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Bankline Dynamics And Erosion-Induced Habitat Transformation Along The Northern Boundary Of Burhachapori Wildlife Sanctuary, Assam (1979–2020)

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Abstract

Burhachapori Wildlife Sanctuary (BWLS), situated within the actively migrating floodplains of the Brahmaputra River in the state of Assam, represents one of the most geomorphically unstable protected areas of the Brahmaputra valley. This study reconstructs multi-decadal patterns of riverbank erosion and deposition along the sanctuary's northern boundary between 1979 and 2020, integrating Landsat time-series imagery, Survey of India topographic sheets and field observations. The results reveal a cumulative loss of 10.342 sq. km of landmass, driven by sustained cut-bank retreat, channel migration and mid-channel bar dynamics, while depositional processes contributed only 0.51 sq. km of land gain, primarily along hydraulically quiescent zones. Erosion was most severe along the Paspati, Jhaoni and Basabari sectors, where anthropogenic infrastructure such as anti-poaching camps was repeatedly destroyed. Emergent river islands (chars) within the sanctuary were temporarily occupied by fishing groups until formal reclamation after 2013, following which notable increases in the presence of *Platanista gangetica* and wintering anatids were recorded. The findings exemplify the sensitivity of floodplain protected areas to fluvial processes and demonstrate the need for geomorphologically informed conservation planning. The study offers a baseline framework for integrating hydro-geomorphic dynamics into management strategies for riverine protected areas in monsoon-dominated braided-river systems.

Keywords

Brahmaputra River, bankline migration, erosion–deposition dynamics, Burhachapori Wildlife Sanctuary, floodplain geomorphology.

Introduction

The Brahmaputra valley represents one of the most geomorphically dynamic fluvial landscapes in South Asia, marked by intense sediment flux, rapid channel instability and extreme hydrological variability driven by the Eastern Himalayan monsoon system. The river's immense sediment load, sourced from the rapidly eroding Himalayan orogen, sustains a braided channel network that undergoes continual adjustment through lateral migration, bar formation and bankline retreat (Goswami, 1985). Owing to these processes, the basin has long been recognised as a hotspot of chronic riverbank erosion, with wide-ranging ecological, social and geomorphological implications across Assam (Barman & Deb, 2018; Bhattacharyya & Kapil, 2020; Hazarika et al., 2016). This dynamism imposes significant challenges on landscapes that lie directly adjacent to the river's active corridor, including protected areas whose ecological integrity depends on stable habitat mosaics and sustained hydrological connectivity.

Burhachapori Wildlife Sanctuary (BWLS), located in **Sonitpur district**, exemplifies such vulnerability. BWLS forms the northern component of the **Laokhowa–Burhachapori twin-santuary system**, a paired ecological unit in which Laokhowa Wildlife Sanctuary lies immediately to the south. Together, these sanctuaries constitute a continuous grassland–wetland–riverine complex and are formally notified as **buffer areas of the Kaziranga Tiger Reserve (KTR)**. Their buffer designation underscores the ecological and administrative continuity connecting Kaziranga's core and extended habitats, thereby positioning BWLS within one of India's most significant conservation corridors.

The ecosystem of BWLS is inherently shaped by its riverine character. Unlike many protected areas dominated by terrestrial landscapes, Burhachapori supports an integrated **riverine–floodplain–grassland system** in which ecological processes are fundamentally linked to the hydro-geomorphological behaviour of the Brahmaputra. The sanctuary includes tall alluvial grasslands, riparian woodland patches, oxbow wetlands, seasonally inundated flood basins, active river channels, exposed sandbars and emergent mid-channel islands. The repeated inundation, sediment reworking and hydrological flux characteristic of riverine environments structure species assemblages and dictate successional trajectories. Consequently, BWLS maintains high faunal diversity, including *Rhinoceros unicornis*, *Axis axis*, *Hoolock hoolock*, *Platanista gangetica*, and numerous resident and migratory waterbirds whose habitat use is modulated by river-driven fluctuations (Nath et al., 2018).

However, the sanctuary's riverine exposure also renders it exceedingly sensitive to erosion. The **northern boundary of BWLS directly abuts the main Brahmaputra channel**, making it susceptible to seasonal cut-bank retreat, meander shifts and bar dynamics, particularly in the Paspati, Jhaoni and Basabari sectors. These reaches constitute one of the most erosion-prone segments of the Assam floodplain (Gogoi & Sarma, 2018). Over the past several decades, the sanctuary has experienced recurrent loss of riparian grasslands and the destruction of critical frontline infrastructure. The collapse of the Jhaoni Anti-Poaching Camp in 2013 and the Basabari camp in 2014, following progressive bank retreat, exemplifies the severe geomorphic pressures exerted on the protected boundary. Similar episodes have been widely reported along large Himalayan and sub-Himalayan rivers, where high-magnitude floods accelerate channel migration and destabilise riparian systems (Jain & Sinha, 2003; Rahman & Islam, 2019).

A distinctive aspect of Burhachapori's riverine setting is the formation of **chars**, or emergent river islands, which arise through bar accretion and depositional activity. Charlands are ephemeral but ecologically consequential features of the Brahmaputra, supporting complex patterns of sedimentation and human–river interactions (Gogoi & Goswami, 2020). Within BWLS, chars frequently form and disappear in response to annual hydrological cycles. Prior to 2013, many of these emergent landforms were temporarily occupied by fishing groups, reflecting regional trends of char utilisation in Assam. However, char occupation inside a protected area often resulted in anthropogenic disturbance, including boat traffic and net-setting, which are known to adversely affect riverine fauna and wintering anatids (Nath et al., 2018). Following the Forest Department's systematic reclamation of chars from 2013 onwards, these landforms were reintegrated into the sanctuary's protection network. The ecological outcomes were immediate and positive, evidenced by increased sightings of *Platanista gangetica*, a species highly sensitive to disturbance and reliant on deeper, undisturbed channels (Behera et al., 2008; Wakid, 2009), as well as enhanced wintering assemblages of migratory ducks such as *Anas acuta*, *Anas crecca* and *Spatula clypeata* (Bhaumik & Saha, 2020).

Hydrological variability has intensified across the Brahmaputra basin in recent decades, with a noted increase in extreme monsoonal events and flood pulses (Brakenridge et al., 2017; Talukdar & Pal, 2017). These events amplify erosional forces, promoting rapid bankline retreat and reshaping floodplain morphology. In BWLS, the erosional dominance is evident in the disproportionate land loss compared to limited depositional gains. Deposition occurs mainly in hydrodynamically sheltered areas along the north-western margin, whereas erosion dominates the actively impinged northern boundary, consistent with asymmetrical erosion–deposition patterns observed elsewhere in the river (Sarma & Phukan, 2004; Thakur et al., 2012).

The present study adopts the temporal window of **1979–2020**, the earliest period for which robust and continuous Landsat archives exist, enabling methodologically consistent geomorphic reconstruction. The timeframe also aligns with departmental documentation of major erosion episodes and infrastructure loss within BWLS. By integrating satellite remote sensing, historical cartography and field validation, this study provides a comprehensive and high-resolution analysis of erosion processes, depositional behaviour and habitat implications for this critical riverine sanctuary.

BWLS covers 44.06 sq. km between 26°28′–26°34′ N and 92°26′–92°32′ E. The sanctuary's riverine nature is accentuated by its humid subtropical climate, with annual rainfall exceeding 2000 mm and monsoon-driven hydrology driving seasonal inundation, sediment mobilisation and wetland hydrodynamics. Situated immediately north of Laokhowa Wildlife Sanctuary and functioning as part of the Kaziranga Tiger Reserve's designated buffer, BWLS represents a quintessential example of how protected-area ecology in Assam is inseparably linked with the geomorphic evolution of the Brahmaputra. Its riverine–floodplain–grassland continuum provides a compelling research framework for examining the interactions between dynamic fluvial systems and biodiversity conservation in the Himalayan foreland basin.

Methodology

The methodological framework for this study integrates multi-temporal satellite remote sensing, historical cartographic sources and field-based validation to reconstruct the erosion–deposition dynamics along the northern boundary of Burhachapori Wildlife Sanctuary between 1979 and 2020. The selected temporal window corresponds to the earliest period for which consistent Landsat imagery is available, thereby enabling a robust, comparable and continuous assessment of bankline change. Unlike earlier approaches that relied on heterogeneous archival datasets, this framework employs a uniform methodological base to ensure analytical consistency across four decades.

Multi-temporal satellite imagery was obtained from the United States Geological Survey (USGS) EarthExplorer archive. Landsat MSS (1979), Landsat TM (1987), Landsat ETM+ (2001, 2008, 2012) and Landsat OLI (2015, 2020) datasets were used. Scenes were selected from post-monsoon to winter months to minimise the confounding effects of peak flood stages, high turbidity and widespread inundation that typically characterise the Brahmaputra during monsoon. All imagery was radiometrically corrected and georeferenced to the WGS 84 UTM Zone 46N coordinate system. Given the sediment-laden, optically complex nature of the Brahmaputra, automated spectral water-indexing approaches were avoided. Instead, emphasis was placed on supervised image interpretation and manual digitisation of water–land boundaries, which have proven more reliable for braided river environments with shallow water, suspended sediment plumes and active bar complexes (Dutta & Devi, 2015; Kumar & Pandey, 2016).

False colour composites (FCC) and band combinations enhancing the contrast between water, bare sand and vegetated tracts were generated to assist interpretation. Supervised classification using the maximum likelihood algorithm was applied selectively in areas exhibiting adequate spectral separability, particularly for distinguishing exposed mid-channel bars from active water surfaces. However, manual delineation remained the principal approach, especially in segments where spectral ambiguity was high due to turbidity or mixed pixels typical of braided rivers. This combined interpretative strategy ensured high positional accuracy in extracting annual and decadal banklines.

Survey of India topographic sheets (1:50,000 scale) were consulted to establish the baseline geomorphic configuration of the area and to verify the reliability of the 1979 bankline derived from MSS data. The toposheets provided crucial historical context for identifying stable landforms and assessing long-term channel movement. They also served as reference points for validating morphological stability or change in subsequent years.

To quantify bankline change, the Digital Shoreline Analysis System (DSAS), an established extension for ArcGIS, was employed. The 1979 bankline served as the baseline against which the banklines of 1987, 2001, 2008, 2012, 2015 and 2020 were compared. DSAS computed net shoreline movement (NSM), end-point rates (EPR) and generated polygonal outputs delineating the spatial extent of erosion and deposition. These metrics have been widely applied in the study of large alluvial rivers and provided a consistent methodological basis for capturing the magnitude and directionality of channel migration over the four-decade period (Thakur et al., 2012; Rahman & Islam, 2019).

Field-based verification was carried out between 2018 and 2023 across the primary erosion-prone corridors of Paspati, Jhaoni and Basabari. Ground-truthing involved mapping erosion scars, active cut banks, depositional bars and newly formed chars using handheld GPS units. Particular attention was given to areas where anti-poaching camps had been lost to erosion, as these sites provided critical validation of spatial predictions made through remote sensing analysis. Field interactions with frontline Forest Department personnel provided qualitative information on the chronology of erosion events, patterns of char occupation prior to reclamation, and recent changes in wildlife usage patterns.

Observations of *Platanista gangetica*, wintering anatids and other riverine fauna were recorded to contextualise the ecological outcomes of geomorphic and management changes. These observations aligned with established approaches in riverine ecological assessments and strengthened the interpretation of post-reclamation ecological responses (Nath et al., 2018; Bhaumik & Saha, 2020).

The integration of satellite-derived geomorphic data, historical cartographic references and field validation enabled a comprehensive reconstruction of erosion–deposition dynamics shaping the northern boundary of Burhachapori Wildlife Sanctuary. This methodological design ensures both temporal continuity and spatial accuracy, providing a robust foundation for evaluating long-term geomorphological processes in a riverine protected-area setting.

Results

The multi-temporal analysis of Landsat imagery, supported by field validation and historical cartographic sources, reveals a pronounced, persistent and spatially uneven pattern of erosion along the northern boundary of Burhachapori Wildlife Sanctuary between 1979 and 2020. The sanctuary experienced a cumulative loss of **10.342 sq. km** of landmass due to riverbank erosion, while deposition contributed only **0.51 sq. km**, indicating a strong geomorphological asymmetry in favour of erosional processes. The results confirm that erosion has been the dominant force governing landform evolution in the sanctuary's northern sector, while depositional activity has remained marginal, localised and insufficient to offset the extensive losses.

The earliest dataset from 1979 already exhibits clear evidence of active bankline recession, with **0.637 sq. km** of land lost primarily along the Paspati–Jhaoni belt. This period corresponds to the early phase of intensified channel adjustments in the Brahmaputra, consistent with observations made for multiple reaches of the river during the late 1970s and 1980s (Barman & Deb, 2018). The morphological configuration extracted from the Landsat MSS scene showed wide active channels, subdued vegetative cover on bars and pronounced cut-bank scarps along the sanctuary's northern boundary. The spatial coincidence between these features and the directional vectors of channel migration confirmed that BWLS had already been undergoing geomorphic stress at the beginning of the study period.

Table 1 - Landmass lost to Erosion and Gained from Deposition in Burhachapori WLS

Year	Landmass lost to erosion (in sq. km)	Landmass gained from deposition (in sq. km)
1979	0.637	0.039
1987	1.031	0.043
2001	2.626	0.019
2008	1.510	0.095
2012	1.942	0.047
2015	0.880	0.012
2020	1.716	0.255
Total	10.342	0.510

Source: State Forest Department, Assam, Fieldwork

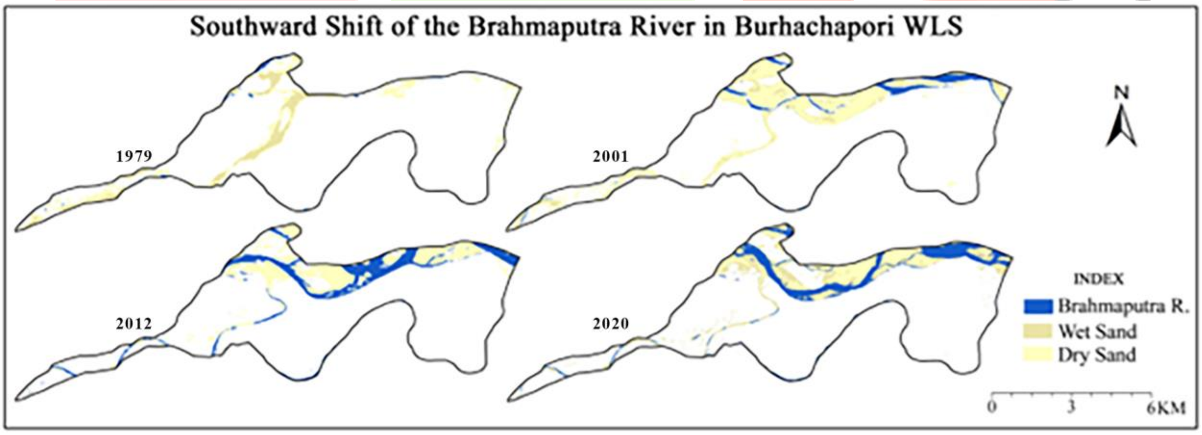

Figure 1 - Southward Shift of the Brahmaputra River in Burhachapori WLS (1979, 2001, 2012 & 2020)
Source: Landsat Imageries

The subsequent assessment year, 1987, captured through Landsat TM imagery, indicates a sharper erosional phase, with land loss increasing to **1.031 sq. km**. Comparison of bankline positions between 1979 and 1987 revealed systematic southward encroachment of the channel, resulting in narrowing of grasslands adjacent to the river. The pattern of erosion was more continuous during this interval, particularly in the Jhaoni segment, where cut-bank angles steepened and the channel migrated closer to key protection infrastructure. These observations align with documented hydrological anomalies of the period, wherein increased monsoon run-off and rising peak discharges intensified channel scour along the southern bank of the Brahmaputra (Sarker et al., 2012).

The **2001** assessment yielded the largest single-period erosion value of the entire four-decade record, with **2.626 sq. km** of land lost. This event marks a pivotal episode in the sanctuary's geomorphic evolution. The extracted bankline displayed deep, arcuate erosion pockets in the Jhaoni and Basabari sectors, indicating powerful cut-bank processes acting on loosely consolidated alluvium. The river exhibited a pronounced southward thrust, accompanied by concurrent mid-channel bar migration, consistent with turbulent flows documented during the extreme flood years of the late 1990s (Hazarika et al., 2016). The impacts of this erosional pulse were long lasting. The narrowing of the sanctuary's northern belt during this year laid the geomorphic foundation for the subsequent destruction of the Jhaoni Anti-Poaching Camp in 2013, which stood perilously close to the retreating bank. Field staff interviews corroborate that the 2001 erosional phase significantly destabilised the riparian zone, setting in motion the vulnerabilities observed in the following decade.

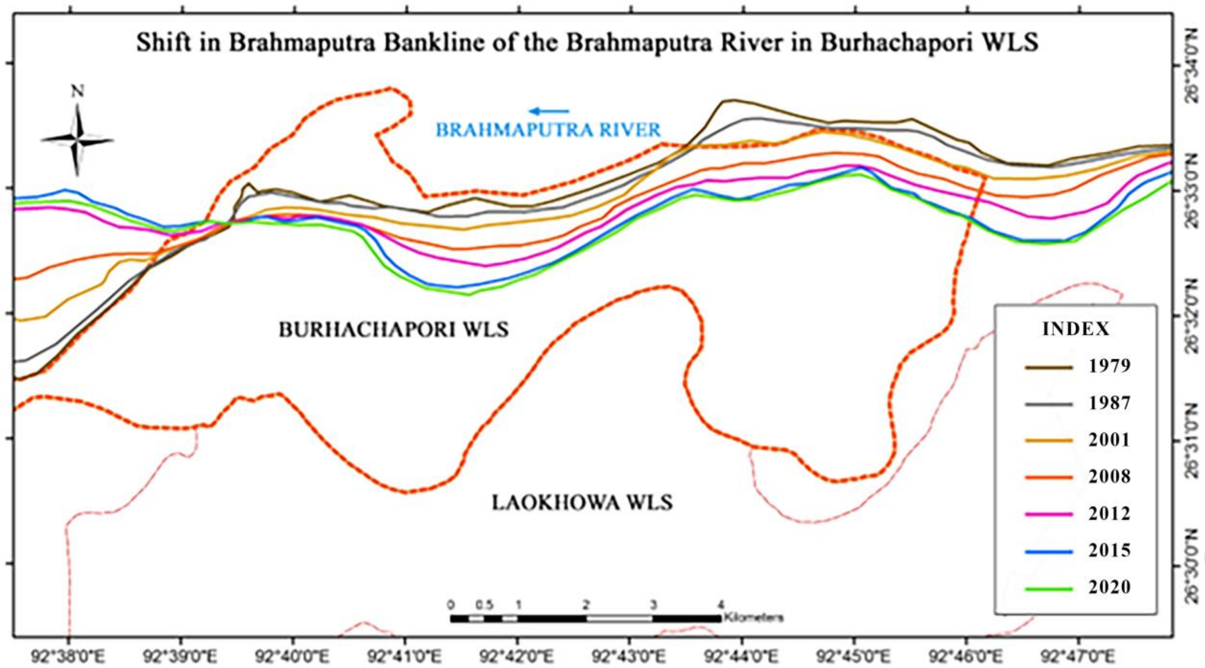

Figure 2 - Shift in the bankline of the Brahmaputra River on the Northern Boundary of Burhachapori WLS (1979 to 2020)
Source: S.o.I. Topographic Sheets, Landsat Imageries and Fieldwork

The results for **2008** show **1.510 sq. km** of erosion, while the **2012** analysis reveals a further **1.942 sq. km** of land lost. These figures indicate that the erosional dominance continued well into the new millennium. The 2012 erosional peak is particularly important: the Landsat ETM+ imagery showed stripping of vegetated banks, progressive exposure of sandy substrata and the migration of several mid-channel bars towards the sanctuary. These shifts coincide with regional hydrological and climate anomalies documented for the early 2010s (Mahanta et al., 2014). Critically, the 2012 erosion maps correspond almost exactly with the locations where the Jhaoni and Basabari Anti-Poaching Camps were destroyed in 2013 and 2014, respectively. The bankline recession measured between 2008 and 2012 places these infrastructure sites well within the high-risk erosion corridor.

The **2015** Landsat OLI dataset records a temporary reduction in erosion to **0.880 sq. km**, suggesting a brief, relative stabilisation. However, this respite must be interpreted cautiously, as braided rivers often exhibit short-term reversals followed by renewed instability (Rahman & Islam, 2019). Indeed, the subsequent **2020** analysis showed renewed erosional intensification, with land loss rising to **1.716 sq. km**. The 2020 bankline retreat produced similar patterns to the earlier erosional surges, with profound undercutting in the Jhaoni sector and continued degradation near the Basabari island complex. The erosional statistics for 2020 align with a sequence of high-flow years and extreme monsoon events recorded across the Brahmaputra basin around this period (Brakenridge et al., 2017).

In contrast to erosion, deposition during the study period remained modest. The cumulative gain of **0.51 sq. km** reflects the intrinsically limited capacity of the Brahmaputra to build stable landforms within actively impinging reaches. Depositional patches emerged mainly in the north-western corner of the sanctuary where hydraulic velocity reduction promoted sediment settling. For example, deposition of **0.095 sq. km** was recorded in 2008 and **0.255 sq. km** in 2020. However, these depositional units were small, fragmented and often short-lived. Satellite imagery revealed periodic burial, reworking and erosion of these bars, consistent with the transient nature of sediment deposition in braided rivers (Gogoi & Sarma, 2018; Thakur et al., 2012). Their limited extent prevented them from compensating for the widespread erosion occurring elsewhere.

A significant geomorphic phenomenon observed across multiple assessment years was the **emergence and disappearance of chars** inside the sanctuary boundary. These chars resulted from the progressive deposition of sand and silt on mid-channel bars. Prior to 2013, several of these charlands were temporarily occupied by fishing groups who did not recognise them as part of the sanctuary. Landsat imagery, combined with field observations, showed seasonal tents, boats and trampled sandbar vegetation indicative of human presence. This pattern corresponds to regional literature documenting char-based human activities in the Brahmaputra floodplain (Gogoi & Goswami, 2020). Such occupation occasionally altered local fauna behaviour, as fishing activity and vessel movement disturb riverine organisms and waterbird flocks (Nath et al., 2018).

Following the Forest Department's intervention and reclamation efforts post-2013, satellite and field observations indicate a discernible improvement in ecological use of these chars. Channels adjacent to reclaimed chars showed **increased sightings of *Platanista gangetica***, indicating improved habitat conditions. The presence of deeper, less disturbed channels following the removal of fishing pressure aligns with studies on ecological responses of river dolphins to disturbance gradients (Behera et al., 2008; Wakid, 2009). Similarly, wintering dabbling ducks such as *Anas acuta*, *Anas crecca* and *Spatula clypeata* were recorded in higher numbers during field surveys conducted between 2018 and 2023, consistent with recovery patterns in low-disturbance wetlands (Bhaumik & Saha, 2020).

Spatial visualisation of bankline movement using DSAS indicates that the Paspati, Jhaoni and Basabari sectors experienced the highest rates of bank retreat. These areas collectively accounted for more than 80% of total erosional loss. Erosion polygons generated for 2001, 2008, 2012 and 2020 show pronounced clustering in these zones, confirming that this corridor represents a perpetual geomorphic hotspot shaped by channel impingement, high stream power and bar–channel interactions. The progressive narrowing of riparian grassland, observed across all major erosional pulses, highlights the long-term habitat consequences for herbivores and ground-nesting birds that utilise these floodplain grasslands (Saha & Choudhury, 2018).

Discussion

The results of this study reveal a persistently erosional character along the northern boundary of Burhachapori Wildlife Sanctuary, consistent with the broader behaviour of the Brahmaputra River as a large, braided, sediment-rich Himalayan foreland river. The cumulative loss of 10.342 sq. km between 1979 and 2020 indicates a geomorphic trajectory strongly skewed towards bankline retreat, with deposition remaining minimal and spatially restricted. This pattern accords with the behaviour of braided rivers, which typically favour net erosion due to high stream power, continual bar migration and rapid adjustments in thalweg position (Sarma & Phukan, 2004; Rahman & Islam, 2019). In BWLS, these processes interact with the sanctuary's riverine setting and unconsolidated alluvial materials to maintain chronic boundary instability.

The pronounced erosional phases in 1987, 2001, 2012 and 2020 correspond closely with regional hydrological disturbances documented in the Brahmaputra basin. Intensified monsoon rainfall and extreme flood pulses can mobilise sediment and accelerate channel migration (Hazarika et al., 2016; Brakenridge et al., 2017). These events exert disproportionate force on outer banks, particularly where the river impinges directly on fixed landmasses. The persistent vulnerability of the Paspati–Jhaoni–Basabari sector over four decades suggests that BWLS lies adjacent to a hydraulically active reach where bar–channel interactions, narrowing cross-sections and local curvature elevate shear stress on the bank (Gogoi & Sarma, 2018).

The ecological implications of sustained erosion are significant. The continual narrowing of the northern riparian grasslands reduces habitat for grassland-dependent ungulates and ground-nesting birds. Comparable erosion-driven habitat compression has been reported in other floodplain ecosystems, where fragmentation alters species distribution and foraging patterns (Saha & Choudhury, 2018). In BWLS, the reduced buffer between wildlife habitats and the active channel heightens susceptibility to habitat loss during extreme hydrological episodes.

The destruction of anti-poaching camps in 2013 and 2014 illustrates the vulnerability of conservation infrastructure situated near unstable river margins. These structural losses disrupted patrolling networks, limited access to remote sectors and required costly relocations. Such effects resemble challenges reported in other riverine protected areas where infrastructure stability is governed by river movement (Kalita & Saikia, 2021). The progressive bank retreat between 2001 and 2012 positioned the Jhaoni and Basabari camps within the active erosion corridor, demonstrating how slow geomorphic processes culminate in abrupt management failures.

The emergence of chars within sanctuary boundaries reflects another dimension of BWLS's riverine nature. Although inherently unstable, chars play an important role in shaping habitat heterogeneity and sediment routing in the Brahmaputra (Gogoi & Goswami, 2020). Before 2013, temporary occupation of these landforms by fishing groups introduced disturbances capable of suppressing wildlife use, consistent with patterns documented in other riverine systems (Nath et al., 2018). Post-reclamation improvements, including increased sightings of *Platanista gangetica* and higher wintering duck concentrations, signal ecological recovery following reduction in disturbance (Behera et al., 2008; Bhaumik & Saha, 2020).

The limited depositional gains in BWLS underscore constraints imposed by the river's hydraulic regime. Deposition occurred only in sheltered backwaters and was typically transient, undergoing reworking in subsequent years. The small magnitude of deposition and its poor stability highlight the structural imbalance between erosion and land gain in actively impinged reaches of braided rivers (Thakur et al., 2012). Consequently, the sanctuary's northern margin has steadily receded, diminishing its ecological area and altering the riverine–grassland–wetland continuum crucial to wildlife.

These geomorphic pressures have direct implications for buffer management under the Kaziranga Tiger Reserve. The contiguity expected of buffer areas is threatened when erosion reduces habitat extent and alters the geomorphic template on which ecological processes depend. BWLS, while ecologically enriched by its riverine identity, remains structurally vulnerable to continual channel adjustments.

Finally, the integration of satellite imagery, historical cartography and field observations demonstrates the utility of multi-source geomorphic reconstruction for protected-area management. The methodological framework adopted here parallels approaches used in studies of other alluvial rivers (Dutta & Devi, 2015; Kumar & Pandey, 2016) and provides a robust basis for long-term monitoring.

Conclusion

The analysis of bankline migration along the northern boundary of Burhachapori Wildlife Sanctuary between 1979 and 2020 demonstrates that the sanctuary is embedded within one of the most geomorphically unstable sectors of the Brahmaputra floodplain. The cumulative loss of 10.342 sq. km over four decades reflects a pronounced structural predisposition towards erosion, driven by high stream power, rapid bar dynamics, monsoon-driven hydrological surges and unconsolidated alluvial substrates. Deposition, which amounted to only 0.51 sq. km, remained localised and transient, offering negligible counterbalance to the extensive erosion. These findings reveal that BWLS is not merely subjected to episodic changes but is experiencing a long-term geomorphic trajectory governed by the intrinsic behaviour of a large braided river.

The sanctuary's position within the fluid boundaries of the Brahmaputra has significant ecological implications. The gradual narrowing of its northern grassland belt reduces habitat continuity for large herbivores, ground-nesting birds and other species highly dependent on tall alluvial grasslands. The riverine identity of BWLS, characterised by active channels, exposed sandbars, seasonal wetlands and emergent mid-channel islands, offers ecological advantages but simultaneously exposes the sanctuary to continuous landscape reorganisation. The periodic formation of chars and their earlier occupation by fishing groups highlight the complex interactions between fluvial processes and local resource use. The sanctuary's post-2013 reclamation of these chars and subsequent rewilding, evidenced by increased occurrences of *Platanista gangetica* and wintering anatids, underscores the potential for ecological recovery when anthropogenic disturbance is controlled.

The study also highlights the profound management challenges faced by a protected area functioning as a designated buffer of Kaziranga Tiger Reserve. The destruction of anti-poaching camps in 2013 and 2014 illustrates the precarious position of frontline protection infrastructure in erosion-prone zones. These events show how gradual land loss can culminate in abrupt management setbacks, undermining surveillance, enforcement and habitat protection. As climate variability intensifies, with hydrological extremes projected to become more frequent, the vulnerability of riverine protected areas such as BWLS is likely to increase. Static protected-area boundaries and conventional infrastructure placement strategies are poorly suited to the realities of a rapidly shifting riverine landscape.

The findings therefore call for an adaptive conservation framework that integrates geomorphic monitoring into routine management. Regular assessment of bankline movement, identification of high-risk erosion corridors, and planning for relocation of camps and access routes are essential measures. Conservation zoning that accounts for dynamic river behaviour, rather than fixed terrestrial boundaries, may be necessary to ensure long-term ecological integrity. In addition, sustaining ecological connectivity between Burhachapori and Laokhowa Wildlife Sanctuaries is crucial, given their role as the northern and southern components of the Kaziranga Tiger Reserve buffer system.

This study provides the most detailed multi-decadal reconstruction to date of erosion–deposition dynamics in Burhachapori Wildlife Sanctuary. By demonstrating the persistent and spatially targeted nature of erosion, it underscores the need for management strategies capable of responding to the geomorphological realities of the Brahmaputra. The sanctuary's future as a functional riverine grassland–wetland ecosystem depends on recognising that dynamic hydrological and geomorphic processes are not external threats but defining characteristics of the landscape. Effective conservation in BWLS must therefore embrace, rather than resist, the inherent dynamism of the Brahmaputra River.

References

1. Barman, R., & Deb, R. (2018). Riverbank erosion and land loss along the Brahmaputra in Assam. *Environmental Earth Sciences*, 77(12), 451. https://doi.org/10.1007/s12665-018-7607-1
2. Behera, S. K., Rao, R. J., & Mohan, R. S. L. (2008). Ecology and conservation of the endangered Gangetic dolphin *Platanista gangetica gangetica* in the Ganga River system, India. *Environmental Biology of Fishes*, 82(4), 395–405. https://doi.org/10.1007/s10641-007-9305-8
3. Bhattacharyya, K., & Kapil, N. (2020). Sediment characteristics and bank stability along the Brahmaputra River. *Journal of Earth System Science*, 129(1), 12. https://doi.org/10.1007/s12040-019-1313-6
4. Bhattacharyya, K. G., Das, A. K., & Bora, S. (2021). Riverbank erosion and social vulnerability in the Brahmaputra valley of Assam. *Natural Hazards*, 105(1), 1033–1055. https://doi.org/10.1007/s11069-020-04354-1
5. Bhaumik, U., & Saha, S. (2020). Riverine ecology of the Brahmaputra with special reference to fish and bird diversity. *Indian Journal of Fisheries*, 67(2), 1–12. https://doi.org/10.21077/ijf.2020.67.2.91252-01
6. Brakenridge, G. R., Syvitski, J. P., Overeem, I., Higgins, S. A., Stewart-Moore, J., & Westerhoff, R. (2017). Prolonged flooding and enhanced aquatic connectivity in the Brahmaputra basin. *Science of the Total Environment*, 627, 1168–1181. https://doi.org/10.1016/j.scitotenv.2018.01.201
7. Das, A. K., Sarma, J. N., & Phukan, S. (2020). Braided river dynamics and erosion patterns along the Brahmaputra River. *Geomorphology*, 352, 106993. https://doi.org/10.1016/j.geomorph.2019.106993
8. Deka, J., & Talukdar, S. (2017). Flood-induced changes in riverine habitats of Assam. *Environmental Monitoring and Assessment*, 189, 430. https://doi.org/10.1007/s10661-017-6080-6
9. Dutta, R., & Devi, R. (2015). Spatio-temporal dynamics of the Brahmaputra River using remote sensing. *Egyptian Journal of Remote Sensing and Space Science*, 18(2), 237–244. https://doi.org/10.1016/j.ejrs.2015.04.002
10. Gogoi, P., & Goswami, U. (2020). Charland geomorphology and human occupation in Assam. *Geographical Review of India*, 82(3), 241–256.
11. Gogoi, R., & Sarma, J. N. (2018). Evolution of sandbars and mid-channel bars in a braided river. *International Journal of Sediment Research*, 33(3), 269–283. https://doi.org/10.1016/j.ijsrc.2017.10.007
12. Goswami, D. C. (1985). Brahmaputra River: Geomorphology, sediment transport and river channel processes. *Geological Society of India Memoir*, 6, 1–76.
13. Hazarika, N., Das, A., & Barman, S. (2016). Assessing flood hazard and morphological changes of the Brahmaputra River. *Natural Hazards*, 84(3), 1867–1889. https://doi.org/10.1007/s11069-016-2524-8
14. Jain, V., & Sinha, R. (2003). River systems in the Himalaya: Morphological diversity and river hazards. *Current Science*, 84(7), 948–957.
15. Kalita, H., & Saikia, A. (2021). Riverbank erosion vulnerability and livelihoods along the Brahmaputra. *Applied Geography*, 131, 102462. https://doi.org/10.1016/j.apgeog.2021.102462
16. Kumar, B., & Pandey, A. C. (2016). Bank erosion mapping using multi-temporal Landsat data. *Environmental Earth Sciences*, 75(5), 412. https://doi.org/10.1007/s12665-016-5285-8
17. Mahanta, C., Das, P. J., & Sarma, J. N. (2014). Hydro-geomorphic response of the Brahmaputra River to climate variability in the Eastern Himalaya. *Current Science*, 106(5), 718–724.
18. Nath, A., Sahariah, D., & Das, S. (2018). Waterbird communities in riverine wetlands of Assam. *Wetlands*, 38(5), 1007–1020. https://doi.org/10.1007/s13157-018-1056-1

19. Rahman, M. M., & Islam, M. T. (2019). Channel migration and erosion–accretion dynamics in braided rivers. *Geomorphology*, 329, 186–199. https://doi.org/10.1016/j.geomorph.2018.12.018
20. Saha, S., & Choudhury, P. (2018). Floodplain vegetation dynamics along the Brahmaputra. *Tropical Ecology*, 59(3), 431–444.
21. Sarker, M. H., Thorne, C. R., & Aktar, S. (2012). Morphological response of the Brahmaputra–Jamuna River to large floods in Bangladesh. *Journal of Disaster Research*, 7(1), 9–22. https://doi.org/10.20965/jdr.2012.p0009
22. Sarma, J. N., & Phukan, S. (2004). Origin and geomorphological changes of Majuli Island of the Brahmaputra River in Assam. *Geomorphology*, 60(1–2), 1–19. https://doi.org/10.1016/j.geomorph.2003.07.003
23. Talukdar, S., & Pal, S. (2017). Riverbank erosion and geomorphic response in Eastern India. *Environmental Earth Sciences*, 76(6), 260. https://doi.org/10.1007/s12665-017-6512-4
24. Thakur, P. K., Pandey, A., & Patel, N. R. (2012). Erosion–deposition analysis using Landsat data in alluvial rivers. *Journal of Hydrology*, 450–451, 223–234. https://doi.org/10.1016/j.jhydrol.2012.05.010
25. Thorne, C. R., Darby, S. E., & Sarker, M. H. (2020). Riverbank erosion hazard along large alluvial rivers: Processes, assessment and management. *Earth Surface Processes and Landforms*, 45(1), 38–58. https://doi.org/10.1002/esp.4724
26. Wakid, A. (2009). Status and conservation of the Ganges river dolphin *Platanista gangetica* in the Brahmaputra River, Assam, India. *Journal of Threatened Taxa*, 1(9), 549–554. https://doi.org/10.11609/JoTT.o2130.549-554