assess the influence of anthropogenic activities on riverbank erosion along the Bhagirathi-Hooghly River by generating temporal land use/land cover maps and NDVI analysis which derived from satellite imagery. Specifically, the study shows to identify the changes of land use and vegetation cover, and evaluate the relationship between anthropogenic interaction and riverbank erosion.

Study Area

Study area is selected along Bhagirathi-Hoogly River which is extended from confluence of Ajay and Bhagirathi (near Katwa, Purba Bardhaman District) to confluence of Churni and Bhagirathi (near Payradanga, Nadia District) (Fig 1). Study area is situated from 22°80'N-23°60'N and 88°E-89°E. Most part of Nadia district and small part of Purba Burdwan district are included in the area. Eight block such as Kaliganj, Nakashipara, Krishnagar II, Krishnagar I, Nabadwip, Santipur, Ranaghat I and Chakdaha are in Nadia District and two blocks such as Katwa II and Purbasthali II are in Purba Burdwan District. Bhagirathi-Hoogly river changes their path frequently and the area is more erosion prone so the area is selected for this study.

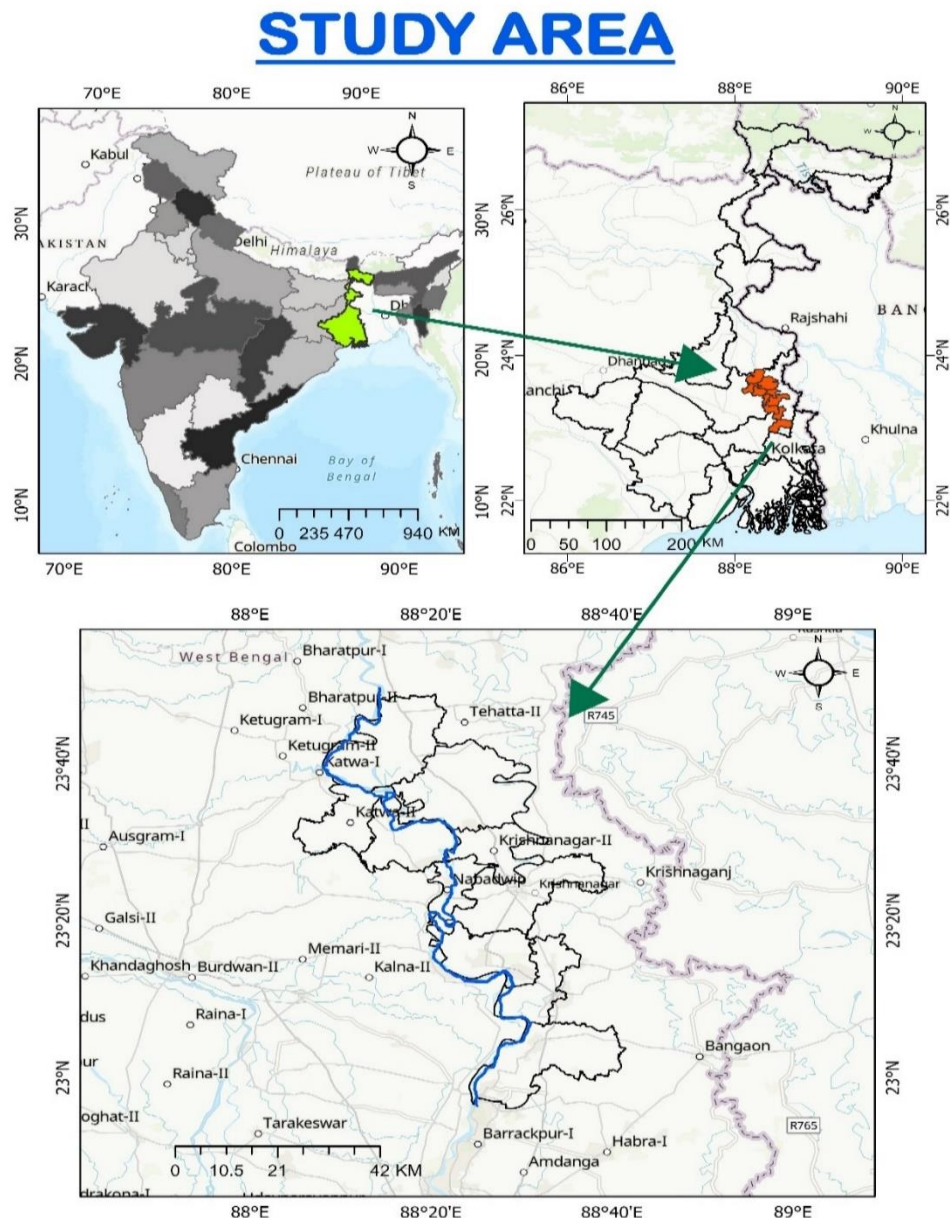


Fig 1: Study Area

Methodology

Four Landuse map (1993, 2003, 2013, 2023) were generated from satellite imagery through GIS software. 1st landsat images was download then shape file was created. Then all necessary class was decided and then supervised classification were also made.

For more intensive study NDVI maps of 1993 and 2023 were made due to detect vegetation loss specially riparian vegetation. NDVI was calculated using the Near-Infrared (NIR) and Red spectral bands of Landsat imagery. For Landsat 5 TM (1993), Band 4 (NIR) and Band 3 (Red) were used, whereas for Landsat 8/9 OLI (2023), Band 5 (NIR) and Band 4 (Red) were used. The NDVI values range from -1 to +1, where higher positive values indicate healthy and denser vegetation cover and negative value indicates no vegetation.

Result and Discussion

- From the landuse map (Fig 2 and Table 1) of the study area it is seen that percentage rate of Built-up area is increasing rapidly along riverbank of Bhagirathi-Hoogly. From 1993 to 2023, 33% Built-up area is increased. But Vegetation areas are decreased day by day. From 1993 to 2023 total 6.78% vegetation area is decreased. So this is the result of deforestation which is the main cause of Riverbank Erosion. Percentage of waterbody area is decreased. From 1993 to 2023 3.14% area is decreased due to fill up of waterbody for construction. It is the cause of riverbank erosion as well as flood. Area percentage of Waste Land and Agricultural Land are also decreased which increases rate of Riverbank Erosion.

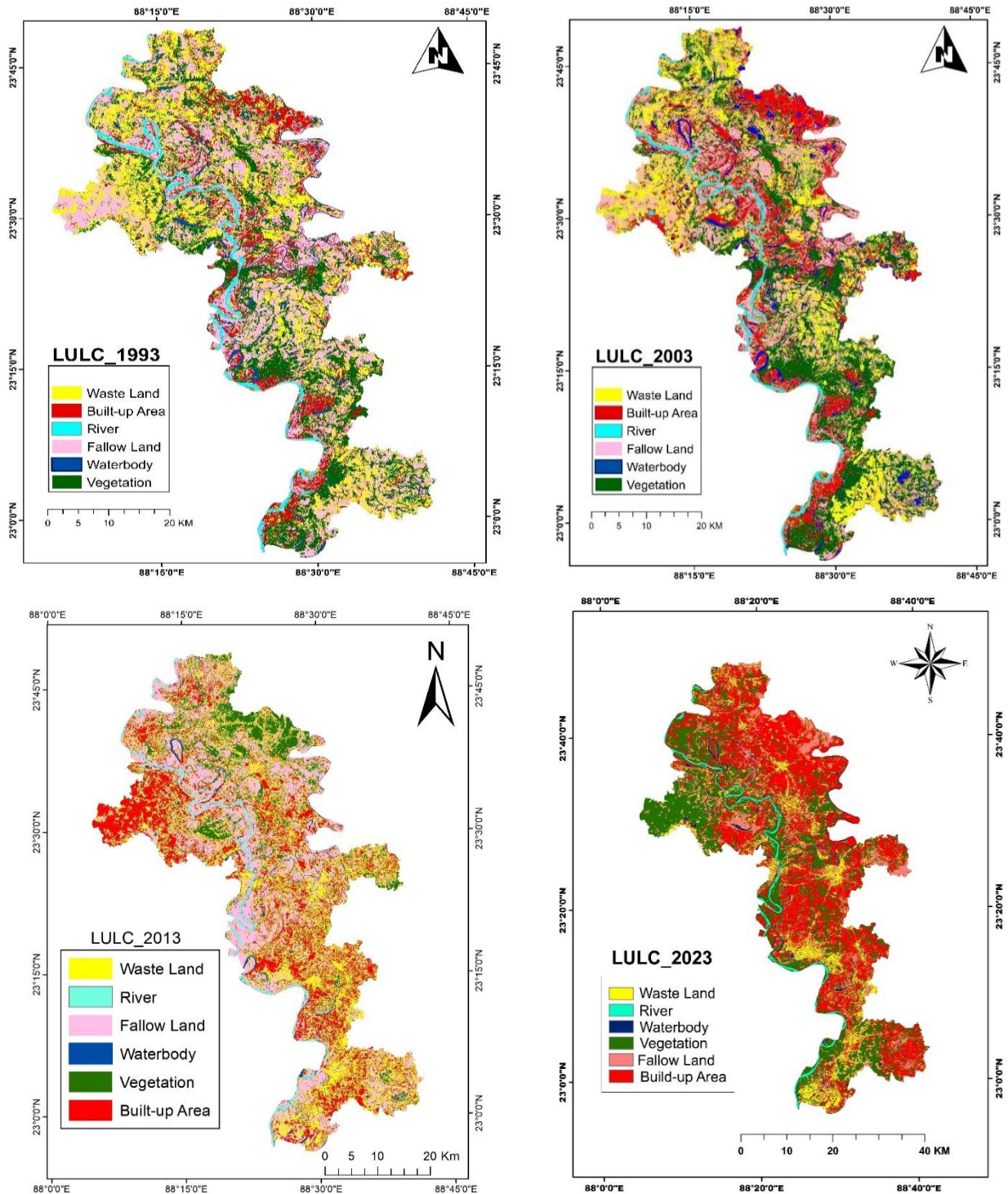


Fig 2: Landuse maps of 1993, 2003, 2013, 2023

Table 1: Area (ha) and Percentage of Area of Different LULC Class (1993- 2023)

Year	1993		2003		2013		2023	
LULC Class	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
Waste Land	635323	21.86	556964	21.12	497859	19.62	306060	13.05
Built-up Area	404652	13.92	608294	23.07	800104	31.53	1100257	46.92
River	68429	2.35	64289	2.44	54902	2.16	51179	2.18
Agricultural Land	786750	27.07	567599	21.53	502741	19.81	303610	12.95
Waterbody	160948	5.54	146285	5.55	67421	2.66	56226	2.40
Vegetation	850783	29.27	693454	26.30	614858	24.23	527439	22.49

- To analyses vegetation cover along riverbank of the study area NDVI map was generated. From 1993 to 2023 vegetation cover was loosed due to human interaction. Maximum vegetation was loosed due to increase buildup area due to rapid rate of population explosion. Which leads riverbank erosion.

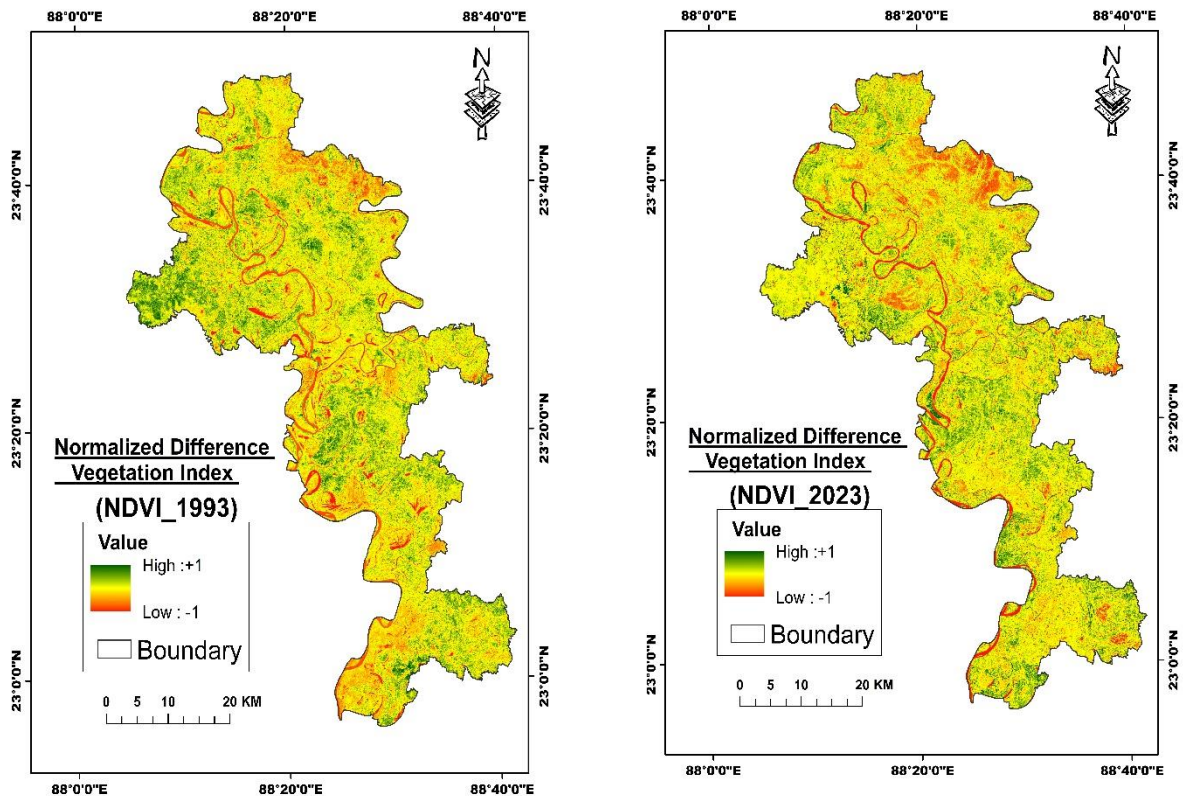


Fig 3: NDVI maps of 1993 and 2023

Natural hazards have a devastating effect on people around the world. In India, numerous natural hazards occur every year, such as droughts, floods, cyclones, and earthquakes. Floods and river-bank erosion are the most frequent hazards in India, specifically in the Ganga-Brahmaputra delta regions. The Ganga is a lengthy river flowing through various states of India and transporting large volume of water. The effects riverbank erosion is vigorous in the lower courses of the Ganga river, mainly in West Bengal. Numerous factors that impact riverbank bank erosion, such as topography, drainage, and variation of rainfall intensity, channel width-depth ratio, and channel slope, texture of soil, organic matter of soil, water holding capacity of soil along riverbank etc. River-bank erosion is most common phenomena in Nadia and Burdwan district. Overall, the findings indicate that the loss of vegetation and increasing anthropogenic pressure have significantly contributed to riverbank instability along the Bhagirathi–Hooghly River. Protecting and restoring vegetation, together with regulated land-use planning, should therefore be considered key components of long-term riverbank erosion management.

Conclusion

From the study it has been cleared that river changes their path more rapidly and flooding occurs as well as riverbank erosion occurs drastically. Immediate concerns and proper land use pattern with help of Govt as well as local people awareness should be taken action immediately to save the river, riverbank erosion and as sustainable development also.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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