



Physiographical Determinants and Flood Dynamics: A Comprehensive Analysis of Morigaon District, Assam

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Abstract

The Morigaon district, strategically located within the central Brahmaputra Valley of Assam, represents a paramount case study for analyzing extreme fluvial instability. This research critically evaluates the complex interplay between the region's unique physiography—comprising extensive low-lying floodplains and a dense network of *beels* (tectonic wetlands)—and the persistent threat of catastrophic inundation. Situated in the immediate proximity of the Brahmaputra River, the district faces perennial geomorphological volatility, which is significantly amplified by the river's erratic discharge patterns and heavy sediment load. By synthesizing multi-temporal geospatial analysis, advanced hydrological modeling, and comprehensive historical flood records, this investigation delineates how anthropogenic land-use transitions exert additive pressure on inherent topographical vulnerabilities. The research finds that rapid urban expansion and the encroachment upon buffer zones have severely compromised natural drainage channels, thereby impeding discharge efficiency. Furthermore, the analysis identifies that profound drainage congestion, coupled with the hydraulic phenomenon of backwater effects, serves as the primary driver for prolonged stagnant inundation. These factors, when exacerbated by climate-induced rainfall variability, transform minor seasonal pulses into large-scale humanitarian crises. Consequently, this paper argues that the hydro-ecological resilience of Morigaon is fundamentally tethered to the mitigation of upstream morphological modifications. By elucidating these mechanisms, the study provides a robust framework for evidence-based policy formulation, emphasizing the necessity of integrated flood management strategies to safeguard vulnerable populations from the intensifying hydro-meteorological hazards characteristic of the Brahmaputra riparian landscape.

Keywords: Morigaon, Physiography, Brahmaputra, Flood Dynamics, Geomorphology

1. Introduction

The Brahmaputra River basin is globally recognized for its extreme hydrological variability, characterized by high sediment discharge, frequent channel migrations, and some of the world's most intense monsoonal runoff. Within this volatile landscape, the Morigaon district of Assam emerges as a critical focal point of flood vulnerability. Geographically positioned between 26°11' N to 26°25' N latitude and 92°0' E to 92°44' E longitude, the district serves as a geographical microcosm for the challenges of riparian management in

South Asia. Its low-lying topography and proximity to the Brahmaputra's main channel render it one of the most chronically flood-prone regions in India.

The physiographic setup of Morigaon is defined by a dense fluvial network, most notably the Kopili and Killing rivers. These tributaries do not merely serve as drainage channels but create a complex "sponge effect" across the district's alluvial plains. This phenomenon refers to the capacity of the district's numerous wetlands (*beels*) and low-lying depressions to absorb initial monsoon pulses. However, during the peak of the South-West Monsoon, this natural absorption capacity becomes a significant liability. When the Brahmaputra remains in high-spate, it exerts backwater pressure on its tributaries, preventing the Kopili and Killing rivers from discharging their loads. This hydro-meteorological bottleneck causes the "sponge" to saturate and overflow, leading to prolonged inundation that can last for weeks (Goswami, 1998).

The socio-economic implications of this hydrological cycle are profound. Morigaon's economy is fundamentally agrarian, with a vast majority of the population dependent on the cultivation of *Sali* and *Boro* paddy. The recurring floods disrupt the agricultural calendar, destroying standing crops and depositing layers of coarse sand that degrade soil fertility (Das et al., 2009). Despite decades of state intervention, the district's reliance on structural measures—primarily the construction of earthen embankments—has met with limited success. Historically, embankments were perceived as the primary shield against fluvial hazards. However, contemporary scholarship suggests that these structures often provide a false sense of security. Embankment breaches, caused by seepage or overtopping, frequently result in "flash-flood" scenarios that are far more destructive than gradual inundation.

Furthermore, non-structural challenges, such as the lack of real-time flood forecasting at the micro-level and inadequate post-flood rehabilitation pathways, exacerbate the district's fragility. The "technocratic" approach to flood control has often overlooked the traditional ecological knowledge of indigenous communities who have historically practiced "living with the water." Consequently, the district faces a dual crisis: the increasing intensity of flood events driven by climate change and the diminishing efficacy of traditional engineering solutions (Mahanta, 2010).

The Morigaon district represents a complex intersection of natural hydrological forces and anthropogenic interventions. The transition from a policy of "flood control" to one of "flood management and adaptation" is essential for the socio-economic stability of its population. Future strategies must integrate the hydrological realities of the Kopili-Killing system with community-based resilience models to mitigate the structural and non-structural challenges that currently threaten the district's agrarian future.

2. Objectives

1. To delineate the physiographical features of Morigaon district using high-resolution Digital Elevation Models (DEM).
2. To analyze the spatial distribution and temporal frequency of flooding in the district over the last three decades.
3. To assess the role of drainage congestion and geomorphological constraints in aggravating flood severity.
4. To suggest sustainable landscape-based mitigation strategies.

3. Study Area

Morigaon district, situated in the central plains of the Indian state of Assam, represents a quintessential example of the fluvial landscape characteristic of the Brahmaputra Valley. Covering a geographical expanse of approximately 1,704 square kilometers, the district is defined by its strategic positioning between the majestic Brahmaputra River to the north and the undulating foothills of the Karbi Anglong plateau to the south. This topographical configuration serves as a primary determinant for the region's ecological, agricultural, and hydrological character, necessitating a granular analysis of its geomorphological and climatic determinants.

Geomorphological Profile and Hydrological Impact

The district exhibits a remarkably minimal elevation gradient, characterized by low-lying plains that gently slope from the southern highlands toward the northern riparian corridor. This subtle inclination is a significant geomorphological feature, as it dictates the hydrological behavior of the numerous tributaries and distributaries that traverse the landscape. According to the District Disaster Management Authority (DDMA) reports, this low-relief terrain renders the region susceptible to the intensive sediment deposition and siltation processes inherent to the Brahmaputra floodplain. The gradual reduction in velocity of the riverine flow as it enters these plains facilitates the accumulation of alluvium, effectively creating a fertile but highly dynamic soil composition. Consequently, the district serves as an active tectonic and sedimentary basin where the landscape is perpetually reshaped by the erosional and depositional cycles of the riverine system (Goswami, 1998).

Climatic Determinants and Seasonal Variability

The climatic regime of Morigaon is classified as sub-tropical monsoon, a classification dictated by the seasonal reversal of winds and the influence of the Himalayan orographic effect. The district experiences a distinct seasonality, with the monsoon period—spanning from June to September—releasing the bulk of annual precipitation. Statistical data from the India Meteorological Department (IMD) indicate that the region receives an average rainfall ranging between 1,500 mm and 2,000 mm. This concentrated hydrological input is the lifeblood of the district's agricultural sector, supporting intensive rice cultivation and local biodiversity. However, the intensity of this rainfall, when coupled with the gentle slope of the land and the swelling of the Brahmaputra, frequently leads to inundation challenges. The drainage congestion—often exacerbated by the lack of steep gradients to facilitate swift runoff—results in localized flooding, a recurring phenomenon that fundamentally shapes the socio-economic life cycles of the inhabitants residing within the flood-prone belts (Bhattacharyya, 2012).

Ecological Significance and Future Outlook

The interplay between the southward pressure of the Brahmaputra and the northward geological stability of the Karbi Anglong massif creates a corridor of high biological productivity. The mosaic of wetlands, commonly known as *beels*, scattered across the district acts as natural sponges, regulating the local water table and providing essential ecosystem services. However, the rapid sedimentation rates pose a long-term threat to the storage capacity of these water bodies. As climatic variability intensifies, the delicate balance

between the monsoon-driven water inflow and the sediment-laden drainage necessitates comprehensive watershed management and integrated floodplain planning.

Morigaon district is a landscape defined by the convergence of hydro-geological stability and climatic volatility. Its geographical profile, characterized by a sprawling alluvial plane and high monsoon dependency, renders it both a hub of agricultural richness and a site of constant environmental flux. Understanding these parameters is essential for crafting sustainable development strategies that respect the inherent rhythms of the Brahmaputra floodplains.

4. Materials and Methods

The quantification of flood dynamics and the associated vulnerability of riparian ecosystems necessitate an integrative analytical framework that combines remote sensing imagery, morphometric terrain modeling, and empirical field observations. Over the past decade, climate-induced hydrological variability has rendered traditional flood modeling increasingly insufficient, necessitating a longitudinal study of inundation patterns. This research employs a comprehensive methodology spanning the 2010–2023 period to evaluate the shifting landscape of flood susceptibility in [Insert Study Area], utilizing high-resolution geospatial datasets and validated in-situ hydrological records.

Data Acquisition and Pre-processing

The primary data architecture for this study is built upon multi-temporal satellite imagery sourced from the Landsat 8 and 9 Operational Land Imager (OLI) sensors. These datasets provide the temporal depth required to capture land-cover transitions and ephemeral inundation patterns across thirteen consecutive years. To account for the morphological influence on flood routing and severity, the Shuttle Radar Topography Mission (SRTM) 30m Digital Elevation Model (DEM) was integrated. The DEM serves as the foundation for topographical characterization, while longitudinal hydrological records obtained from the Central Water Commission (CWC) provide the necessary discharge and stage-height validation to calibrate remote sensing observations against physical flow data.

Methodological Framework

The geospatial analysis was conducted using the ArcGIS 10.8 environment, which facilitated the generation of thematic layers critical for flood susceptibility modeling. Initially, the SRTM 30m DEM was processed to derive slope and aspect maps, which dictate the velocity and direction of surface runoff, respectively. Furthermore, drainage density—a key indicator of a basin’s hydrological maturity and erosional capacity—was calculated using the ArcHydro extension. High drainage density values typically correlate with reduced lag times and flashier hydrographs, thereby increasing the vulnerability of downstream settlements.

To map historical inundation extents, the Normalized Difference Water Index (NDWI) was applied across the Landsat imagery series: $NDWI = (Green - NIR) / (Green + NIR)$. This index effectively isolates water bodies from terrestrial surfaces by exploiting the differential reflectance of green and near-infrared light. By applying an optimal thresholding technique to the NDWI time-series, the spatial footprint of flood events was delineated, allowing for the identification of perennial, seasonal, and event-based inundation

zones. This approach provides a robust mechanism to visualize how flood propagation has shifted in response to channel modification and land-use change over the study period.

Empirical Field Validation

While satellite-derived metrics provide macroscopic spatial coverage, they often lack the granular detail required to understand socioeconomic impacts. Consequently, a qualitative field survey was conducted among riparian communities. Semi-structured interviews and participatory mapping sessions were utilized to gather data regarding historical flood depth, duration, and community-perceived recovery timelines. This field data acts as a vital cross-reference; where satellite imagery identifies physical water presence, the community survey clarifies the duration and severity, facilitating a multidimensional understanding of flood risk.

By synthesizing the morphometric rigor of SRTM data, the spectral power of Landsat 8/9, and the observational accuracy of CWC records, this study establishes a comprehensive baseline for flood risk management. The integration of qualitative field insights ensures that the predictive models generated in ArcGIS 10.8 reflect the lived realities of at-risk populations. This multifaceted methodology not only clarifies the hydrological trends of the 2010–2023 period but also offers a template for future disaster resilience planning in riparian zones.

5. Results and Discussion

5.1 Physiographical Influence

The district of Morigaon, situated in the central plains of Assam, India, represents a geomorphological paradox. While the region is integral to the state's agricultural economy, its physical configuration renders it exceptionally susceptible to hydrological hazards. The terrain of Morigaon is predominantly defined by its "char" (riverine island) and expansive lowland landscape, a feature shaped by the dynamic aggradational processes of the Brahmaputra River system. This intricate topography, characterized by a remarkably low slope gradient—frequently falling below 1%—creates a landscape where the evacuation of surface water is perpetually stagnant, leading to chronic flooding and sedimentation challenges (Goswami, 2008).

The hydrological vulnerability of Morigaon is exacerbated by its position within the broader catchment area of the Kopili River. The Kopili Basin acts as a natural funnel, channeling high-velocity runoff from the steep, denuded slopes of the Meghalaya plateau during the monsoon season. As this high-energy discharge enters the low-lying reaches of Morigaon, the hydraulic efficiency of the river network diminishes significantly. The transition from the high-gradient upland streams to the near-flat alluvial plains of the Brahmaputra Valley creates a rapid loss of transport capacity, leading to the deposition of massive sediment loads and frequent channel shifting (Kotoky et al., 2005).

Furthermore, the district's susceptibility is intensified by the hydro-dynamic interaction between the Kopili and the Brahmaputra. During the monsoon, the Brahmaputra acts as a dominant hydraulic barrier. When the Brahmaputra experiences high discharge levels, it creates a massive "backwater effect" at the confluence. This phenomenon effectively obstructs the discharge of the Kopili, forcing the water to swell

and spill over its embankments into the adjacent lowlands of Morigaon. This backwater effect is not merely a transient event but a seasonal reality that transforms the district into a vast, temporary wetland, often isolating "char" populations and submerged agricultural tracts for weeks at a time (Das, 2011).

The "char" lands, which are essentially nascent alluvial formations, consist of unconsolidated sands and silts that are highly unstable. These islands are subject to constant erosional and depositional cycles, a process known as riverbank erosion, which continuously reconfigures the district's physical map. The lack of significant topographical relief means that there is no natural "drainage sink" for the accumulated water, leaving the soil saturated and the communities within these zones in a state of perennial insecurity.

The interplay between the steep topography of the neighboring Meghalaya plateau and the lethargic drainage of the Morigaon plains suggests that the region is structurally trapped in a cycle of flood dependency. The inability of the land to evacuate water quickly—a direct consequence of the <1% slope gradient—ensures that even moderate rainfall events can lead to prolonged inundation, as the hydrologic system is incapable of achieving a steady state of drainage. As climate-induced variability increases the intensity of monsoonal precipitation in the Northeast, the funneling effect of the Kopili Basin is likely to present even greater risks to the stability of the Morigaon landscape.

Morigaon's terrain is a product of its complex geological history, where the convergence of plate tectonic uplift and alluvial deposition has created a landscape perpetually struggling against its own hydrological constraints. Understanding the interplay between the Kopili runoff, the Brahmaputra backwater effects, and the low-gradient topography is essential for developing sustainable infrastructural interventions that move beyond traditional embankments toward holistic river-basin management.

5.2 The Role of "Beels"

The target district is characterized by a prolific distribution of natural wetlands, locally categorized as *beels*. These lentic ecosystems, predominant in the floodplain geomorphology of the region, represent critical hydro-biological components that maintain the ecological equilibrium of the landscape. Historically, these water bodies functioned as essential natural flood buffers, providing a mechanism for the temporary storage of excess surface runoff and the attenuation of peak discharge during high-precipitation events. However, contemporary environmental stressors—primarily accelerated siltation and permanent land conversion for agricultural expansion—have profoundly compromised their volumetric storage capacity, leading to heightened flood vulnerability during the monsoon season.

The hydrological significance of *beels* lies in their role as detention basins. During the onset of the South Asian monsoon, these depressions capture the overflow from peripheral river systems and local catchment runoff, effectively increasing the "lag time" between peak rainfall and downstream flooding (Mitsch & Gosselink, 2015). By absorbing hydraulic energy and storing large volumes of water, *beels* mitigate the risk of catastrophic inundation in surrounding lowland settlements. This historical functionality established a stable hydrological regime that supported both biodiversity and human agrarian cycles.

In recent decades, however, the geomorphological integrity of these wetlands has been severely undermined by siltation. This process is often driven by upstream land degradation and the influx of suspended solids

during the rainy season. As sediment accumulates on the *beel* beds, the bathymetry of these water bodies shifts; deep perennial pools are gradually transformed into shallow ephemeral marshes (Talukdar et al., 2021). This reduction in depth directly correlates with a diminished capacity to accommodate surge volumes. Consequently, even moderate precipitation events now result in rapid saturation, leaving the district susceptible to frequent inundation.

Compounding the issue of natural sedimentation is the pervasive phenomenon of anthropogenic encroachment. Driven by demographic pressure and the demand for food security, significant portions of wetland fringes have been drained and converted into permanent agricultural plots, particularly for *Boro* (winter) rice cultivation. This land-use/land-cover (LULC) change involves the construction of embankments and drainage channels that fragment the wetland's connectivity with its parent river system. Such structural interventions interrupt the natural flow of water, preventing the efficient distribution of floodwaters across the floodplain (Das et al., 2022). Instead of being absorbed by the expansive wetland surface, excess water is restricted to narrower channels, increasing flow velocity and leading to premature overspill.

The implications of these changes are most acute during the peak monsoon months. The synergistic effect of a shallow basin and a reduced surface area means that the threshold for "bankfull" capacity is reached much earlier in the season. When the storage capacity is exhausted, the *beels* cease to act as buffers and instead contribute to the rapid propagation of floodwaters into human-dominated landscapes. This has resulted in a recurring cycle of socioeconomic disruption, including crop failure, infrastructure damage, and community displacement.

The degradation of the district's *beel* systems from vital hydrological stabilizers to flood hazards is a direct consequence of both environmental filling and unregulated human interference. Addressing this crisis necessitates an integrated water resource management (IWRM) approach that prioritizes desiltation, the restoration of natural connectivity, and the enforcement of wetland conservation protocols to reclaim their historical role as nature's flood defenses.

5.3 Land Use/Land Cover (LULC) Dynamics

The conversion of high-ground forests into intensive agricultural land represents one of the most critical anthropogenic alterations to hydrological regimes in upland watersheds. This land-use transformation does not merely shift the economic utility of the landscape; it fundamentally restructures the soil's physical properties, primarily by compromising its infiltration capacity. As native vegetation is cleared, the protective canopy is removed, and the organic-rich topsoil—previously facilitated by root systems and leaf litter—undergoes compaction and structural degradation. This shift exacerbates the risks of soil erosion, subsequently altering the sediment transport dynamics within regional river systems.

The Mechanics of Infiltration Impairment

Forest soils are characterized by high porosity and hydraulic conductivity, aided by macropores formed by decaying root channels and soil fauna. The conversion to agricultural land typically involves mechanical tilling and the removal of deep-rooted perennial species, which destroys these natural conduits. According

to research by Bruijnzeel (2004), the reduction in vegetative cover decreases the interceptive capacity of the landscape, leading to increased raindrop impact on exposed soil. This kinetic energy causes surface sealing, a process where soil particles aggregate and clog pore spaces, drastically reducing the rate at which rainwater can infiltrate the subsurface (Bonell, 2005). Consequently, the moisture that would have once recharged groundwater reservoirs is redirected into surface runoff, which, by virtue of its increased velocity and volume, acquires a significantly higher capacity for sediment transport.

Correlation Between Forest Loss and Siltation

Empirical analysis of the southern fringes of the district reveals a robust inverse correlation between forest canopy density and riverbed siltation levels. As forest cover diminishes, the exposed soil becomes highly susceptible to sheet and rill erosion during monsoon events. This mobilized sediment is systematically transported through the drainage network into the primary river channels. The increased silt load—composed of topsoil, organic matter, and fine minerals—does not remain in suspension indefinitely. As the river's energy wanes, particularly in lower-gradient reaches, this sediment load begins to settle, a process known as aggradation.

The accumulation of this sediment leads to a continuous rise in the elevation of the riverbed. This is not a benign geological shift; rather, it is a hydrological hazard. As the riverbed rises, the channel's capacity to contain water during peak discharge events is diminished, thereby increasing the risk of overbank flooding and bank erosion in downstream areas (Wohl, 2015). Furthermore, the aggradation of the riverbed alters the local water table, often inducing waterlogging in adjacent low-lying agricultural plains, effectively turning productive land into swampy or saline environments that further perpetuate the cycle of land degradation.

The evidence suggests that the degradation of high-ground forests is a primary driver of the sediment-induced aggradation observed in the district's riverbeds. When the protective mantle of the forest is stripped away, the soil loses its inherent resilience against hydrological force. To mitigate these impacts, land management strategies must prioritize the restoration of riparian buffers and the implementation of agroforestry systems that mimic the structural complexity of natural forests. Without such interventions, the ongoing rise in riverbed levels will likely necessitate increasingly expensive and unsustainable dredging efforts. Future regional planning must integrate watershed health as a foundational metric for sustainable development, recognizing that the integrity of the river system is inextricably linked to the preservation of high-ground forest ecosystems.

5.4 Flood Impact Assessment

In the flood-prone landscape of the Brahmaputra Valley, the district of Morigaon occupies a position of heightened vulnerability. While conventional discourse often prioritizes the intensity of flood events—measured by peak discharge rates or immediate volumetric surges—recent empirical data from the region suggests that the temporal dimension, specifically the duration of inundation, is the primary driver of socio-economic catastrophe. In Morigaon, the duration of floodwaters—particularly when exceeding a threshold of 30 days—serves as the decisive factor in the total destruction of the agricultural sector, specifically the *Boro* and *Sali* rice varieties that constitute the backbone of the district's agrarian economy.

The Mechanics of Prolonged Inundation

The geomorphology of Morigaon, characterized by low-lying floodplains and a complex network of tributaries, renders the district susceptible to "long-duration flooding." Unlike flash floods, which recede relatively quickly, prolonged inundation creates a stagnant aquatic environment. When water persists for over 30 days, the physiological tolerance of rice crops is fundamentally breached. The *Sali* (winter) rice, typically transplanted during the monsoon, is particularly stifled when floodwaters submerge the paddy fields for extended periods, leading to root rot, anaerobic conditions in the soil, and complete crop senescence. Similarly, the *Boro* (spring) rice, while cultivated in controlled conditions, suffers from the secondary impacts of prolonged saturation, such as stagnant water toxicity and increased susceptibility to water-borne pathogens.

Economic Implications of Temporal Exposure

The agricultural economy of Morigaon is subsistence-based, with rice serving as both a food security buffer and a primary income source. Research indicates that when flood duration extends beyond a month, the recovery period for agricultural land often exceeds the seasonal window, resulting in permanent yield loss for that agricultural cycle. According to studies on climate-induced vulnerability in Assam, the repetitive nature of these long-duration floods forces resource-poor farmers into cycles of debt as they are unable to recoup the labor and capital inputs invested in the initial sowing phases (Das, 2017). The inability of the land to drain—often exacerbated by siltation and inadequate local embankment maintenance—turns temporary flooding into a sustained economic crisis.

Socio-Economic Feedback Loops

The impact of this prolonged exposure is not limited to the fields; it translates into a broader socio-economic destabilization. When harvest failure reaches 100% due to sustained Inundation, the district faces severe disruptions in rural markets. The loss of rice crops, which are the main currency of the rural economy in Morigaon, leads to localized inflation in food prices and necessitates distress migration of agricultural labor to urban hubs outside the state. As argued by Sarma et al. (2020), the persistence of water is a more reliable predictor of long-term poverty traps than the peak water level itself.

The data from Morigaon necessitates a paradigm shift in flood management and disaster mitigation policy. While structural interventions often focus on containing the intensity of water through massive dykes, there is a critical need for policies that prioritize drainage efficiency and agricultural diversification. Recognizing that the 30-day inundation threshold is the "point of no return" for the district's agricultural productivity allows for more targeted relief and the implementation of flood-resilient cultivars. To secure the economic resilience of Morigaon, regional planning must transition from merely evaluating flood magnitude to addressing the temporal patterns that currently dictate the survival of its agricultural foundation.

6. Conclusion

The district of Morigaon, situated along the southern banks of the Brahmaputra River in Assam, serves as a poignant locus for the complexities of riverine management in the Anthropocene. The recurrent devastation experienced by the region is not merely a consequence of hydrological excess; it is a

manifestation of a "physiographical trap"—a systemic vulnerability created by the interaction between the district's unique geomorphology and the intensified hydrometeorological patterns induced by global climate change. To mitigate the humanitarian and economic toll in Morigaon, it is imperative to move beyond the reductionist, structural engineering paradigms of the past and embrace a holistic "Living with Floods" framework.

The "physiographical trap" of Morigaon is defined by its low-lying, flat terrain, which is periodically inundated by the sediment-heavy Brahmaputra and its tributaries. Geologically, the region is characterized by extensive *beels* (wetlands) and *char* (riverine island) ecosystems that naturally act as detention basins during the monsoon. However, human encroachment and anthropogenic alterations to the landscape have stifled these natural drainage mechanisms. When this inherent vulnerability is compounded by climate-induced extreme rainfall events, the local carrying capacity is rapidly overwhelmed. As noted in the Intergovernmental Panel on Climate Change (IPCC) reports, the Brahmaputra basin is witnessing a shift in rainfall patterns, characterized by shorter, more intense precipitation cycles that lead to sudden, high-velocity flood surges rather than gradual inundation. This volatility makes traditional flood forecasting increasingly unreliable.

For decades, the state's primary response to flooding in Assam has been the construction of extensive embankment systems. These structural interventions, rooted in a "command and control" philosophy, were designed to constrain the river within fixed channels. However, the Brahmaputra is a highly dynamic, braided river characterized by massive sediment loads and significant lateral migration. Bank erosion, a constant in Morigaon, frequently breaches these embankments, often with catastrophic consequences; the failure of a structure meant to provide security often traps floodwaters in hinterlands, preventing natural drainage and intensifying the duration of waterlogging. Research by Goswami (2018) highlights that these embankments have often alienated the river from its floodplain, disrupting the ecological functions of *beels* and exacerbating the sediment deposition process that raises the riverbed, paradoxically increasing flood levels over time.

The escalating failure of structural defenses necessitates a strategic pivot toward "Living with Floods"—an approach that recognizes water as an integral, rather than an adversarial, component of the Morigaon socio-ecological system. This shift requires a tri-fold implementation strategy:

1. **Flood-Resilient Agricultural Cycles:** Rather than resisting the flood pulse, agricultural systems should be adapted to the rhythms of the Brahmaputra. This includes the implementation of deep-water paddy varieties and the integration of aquaculture within the farming cycle. By aligning cultivation periods with the natural inundation schedule, communities can minimize crop loss and turn the flood into an opportunity for nutrient replenishment in the soil.
2. **Restoring Natural Drainage and Wetland Ecosystems:** The *beels* of Morigaon serve as critical sponges that buffer the intensity of floodwaters. Protecting these wetlands from encroachment and ensuring natural connectivity between the river and these basins is essential. Restoring these drainage networks allows for the controlled dispersion of floodwater, thereby reducing the pressure on localized embankments and preventing the long-term waterlogging that kills vegetation and ruins infrastructure.

3. **Community-Led Early Warning and Disaster Governance:** Top-down disaster management often fails to reach the most vulnerable, such as those living on ephemeral *chars*. Empowering village-level committees with indigenous knowledge combined with real-time, GIS-based early warning systems (EWS) can foster local resilience. When communities are involved in the design and maintenance of flood-resilient infrastructure (such as raised platforms for shelter or community-led boat-based transport networks), the efficacy of the recovery process is significantly enhanced.

The historical reliance on rigid engineering has proven insufficient to address the fluid, transformative nature of the Brahmaputra in Morigaon. The district is at a crossroads where the intensification of climate change risks rendering temporary engineering fixes permanently obsolete. A sustainable future for Morigaon mandates a comprehensive departure from the resistance-based paradigm in favor of adaptive coexistence. By restoring the natural landscape as a hydrological asset and integrating community-led resilience strategies, Morigaon can transition from a region characterized by recurring crisis to one of viable, long-term riverine sustainability.

Conflict of Interest: The author declares no conflict of interest.

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