Shoreline Change and Coastal Settlement Planning in Selected Niger Delta Communities

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ABSTRACT

Shoreline change poses a major geomorphological and planning challenge for densely settled estuarine communities in the Niger Delta, where fluvial discharge, tidal processes and human activities continually reshape the land–water boundary. This study examines multi-decadal shoreline dynamics along the Sombreiro River in the coastal communities of Abonnema, Degema and Idama and evaluates their implications for coastal settlement planning. Shoreline positions for 2005, 2010, 2015 and 2020 were extracted from medium-resolution satellite imagery and analysed using the Digital Shoreline Analysis System (DSAS) version 6.1. Shoreline change was quantified using the Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM), End Point Rate (EPR), Linear Regression Rate (LRR) and Weighted Linear Regression (WLR). Results reveal pronounced spatial variability among the three communities. Abonnema experienced moderate but persistent erosion (LRR = −0.75 m/yr), while Degema recorded the most severe and spatially variable retreat (LRR = −2.07 m/yr), with a mean SCE of 81.82 m and maximum shoreline recession of 74.58 m. In contrast, Idama exhibited dominant accretion (LRR = +0.73 m/yr), with approximately 70% of transects showing shoreline advance. The comparatively greater stability of Abonnema may reflect existing shoreline protection measures and favourable local geomorphological conditions relative to Degema. The close agreement between LRR and WLR confirms the internal consistency of the historical shoreline dataset despite uncertainties associated with image resolution, tidal variation and shoreline extraction. The study recommends integrating DSAS-derived shoreline information into coastal settlement planning through risk-based development setbacks, targeted shoreline protection, ecosystem-based management, conservation of vulnerable waterfront corridors and community-based land allocation strategies that discourage future residential development within erosion-prone areas. Periodic field validation and higher-resolution monitoring are also recommended to strengthen future shoreline-management decisions.

Keywords: shoreline change; Digital Shoreline Analysis System (DSAS); coastal erosion; Niger Delta; Sombreiro River; coastal settlement planning; geographic information systems

INTRODUCTION

Coastlines are among the most dynamic and economically significant environments on Earth, supporting a disproportionate share of the global population, critical infrastructure and ecological resources (Luijendijk et al., 2018; Vousdoukas et al., 2020). Their position is the product of continuous interaction between marine, fluvial and aeolian processes, and is increasingly modulated by anthropogenic interventions and accelerating sea-level rise (Mentaschi et al., 2018; Toimil et al., 2020). In low-lying deltaic settings, the land–water boundary is especially mobile, responding rapidly to changes in sediment supply, hydrodynamic forcing and human disturbance. Understanding the rate, direction and spatial variability of shoreline and foreshore movement in such environments is therefore fundamental to sustainable coastal planning and disaster-risk reduction (Nicholls et al., 2021).

The Niger Delta, located along the Atlantic coast of southern Nigeria, is one of the world's largest and most ecologically significant deltaic systems. It is characterised by an intricate network of distributary channels, estuaries, tidal creeks, mangrove forests, and barrier islands that collectively form a highly dynamic coastal landscape (Dada et al., 2018; George et al., 2019). The region sustains millions of inhabitants whose settlements, livelihoods and cultural identity are intimately tied to the waterfront. At the same time, the Niger Delta is increasingly exposed to chronic coastal erosion, recurrent flooding, land subsidence, and the cumulative impacts of hydrocarbon exploitation, dredging, and unregulated coastal development, all of which have heightened environmental degradation and the vulnerability of coastal communities (Woillez et al., 2023; Dike et al., 2024). These pressures have produced widespread shoreline instability that threatens residential areas, transport infrastructure and the mangrove ecosystems that buffer communities against storm and tidal energy.

Within the Delta, the communities situated along the Sombreiro River – among them Abonnema, Degema and Idama – illustrate the planning dilemma posed by mobile shorelines. These settlements have expanded along the riverbank with limited setback regulation, leaving dwellings, jetties and public facilities directly exposed to bank erosion and tidal undercutting. Despite the evident vulnerability, community-scale shoreline-change assessments remain relatively limited compared with regional-scale studies, restricting the availability of locally relevant evidence for coastal planning and management (Dada et al., 2018; Popoola, 2022; Afolabi et al., 2022; Li et al., 2023). This knowledge gap constrains the design of evidence-based protection and adaptation measures.

Advances in remote sensing and geographic information systems (GIS) now permit the systematic reconstruction of historical shoreline positions and the computation of standardised change statistics. The Digital Shoreline Analysis System (DSAS), developed by the United States Geological Survey, has become the de facto standard for such analyses, providing reproducible measures of shoreline movement along regularly spaced transects (Himmelstoss et al., 2021). When coupled with multi-temporal satellite imagery, DSAS enables the identification of s and accretional zones at a spatial resolution directly relevant to local planning decisions (Nassar et al., 2019; Mutaqin, 2017).

Against this background, the present study quantifies and compares shoreline change in three Sombreiro River communities over the period 2005–2020 and interprets the findings in the context of coastal settlement planning. The specific objectives are: (i) to reconstruct and analyse shoreline positions for Abonnema, Degema and Idama using ; (ii) to compute and compare the SCE, NSM, EPR, LRR and WLR statistics across the three communities; (iii) to identify s, accretional zones and critical transects requiring priority intervention; and (iv) to translate the empirical findings into actionable, community-specific policy and planning recommendations. The significance of the study lies in its provision of a replicable, transect-level evidence base that can directly inform shoreline management, hazard mapping and statutory development control in the Niger Delta, while contributing to the broader scholarship on deltaic shoreline dynamics in the Global South.

LITERATURE REVIEW

Coastal Erosion in the Niger Delta

Coastal erosion in the Niger Delta has been documented for several decades, but the pace and spatial extent of shoreline retreat have intensified in the contemporary period. Recent studies indicate that the low-lying Niger Delta is highly vulnerable to the combined effects of sea-level rise, land subsidence, coastal erosion and flooding, underscoring the need for integrated adaptation strategies and improved coastal resilience planning (Dada et al., 2018; Woillez et al., 2023). Dada et al. (2018) demonstrated that the Niger Delta coastline has experienced both erosion and accretion in a spatially complex pattern, with barrier-island and estuarine reaches displaying the highest mobility. The drivers commonly associated with shoreline change in the Niger Delta include reduced fluvial sediment supply resulting from upstream damming, relative sea-level rise compounded by land subsidence, wave and tidal processes, and a range of anthropogenic activities including sand mining, dredging, oil and gas infrastructure development, canalisation, and widespread mangrove degradation (Ayanlade & Proske, 2016; Kuenzer et al., 2014; Dike et al., 2024). Estuarine and riverbank environments such as the Sombreiro River corridor exhibit shoreline dynamics that differ markedly from those of open coasts because erosion and channel adjustment are controlled by the interaction of river discharge, tidal processes, estuarine geomorphology, and sediment transport, resulting in highly variable patterns of shoreline change (Li et al., 2023). Bank undercutting, mass failure, and the redistribution of sediment within estuarine systems generate alternating reaches of erosion and accretion over relatively short distances as a consequence of the interaction between tidal forcing, hydrodynamic processes, and bank instability (Gasparotto et al., 2023). This heterogeneity complicates generalisation and reinforces the need for site-specific, community-scale assessment, as undertaken in the present study.

Applications of the Digital Shoreline Analysis System (DSAS)

The Digital Shoreline Analysis System has been widely adopted for quantifying shoreline change across diverse coastal environments. Developed by Himmelstoss et al. (2021) as an extension to GIS software, DSAS automates the casting of shore-normal transects from a user-defined baseline and the computation of standardised change statistics, thereby ensuring methodological consistency and reproducibility. The system's principal metrics – SCE, NSM, EPR, LRR and WLR – capture both the magnitude and the rate of shoreline movement and allow statistical confidence to be attached to the derived rates (Thieler et al., 2009; Himmelstoss et al., 2021).

DSAS has been applied successfully in a broad range of settings, including the Nile Delta (Nassar et al., 2019), the coasts of India and South-east Asia (Kankara et al., 2015; Mutaqin, 2017), Mediterranean beaches (Manca et al., 2013) and West African shorelines (Dada et al., 2018; Anthony et al., 2019). Recent applications of the Digital Shoreline Analysis System (DSAS) in Nigeria have demonstrated its effectiveness for quantifying long-term shoreline change along the transgressive mud coast and across the Niger Delta, confirming its suitability for analysing shoreline dynamics in tropical, sediment-rich coastal environments (Popoola, 2022; Afolabi & Darby, 2022). Comparative analyses have shown that LRR and WLR generally provide more robust long-term trend estimates than EPR because they incorporate all available shoreline positions, although the two regression measures frequently converge when positional uncertainties are small (Kankara et al., 2015; Nassar et al., 2019). These methodological insights directly inform the analytical framework adopted here.

Coastal Settlement Vulnerability and Planning

Shoreline change has profound implications for the vulnerability of coastal settlements, particularly where rapid, unplanned urbanisation has encroached upon dynamic shorelines (Neumann et al., 2015; Nicholls et al., 2021). Vulnerability in this context is understood as a function of exposure to shoreline retreat, the sensitivity of settlements and infrastructure, and the adaptive capacity of communities and institutions (McLaughlin & Cooper, 2010). The low-lying coastal environment of the Niger Delta, coupled with persistent shoreline retreat and sea-level-rise-induced inundation, places coastal settlements, infrastructure, and livelihoods at increasing risk, highlighting the need for integrated shoreline management and adaptive spatial planning (Popoola, 2022; Dada et al., 2018). Contemporary coastal-planning scholarship advocates a shift from reactive, hard-engineering responses towards integrated coastal zone management (ICZM), ecosystem-based adaptation and risk-informed spatial planning (Wong et al., 2019; Sutton-Grier et al., 2015). Nature-based solutions – notably mangrove restoration and living shorelines – are increasingly recognised as cost-effective and ecologically beneficial means of attenuating erosion in deltaic environments (Sutton-Grier et al., 2015; Temmerman et al., 2023). The effective deployment of such strategies, however, depends on reliable, spatially explicit shoreline-change data that identify where intervention is most urgently required. By generating transect-level change statistics for three contrasting communities, the present study provides precisely this kind of evidence base, linking geomorphological analysis to the practical needs of coastal settlement planning.

Study Area

The study focuses on three coastal communities – Abonnema, Degema and Idama – located along the Sombreiro River in the western Niger Delta, Rivers State, Nigeria. The Sombreiro River is a major distributary of the Niger Delta system that drains southwards into the Atlantic Ocean through a network of tidal creeks and estuarine channels. The study area lies within the brackish-water mangrove belt of the Niger Delta and is characterised by

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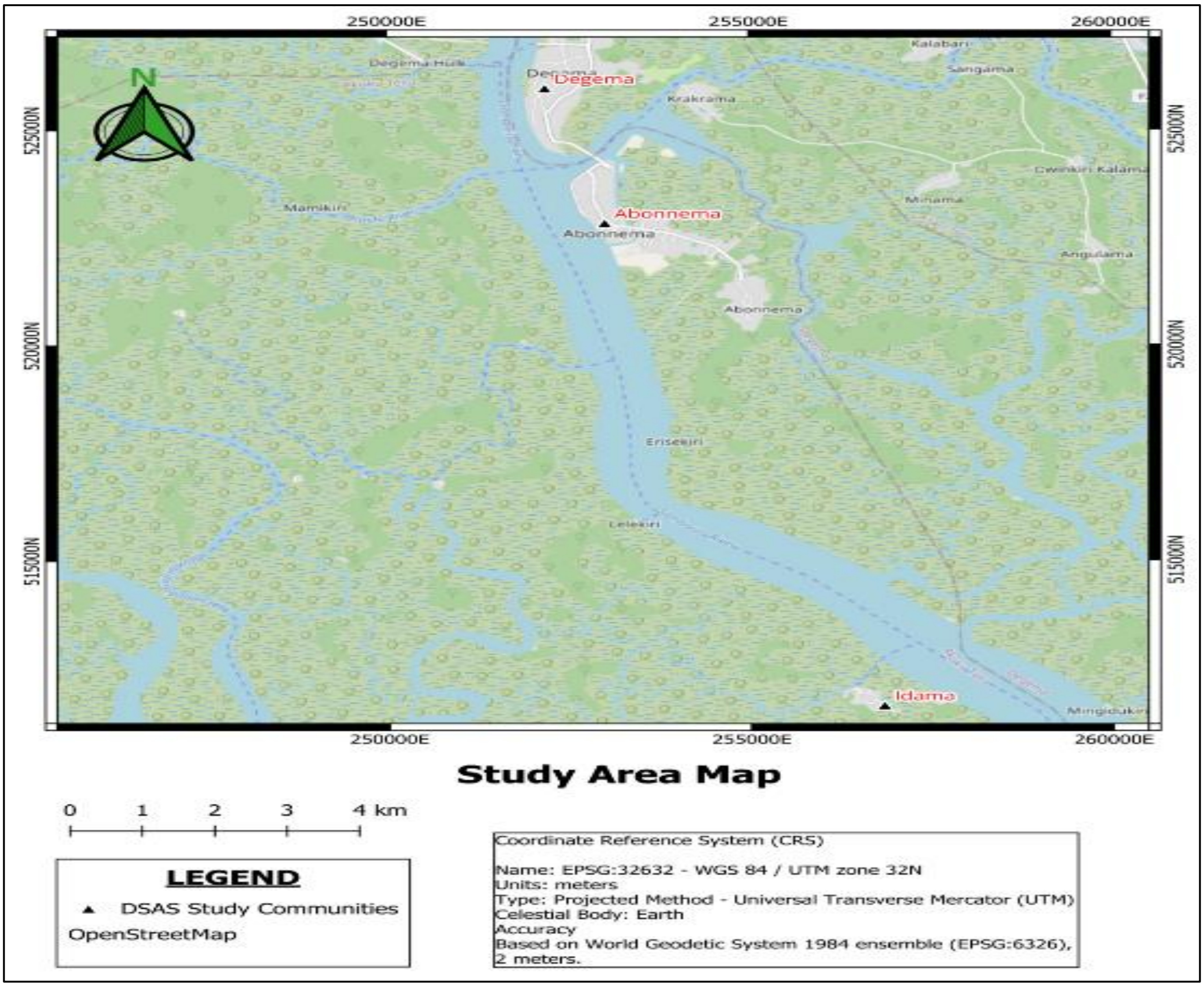
low-lying coastal terrain, extensive tidal creeks and estuaries, semi-diurnal tidal influence, high annual rainfall exceeding 2,500 mm, and a pronounced wet season extending from April to October (Lemenkova & Debeir, 2023; Dada et al., 2018). These conditions sustain extensive mangrove forests, nipa palm stands and intertidal mudflats that fringe the settlements.

Abonnema, the headquarters of the Akuku-Toru Local Government Area, is a densely built waterfront town whose commercial and residential development extends to the river's edge. Degema, headquarters of the Degema Local Government Area, occupies a comparable estuarine position and supports administrative, residential and port-related functions. Idama is a smaller riverine settlement situated downstream within the same estuarine corridor, with a livelihood base dominated by fishing and subsistence activities. All three communities are connected primarily by waterborne transport, and their jetties, markets and dwellings are positioned directly along the shoreline, rendering them sensitive to even moderate shoreline movement.

The three communities were selected because they occupy distinct segments of the Sombreiro estuarine system yet share comparable socio-economic and physiographic settings, providing an instructive basis for comparative shoreline-change analysis. Their differing exposure to fluvial and tidal energy, channel curvature and sediment supply is expected to produce divergent shoreline trajectories, making them suitable representatives of the broader spectrum of coastal conditions in the Niger Delta. The spatial distribution of the communities and the transects analysed is depicted in the study area map below.



Study Area Map

Figure 1. Location of Abonnema, Degema and Idama communities along the Sombreiro River, western Niger Delta, Nigeria. (Source: OpenStreetMap (OSM), 2026.)

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METHODOLOGY

Data Sources and Satellite Imagery

Multi-temporal shoreline positions were derived from medium-resolution optical satellite imagery acquired for four reference years – 2005, 2010, 2015 and 2020 – yielding a 15-year analytical window. Imagery from the Landsat series (Landsat 5 Thematic Mapper, Landsat 7 Enhanced Thematic Mapper Plus and Landsat 8 Operational Land Imager, 30 m spatial resolution), supplemented where available by higher-resolution Sentinel-2 MultiSpectral Instrument data (10 m) for the most recent epoch, provided the basis for shoreline extraction. Scenes were selected to minimise cloud cover and, as far as practicable, to correspond to comparable tidal stages and the dry-season period in order to reduce tidal and seasonal bias in the mapped shoreline position (Kankara et al., 2015; Mutaqin, 2017). All imagery was geometrically and radiometrically corrected and re-projected to the Universal Transverse Mercator (UTM) Zone 32N coordinate system on the WGS 1984 datum.

Shoreline Extraction and Pre-processing

For each reference year the instantaneous land–water boundary was delineated within a GIS environment. The Modified Normalised Difference Water Index (MNDWI) was computed to enhance the contrast between water and land, after which the shoreline was extracted and refined through on-screen digitisation at a consistent mapping scale to ensure positional comparability across epochs (Nassar et al., 2019). The digitised shorelines were stored as vector polylines in a single geodatabase, each attributed with its acquisition date as required by DSAS. Positional uncertainty arising from image resolution, georeferencing, tidal fluctuation and digitising error was accounted for through a default shoreline uncertainty value, described below.

DSAS Configuration

Shoreline change was quantified using the Digital Shoreline Analysis System (DSAS) version 6.1 (Himmelstoss et al., 2021) operating within the GIS. A single onshore baseline was constructed parallel to the general trend of the shoreline for each community, and shore-normal transects were cast automatically at a uniform spacing of 100 m. A transect smoothing distance of 500 m was applied to ensure that transects were oriented orthogonally to the generalised shoreline trend rather than to minor local irregularities. A shoreline threshold of 2 m, a default positional uncertainty of 10 m and a 90% confidence interval were adopted throughout. This configuration generated 8 transects for Abonnema, 16 for Degema and 33 for Idama, reflecting the differing alongshore extent of each community.

Shoreline Change Statistics

Five standard DSAS statistics were computed at each transect. The Shoreline Change Envelope (SCE) measures the total distance between the shoreline positions furthest from and closest to the baseline, irrespective of direction, and therefore indexes shoreline variability. The Net Shoreline Movement (NSM) reports the distance between the oldest (2005) and youngest (2020) shorelines, with negative values denoting retreat and positive values denoting advance. The End Point Rate (EPR) divides the NSM by the elapsed time to yield an annualised rate based on the two end-point shorelines. The Linear Regression Rate (LRR) fits a least-squares regression line to all four shoreline positions to estimate the long-term rate of change, while the Weighted Linear Regression (WLR) repeats this fit but weights each shoreline position by the inverse of its uncertainty, giving greater influence to more reliable observations (Thieler et al., 2009; Himmelstoss et al., 2021). Negative rates indicate erosion and positive rates indicate accretion.

Analytical Procedure and Statistical Interpretation

For each community the transect-level statistics were exported and summarised to obtain mean values, the proportion of eroding and accreting transects, the magnitude and location of erosion and accretion extremes, and the proportion of transects whose rates were statistically significant at the 90% confidence level. s were defined as transects exhibiting the highest erosional rates and net retreat, while accretional zones were identified from transects with the greatest seaward advance. The convergence or divergence of EPR, LRR and WLR was examined to assess the robustness of the derived trends and the influence of positional uncertainty. Finally, the geomorphological findings were interpreted in relation to the exposure of settlements and infrastructure in each community to derive risk classifications and to underpin the policy and planning recommendations presented in subsequent sections.

Uncertainty Assessment and Validation of Shoreline Outputs

Because shoreline positions derived from remotely sensed imagery are affected by acquisition conditions and interpretation procedures, uncertainty was explicitly considered in the analysis. The principal sources of uncertainty include the spatial resolution of the Landsat imagery, the 10 m Sentinel-2 data used for the most recent epoch where available, residual georeferencing error, digitising error, tidal-stage differences at the time of image acquisition, seasonal variation in river discharge, vegetation cover, exposed mudflats and the difficulty of defining a single land–water boundary in mangrove-fringed estuarine environments. These issues are particularly relevant in the Sombreiro River corridor, where turbid water, intertidal sediments, nipa palm and mangrove vegetation may obscure the actual shoreline position.

To minimise these uncertainties, satellite scenes were selected to reduce cloud-cover effects and, as far as practicable, to correspond to comparable seasonal conditions. All imagery was geometrically corrected, projected to a common UTM/WGS 1984 coordinate system and processed using a consistent shoreline-extraction procedure. The Modified Normalised Difference Water Index was used to enhance the land–water boundary, while extracted shorelines were refined through visual interpretation and on-screen digitisation at a consistent mapping scale. A default positional uncertainty value of 10 m was incorporated into the DSAS analysis to account for the combined effects of image resolution, georeferencing, extraction and digitising errors.

Validation of the remote-sensing outputs was undertaken through internal consistency checks and visual quality assessment. Extracted shorelines were overlaid on the original satellite imagery and water-index outputs to confirm that the digitised shoreline corresponded reasonably with the visible land–water boundary. Transects were also inspected to ensure that they intersected the shoreline positions correctly and did not generate anomalous measurements. In addition, the comparison between the Linear Regression Rate and Weighted Linear Regression provided a useful consistency check. The close agreement between both statistics across Abonnema, Degema and Idama suggests that the assigned uncertainty values did not substantially alter the estimated shoreline-change trends. However, the wide confidence interval observed in Degema indicates that this reach is highly variable and should be interpreted with caution.

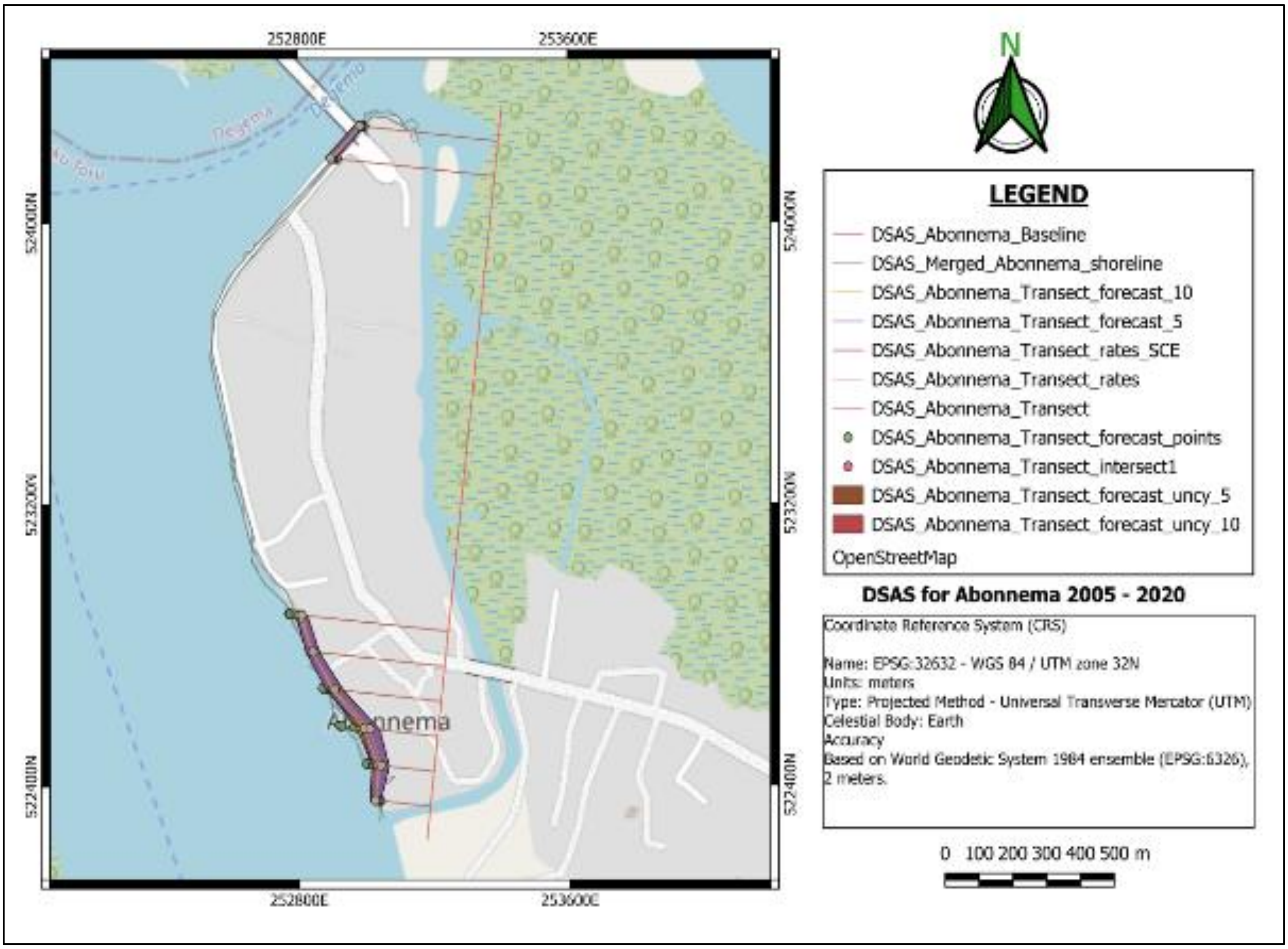
The results therefore provide reliable evidence for identifying shoreline-change tendencies, s and planning priorities, but they should not be interpreted as a substitute for detailed field-based measurements. Future studies would benefit from ground-control surveys, GPS shoreline mapping, UAV-based shoreline monitoring, tidal records, bathymetric data and field observations of bank material, vegetation condition and human activities along the waterfront.

RESULTS

This section presents the DSAS-derived shoreline change statistics for the three study communities. The results are reported sequentially for Abonnema, Degema and Idama, followed by a comparative synthesis. For each community the SCE, NSM, EPR, LRR and WLR statistics are described, and the corresponding transect map is indicated.

Shoreline Change Analysis of Abonnema Community

The shoreline dynamics of Abonnema Community were assessed using the Digital Shoreline Analysis System (DSAS) version 6.1. Four shoreline positions (2005, 2010, 2015, and 2020) were analysed against a single baseline to quantify historical shoreline movement. The analysis generated five shoreline change statistics, namely Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM), End Point Rate (EPR), Linear Regression Rate (LRR), and Weighted Linear Regression (WLR). Eight transects with a spacing of 100 m and a smoothing distance of 500 m were used for the assessment. A shoreline threshold of 2 m, a default uncertainty of 10 m, and a 90% confidence interval were adopted during the analysis.



DSAS Map – Abonnema Community

Figure 2. DSAS transect map for Abonnema Community showing shoreline positions (2005–2020) and Linear Regression Rate (LRR) at each transect.

Shoreline Change Envelope (SCE)

The Shoreline Change Envelope represents the total range of shoreline movement irrespective of direction. The analysis revealed an average shoreline change envelope of 21.86 m, indicating that the shoreline fluctuated by approximately 22 m during the study period. The greatest shoreline variability occurred at Transect 19, where a maximum shoreline displacement of 51.33 m was recorded, while the least variation (9.17 m) occurred at Transect 2. These results indicate moderate spatial variability in shoreline behaviour across Abonnema, with certain shoreline segments experiencing substantially greater fluctuations than others.

Net Shoreline Movement (NSM)

The Net Shoreline Movement analysis showed an overall average movement of -7.89 m, indicating that erosion slightly exceeded accretion across the community during the study period. Out of the eight transects analysed, four transects (50%) recorded shoreline retreat, while the remaining four transects (50%) experienced advancement. The greatest shoreline recession occurred at Transect 19, where a retreat of 43.23 m was observed. Conversely, the highest ment was 6.40 m at Transect 3. Although erosion and accretion occurred in equal proportions, the larger magnitude of erosion resulted in an overall net shoreline retreat for Abonnema.

End Point Rate (EPR)

The End Point Rate analysis produced an average erosion rate of -0.53 m/year, suggesting that the shoreline has generally been retreating at a relatively slow rate over the 15-year study period. The average confidence interval associated with the calculated rates was ±0.94 m/year.

Half of the analysed transects (50%) exhibited erosional trends, while the remaining half showed accretion. However, only 37.5% of all transects experienced statistically significant erosion, whereas none of the accreting transects were statistically significant. The highest erosion rate was recorded at Transect 19 (-2.88 m/year), while the greatest accretion rate occurred at Transect 3 (0.43 m/year). The average erosion rate among all erosional transects was -1.40 m/year, whereas accreting transects recorded an average of 0.35 m/year. These findings indicate that although occurs locally, erosion remains the dominant geomorphic process within the study area.

Linear Regression Rate (LRR)

The Linear Regression Rate, which considers all shoreline dates to estimate long-term trends, produced an average shoreline change rate of -0.75 m/year. This value is slightly more erosive than that obtained using the End Point Rate, suggesting that long-term shoreline recession is more pronounced when all shoreline positions are considered.

Five transects (62.5%) recorded erosional trends, while only three transects (37.5%) showed accretion. The maximum erosion rate was -3.48 m/year at Transect 19, while the highest accretion rate was 0.55 m/year at Transect 3. Only 12.5% of the transects exhibited statistically significant erosion, whereas no statistically significant accretion was detected. The average erosion rate across erosional transects was -1.49 m/year, compared to an average accretion rate of 0.50 m/year. These results further confirm that shoreline retreat represents the prevailing long-term trend in Abonnema.

Weighted Linear Regression (WLR)

The Weighted Linear Regression analysis produced results identical to those obtained from the Linear Regression Rate, with an average shoreline change rate of -0.75 m/year. Similar to the LRR analysis, 62.5% of transects experienced erosion, while 37.5% recorded accretion. The highest erosion rate (-3.48 m/year) was observed at Transect 19, whereas the highest accretion rate (0.55 m/year) occurred at Transect 3. The similarity between the LRR and WLR results indicates that the assigned shoreline uncertainties had minimal influence on the regression analysis, suggesting that the historical shoreline dataset is relatively consistent.

Overall Interpretation

Overall, the DSAS analysis indicates that Abonnema Community is experiencing a gradual but persistent erosional trend. While ment occurs in some locations, the magnitude and spatial extent of erosion exceed those of accretion, resulting in an overall shoreline retreat. The average shoreline recession rates of -0.53 m/year (EPR) and -0.75 m/year (LRR/WLR) suggest that the community is losing shoreline at a relatively slow but continuous rate. The concentration of the most severe erosion at Transect 19 indicates a localized that may require priority management interventions.

The coexistence of erosion and accretion reflects the dynamic nature of the Niger Delta estuarine environment, where tidal processes, river discharge, wave action, sediment transport, and human activities collectively influence shoreline evolution. Although the overall rate of shoreline retreat is moderate compared to highly erosive coastal environments, the continued recession poses potential risks to waterfront infrastructure, residential areas, transportation facilities, and ecosystem stability if appropriate shoreline management measures

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are not implemented. The findings therefore suggest the need for continuous shoreline monitoring, ecosystem-based coastal protection, and integrated shoreline management strategies to enhance the long-term resilience of Abonnema's coastal environment.

Shoreline Change Analysis of Degema Community

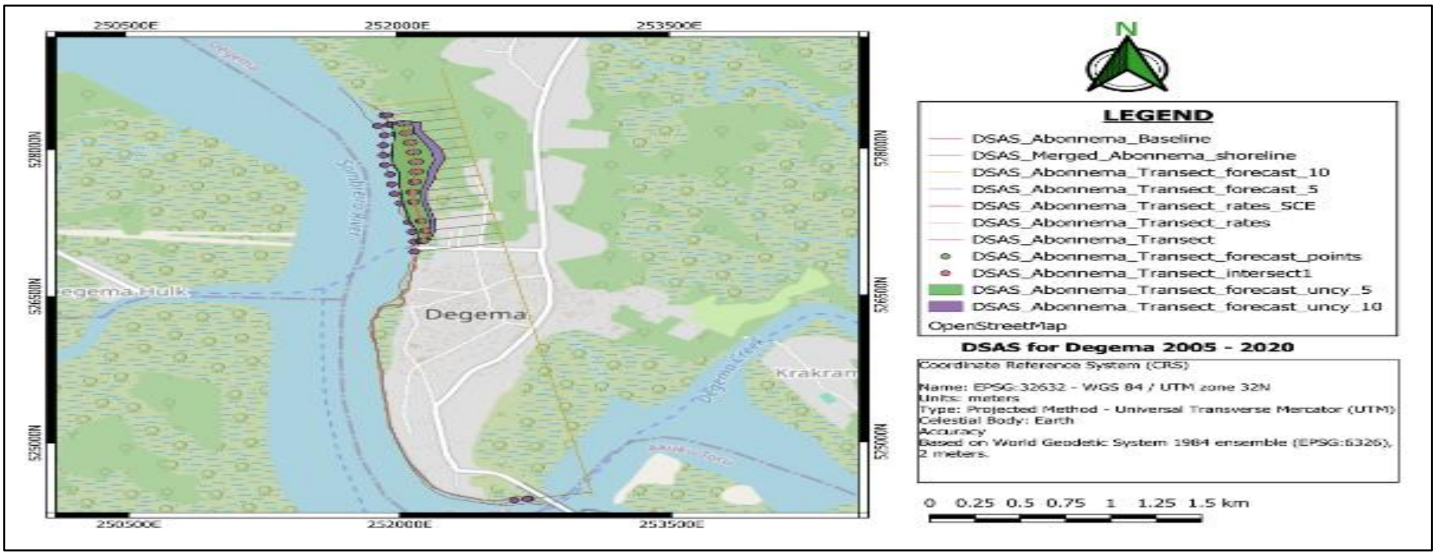
The shoreline dynamics of Degema Community were evaluated using the Digital Shoreline Analysis System (DSAS) Version 6.1. Four shoreline positions (2005, 2010, 2015, and 2020) were analysed against a single baseline to quantify historical shoreline movement. The analysis generated five shoreline change statistics: Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM**)**, End Point Rate (EPR), Linear Regression Rate (LRR)**,** and Weighted Linear Regression (WLR)**.** Sixteen transects with a spacing of 100 m and a smoothing distance of 500 m were used for the analysis. The shoreline threshold was set at 2 m, with a default uncertainty of 10 m and a 90% confidence interval.

Shoreline Change Envelope (SCE)

The Shoreline Change Envelope (SCE) measures the total range of shoreline movement irrespective of whether the d or retreated. The analysis revealed an average shoreline change envelope of 81.82 m, indicating considerably greater shoreline variability than observed in several neighbouring communities. The maximum shoreline displacement of 163.24 m occurred at Transect 10, while the minimum displacement of 2.05 m was recorded at Transect 19. The large difference between the maximum and minimum SCE values demonstrates that shoreline behaviour in Degema is highly variable, with some sections remaining relatively stable while others have undergone substantial positional changes over the study period.

Net Shoreline Movement (NSM)

The Net Shoreline Movement analysis produced an overall average movement of -7.74 m, indicating that shoreline retreat marginally exceeded ment across the community. Of the sixteen transects analysed, ten transects (62.5%) recorded erosion, whereas six transects (37.5%) experienced accretion. The greatest shoreline recession occurred at Transect 45, where a retreat of 74.58 m was observed. In contrast, the greatest ment was recorded at Transect 10, with an advance of 22.59 m. Although several shoreline sections experienced sediment deposition and shoreline growth, the larger number and magnitude of erosional transects resulted in an overall trend of shoreline recession in Degema.



DSAS Map – Degema Community

Figure 3. DSAS transect map for Degema Community showing shoreline positions (2005–2020) and Linear Regression Rate (LRR) at each transect.

End Point Rate (EPR)

The End Point Rate analysis indicated an average shoreline change rate of -0.52 m/year, suggesting a gradual overall erosional trend throughout the study period. The average confidence interval associated with the calculated rates was ±0.94 m/year.

A total of 62.5% of the transects exhibited erosion, while 37.5% showed accretion. Approximately 25% of all transects experienced statistically significant erosion, whereas 18.75% recorded statistically significant accretion. The highest erosion rate was observed at Transect 45 (-4.97 m/year), while the greatest accretion rate occurred at Transect 10 (1.51 m/year). The average erosion rate among all erosional transects was -1.34 m/year, compared with an average accretion rate of 0.86 m/year. These findings indicate that although shoreline accretion occurs in several locations, erosion remains the dominant process influencing shoreline evolution in Degema.

Linear Regression Rate (LRR)

The Linear Regression Rate, which incorporates all available shoreline positions to estimate long-term shoreline trends, produced an average shoreline recession rate of -2.07 m/year, indicating a substantially stronger long-term erosional trend than that suggested by the End Point Rate.

Among the fifteen valid regression transects analysed, fourteen transects (93.33%) exhibited erosional trends, while only one transect (6.67%) recorded accretion. The highest erosion rate was -5.44 m/year at Transect 45, whereas the only accretional transect recorded a modest rate of 0.12 m/year at Transect 15. None of the regression-derived erosion or accretion rates were statistically significant at the selected confidence level, largely due to the relatively high variability among shoreline positions, as reflected by the average confidence interval of ±12.95 m/year. Nevertheless, the overwhelming dominance of erosional transects indicates that shoreline retreat has been the prevailing long-term coastal process in Degema.

Weighted Linear Regression (WLR)

The Weighted Linear Regression analysis produced results identical to those obtained from the Linear Regression Rate, yielding an average shoreline change rate of -2.07 m/year. Similar to the LRR analysis, 93.33% of the transects recorded erosion, while only 6.67% experienced accretion. The highest erosion rate remained -5.44 m/year at Transect 45, while the highest accretion rate was 0.12 m/year at Transect 15. The similarity between the WLR and LRR results suggests that incorporating shoreline positional uncertainties had little influence on the regression estimates, indicating a generally consistent historical shoreline dataset.

Overall Interpretation

Overall, the DSAS analysis demonstrates that Degema Community is experiencing a sustained and relatively pronounced erosional trend. Although some shoreline segments exhibit accretion, the majority of transects are characterised by shoreline retreat, particularly when long-term shoreline positions are considered. The average shoreline recession rates of -0.52 m/year (EPR) and -2.07 m/year (LRR/WLR) indicate that long-term erosion is considerably more severe than suggested by simple end-point comparisons.

The exceptionally high shoreline variability, reflected by an average SCE of 81.82 m, together with the severe erosion recorded at Transect 45, highlights localized shoreline instability that may be associated with tidal currents, river discharge, sediment redistribution, bank undercutting, and anthropogenic disturbances. These conditions present potential threats to residential developments, waterfront infrastructure, transportation networks, and ecological resources within Degema. Consequently, there is a need for continuous shoreline monitoring, implementation of integrated shoreline management strategies, and the adoption of both structural and nature-based erosion control measures to mitigate future shoreline degradation and enhance the long-term resilience of the community.

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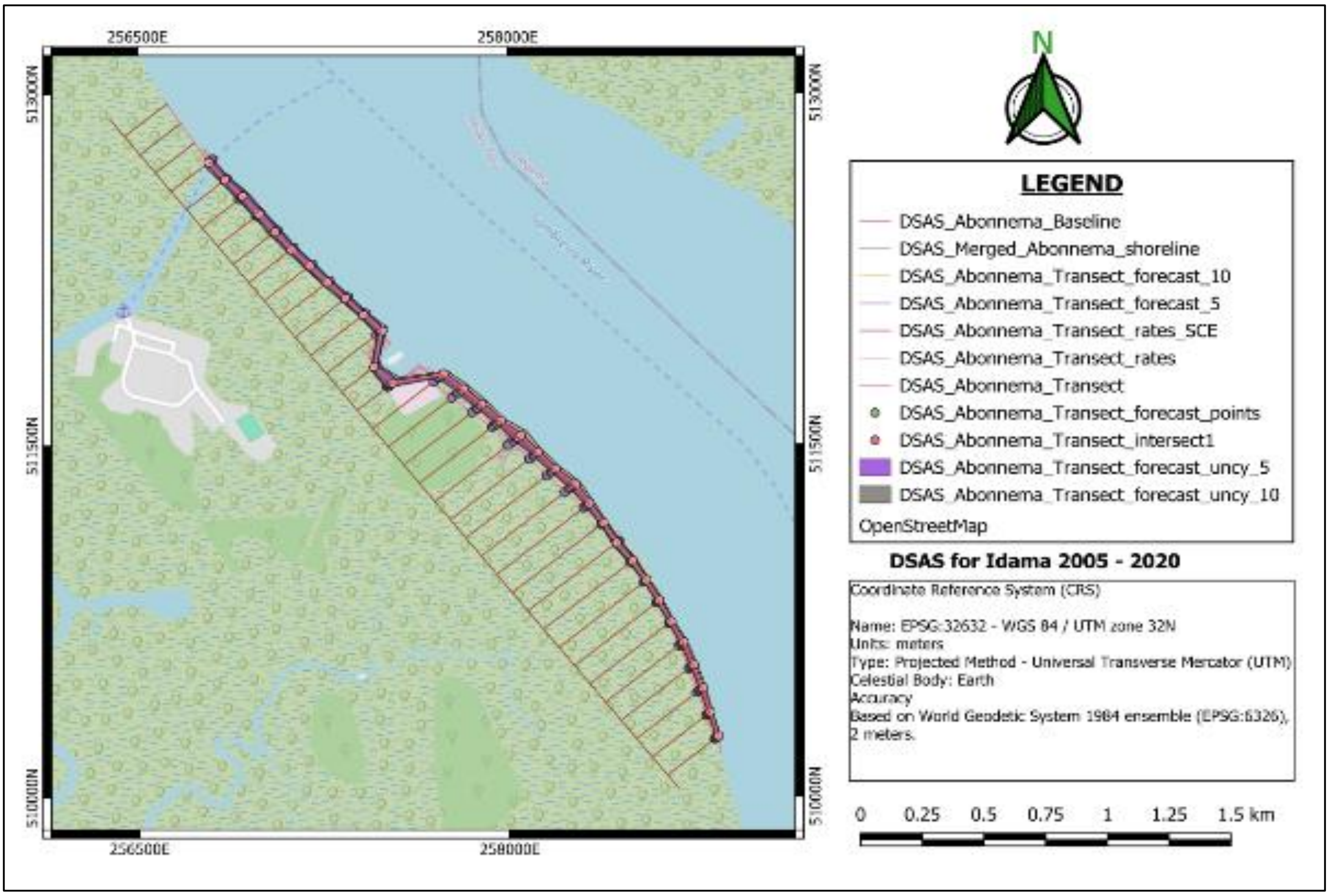
Shoreline Change Analysis of Idama Community

The shoreline dynamics of Idama Community were evaluated using the Digital Shoreline Analysis System (DSAS) Version 6.1. Four historical shoreline positions (2005, 2010, 2015, and 2020) were analysed against a single baseline to quantify shoreline movement over time. Five shoreline change statistics were generated, namely Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM), End Point Rate (EPR), Linear Regression Rate (LRR), and Weighted Linear Regression (WLR). The analysis utilised 33 transects spaced at 100 m intervals, with a smoothing distance of 500 m, a shoreline threshold of 2 m, a default uncertainty of 10 m, and a 90% confidence interval.



DSAS Map – Idama Community

Figure 4. DSAS transect map for Idama Community showing shoreline positions (2005–2020) and Linear Regression Rate (LRR) at each transect.

Shoreline Change Envelope (SCE)

The Shoreline Change Envelope (SCE) represents the total range of shoreline movement regardless of whether the d or retreated. The analysis revealed an average shoreline change envelope of 19.51 m, indicating relatively moderate shoreline variability across Idama during the study period. The maximum shoreline displacement of 42.10 m occurred at Transect 22, whereas the minimum displacement of 7.79 m was recorded at Transect 27. These findings suggest that although shoreline fluctuations occurred throughout the community, the overall spatial variability was moderate and considerably less pronounced than in highly dynamic coastal sections elsewhere in the Niger Delta.

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Net Shoreline Movement (NSM)

The Net Shoreline Movement analysis produced an overall average shoreline movement of 9.41 m, indicating a net seaward advancement of the shoreline over the study period. Of the 33 transects analysed, 23 transects (69.70%) experienced shoreline accretion, while only 10 transects (30.30%) recorded shoreline retreat. The greatest shoreline recession occurred at Transect 28, where a retreat of 9.81 m was observed. Conversely, the largest ment of 35.06 m occurred at Transect 19. The predominance of positive shoreline movement demonstrates that sediment deposition exceeded erosion in most parts of Idama during the study period.

End Point Rate (EPR)

The End Point Rate analysis yielded an average shoreline change rate of 0.63 m/year, indicating that the shoreline has generally advanced seaward over the fifteen-year study period. The average confidence interval associated with the calculated rates was ±0.94 m/year.

Out of the 33 transects analysed, 10 transects (30.30%) recorded erosion, while 23 transects (69.70%) exhibited accretion. None of the erosional transects showed statistically significant erosion; however, 36.36% of all transects recorded statistically significant accretion. The highest erosion rate occurred at Transect 28 (-0.65 m/year), whereas the highest accretion rate was observed at Transect 19 (2.34 m/year). The average erosion rate among erosional transects was -0.34 m/year, compared with an average accretion rate of 1.05 m/year. These results indicate that ment is the dominant coastal process influencing Idama.

Linear Regression Rate (LRR)

The Linear Regression Rate, which incorporates all shoreline positions to estimate long-term trends, produced an average shoreline change rate of 0.73 m/year, confirming a sustained long-term accretional trend. The average confidence interval associated with the regression analysis was ±1.95 m/year, while the reduced uncertainty associated with independent transects was ±0.85 m/year.

Among the analysed transects, 24 transects (72.73%) exhibited accretion, whereas only 9 transects (27.27%) experienced erosion. None of the erosional transects recorded statistically significant erosion, while 15.15% of all transects exhibited statistically significant accretion. The highest erosion rate was -0.55 m/year at Transect 16, whereas the highest accretion rate reached 2.26 m/year at Transect 19. The average erosion rate across erosional transects was -0.22 m/year, while accreting transects recorded an average ment of 1.09 m/year. These findings reinforce the conclusion that shoreline accretion has been the prevailing long-term process along the Idama coastline.

Weighted Linear Regression (WLR)

The Weighted Linear Regression analysis produced results identical to those obtained from the Linear Regression Rate, with an average ment rate of 0.73 m/year. Similar to the LRR results, 72.73% of the transects recorded accretion, while 27.27% exhibited erosion. The maximum erosion rate remained -0.55 m/year at Transect 16, whereas the highest accretion rate remained 2.26 m/year at Transect 19. The similarity between the LRR and WLR analyses indicates that incorporating shoreline uncertainty had minimal influence on the regression estimates, suggesting a consistent and reliable historical shoreline dataset.

Overall Interpretation

Overall, the DSAS analysis indicates that Idama Community is characterised by a dominant accretional shoreline trend. Unlike several neighbouring communities where erosion predominates, Idama has experienced sustained ment over the study period. The positive average shoreline change rates of 0.63 m/year (EPR) and 0.73 m/year (LRR/WLR) demonstrate that sediment deposition has consistently exceeded shoreline retreat. Furthermore, nearly 70% of all transects recorded shoreline accretion, while fewer than one-third experienced erosion.

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The moderate shoreline variability, reflected by an average SCE of 19.51 m, combined with the relatively low erosion rates, suggests that the shoreline is comparatively stable and benefits from favourable sediment accumulation processes. These conditions are likely influenced by local hydrodynamic processes, sediment supply from adjoining river channels, tidal deposition, and estuarine circulation patterns. Although localized erosion occurs in a few shoreline segments, the overall accretional behaviour indicates that Idama presently faces a relatively lower risk of shoreline recession compared with other coastal communities within the Niger Delta. Nevertheless, continued shoreline monitoring and sustainable coastal management remain essential to preserve this favourable shoreline condition and to mitigate the potential impacts of future environmental and anthropogenic changes.

Comparative Analysis of Shoreline Change

The transect-level statistics summarised in Tables 1–3 reveal pronounced contrasts in shoreline behaviour among the three communities. Degema emerges as the most dynamic and most severely eroding reach, Abonnema displays moderate but persistent erosion, and Idama is distinguished by sustained accretion. Table 1 summarises the mean change statistics, Table 2 presents the distribution of eroding and accreting transects, and Table 3 identifies the critical transects and hotspots in each community.

Table 1. Summary of DSAS shoreline-change statistics for the three study communities (2005–2020).

Parameter	Abonnema	Degema	Idama
Number of transects	8	16	33
Transect spacing (m)	100	100	100
Mean SCE (m)	21.86	81.82	19.51
Mean NSM (m)	−7.89	−7.74	+9.41
Mean EPR (m/yr)	−0.53	−0.52	+0.63
EPR confidence interval (m/yr)	±0.94	±0.94	±0.94
Mean LRR (m/yr)	−0.75	−2.07	+0.73
Mean WLR (m/yr)	−0.75	−2.07	+0.73
Dominant trend	Erosion	Erosion (severe)	Accretion

Table 2. Distribution of eroding and accreting transects across the three communities.

Community	Eroding transects, NSM (n, %)	Accreting transects, NSM (n, %)	Eroding, LRR (%)	Accreting, LRR (%)	Statistically significant erosion, LRR (%)
Abonnema	4 (50.0%)	4 (50.0%)	62.5%	37.5%	12.5%
Degema	10 (62.5%)	6 (37.5%)	93.33%	6.67%	0%
Idama	10 (30.30%)	23 (69.70%)	27.27%	72.73%	0%

Table 3. Critical transects, hotspots and resulting risk classification for the three communities.

Community	(transect; max LRR; NSM)	Accretion hotspot (transect; max rate; NSM)	Settlement risk level
Abonnema	T19; −3.48 m/yr; −43.23 m	T3; +0.55 m/yr (LRR); +6.40 m	Moderate
Degema	T45; −5.44 m/yr; −74.58 m	T10; +1.51 m/yr (EPR); +22.59 m	High
Idama	T28; −0.55 m/yr (T16, LRR); −9.81 m	T19; +2.26 m/yr (LRR); +35.06 m	Low

As Table 1 shows, the three communities span the full spectrum of shoreline behaviour, from pronounced retreat at Degema (LRR = −2.07 m/yr) through moderate erosion at Abonnema (LRR = −0.75 m/yr) to net advance at Idama (LRR = +0.73 m/yr). The exceptionally large mean SCE at Degema (81.82 m), more than four times that of the other two communities, confirms that this reach is also the most spatially variable. In every community the LRR and WLR values are identical, indicating that the assigned positional uncertainties had a negligible effect on the regression-derived trends. Table 2 reinforces this gradient: erosion dominates 93.33% of Degema's valid regression transects, compared with 62.5% at Abonnema and only 27.27% at Idama, where almost three-quarters of transects are accreting. Table 3 localises these trends to specific hotspots – Transect 45 at Degema and Transect 19 at Abonnema – which warrant priority management attention, whereas Idama's most active transect (T19) is accretional.

DISCUSSION

The DSAS results show that shoreline change along the Sombreiro River is spatially heterogeneous, with Degema, Abonnema and Idama exhibiting distinct shoreline-change trajectories despite their shared estuarine setting. This confirms a key argument in recent shoreline-dynamics literature: deltaic and estuarine coasts rarely behave as uniform geomorphic systems, as erosion and accretion may occur simultaneously over short distances because of variations in channel morphology, tidal energy, sediment supply, vegetation cover, bank material and human modification (Dada et al., 2018; Afolabi & Darby, 2022; Gasparotto et al., 2023). Recent Niger Delta studies have similarly reported alternating erosional and accretional patterns across sediment cells, river mouths and estuarine environments rather than a single regional trend (Afolabi et al., 2022; Dike et al., 2024a). The coexistence of strong erosion at Degema and Abonnema with net accretion at Idama therefore confirms the dynamic, sediment-redistributing character of the Niger Delta. However, this study extends existing regional-scale studies by demonstrating that such variability is also evident at the community scale, where shoreline change has direct implications for settlement safety, land-use planning and local adaptation.

The severe erosion recorded at Degema, with an LRR of −2.07 m/yr, a maximum recession of 74.58 m at Transect 45 and a mean SCE of 81.82 m, indicates a highly mobile shoreline reach affected by active bank instability and possible channel migration. This finding is consistent with studies that identify parts of the Niger Delta and the wider West African coast as erosion-prone, particularly where fluvial discharge, tidal currents, sediment redistribution and human disturbance interact (Dada et al., 2018; Anthony et al., 2019; Afolabi et al., 2022; Dike et al., 2024a). At the same time, the Degema result challenges broad regional summaries that suggest near-balanced erosion and accretion across the Niger Delta. While such regional assessments are useful, the marked retreat at Degema shows that localised shoreline loss may be more severe than regional averages suggest. This supports the need for reach-specific shoreline assessments rather than relying only on aggregated coastal-change statistics.

The absence of statistically significant regression rates at Degema, despite the dominance of erosional transects, should be interpreted critically. Rather than invalidating the evidence of retreat, the wide confidence interval of ±12.95 m/yr suggests high temporal variability in shoreline position. Similar uncertainty has been reported in DSAS-based studies of dynamic estuarine and deltaic environments, where tidal-stage differences, seasonal discharge, image-date selection and episodic erosion can affect shoreline positions (Kankara et al., 2015; Himmelstoss et al., 2021). This finding therefore adds a methodological contribution by showing that in highly mobile riverine shorelines, geomorphic evidence of erosion may remain strong even where statistical significance is reduced by inter-epoch variability. It also supports recent calls for denser temporal monitoring, higher-resolution imagery and integration of DSAS outputs with field surveys, UAV mapping and hydrodynamic measurements (Dike et al., 2024a; Nnam et al., 2026).

Although this study did not directly measure engineering structures, bathymetry, bank material or topographic controls, the stronger erosion at Degema relative to Abonnema may reflect differences in shoreline protection, bank elevation, channel curvature, vegetation condition and near-bank current intensity. Recent coastal vulnerability studies in the Niger Delta emphasise that shoreline retreat cannot be separated from elevation, slope, exposure and landform setting, because these factors influence the vulnerability of communities and infrastructure to erosion, flooding and sea-level-related hazards (Dike et al., 2024b; Nnam et al., 2026). The Degema result therefore extends the coastal vulnerability literature by identifying a specific community-scale reach where shoreline retreat is not only a geomorphic process but also a settlement-planning concern.

Abonnema presents a different pattern of moderate but persistent erosion, with an LRR of −0.75 m/yr and a localised hotspot at Transect 19, where a regression rate of −3.48 m/yr and a net retreat of 43.23 m were recorded. This partly confirms previous studies showing that erosion in the Niger Delta is often concentrated around river mouths, bends, exposed waterfronts or areas affected by local disturbance rather than being evenly distributed (Afolabi et al., 2022; Dike et al., 2024a; Osondu et al., 2025). However, the Abonnema result also refines this understanding by showing that a shoreline may appear balanced under NSM, with 50% eroding and 50% accreting transects, while regression-based statistics reveal a more persistent erosional tendency. This reinforces the value of using multiple DSAS metrics, since NSM may obscure intermediate fluctuations while LRR and WLR better capture long-term directional trends (Himmelstoss et al., 2021). From a management perspective, the concentration of erosion at Transect 19 suggests that targeted stabilisation would be more appropriate than uniform hard engineering along the entire waterfront.

Idama contrasts with Degema and Abonnema by showing net accretion, with an LRR of +0.73 m/yr and approximately 70% of transects gaining land. This confirms studies that emphasise the role of sediment deposition, tidal import of fine sediments and mangrove-fringed shorelines in promoting shoreline progradation in sheltered estuarine environments (Sutton-Grier et al., 2015; Temmerman et al., 2023). The Idama result is also consistent with wider Niger Delta evidence that accretion and erosion can occur within the same deltaic system where local hydrodynamic and sedimentary conditions differ (Afolabi et al., 2022; Dike et al., 2024a). However, it also challenges an overly erosion-centred interpretation of Niger Delta shoreline change by showing that some estuarine communities may currently function as sediment accumulation zones. Nevertheless, the localised erosion observed at Transect 28 shows that accreting reaches are not uniformly stable. Idama should therefore be managed as a dynamic sediment-storage and ecological-buffer zone rather than treated as risk-free.

Across the three communities, the near-perfect agreement between LRR and WLR suggests internal consistency in the historical shoreline dataset and increases confidence in the estimated trends. This is consistent with DSAS applications elsewhere, where comparison of multiple statistics is used to assess the robustness of shoreline-change estimates (Kankara et al., 2015; Nassar et al., 2019; Himmelstoss et al., 2021). However, this agreement does not eliminate all uncertainty. Shoreline proxy selection, image resolution, tidal variation, seasonal discharge, vegetation cover and georeferencing error may still influence mapped shoreline positions. Future studies should therefore combine DSAS analysis with field validation, topographic surveys and hydrodynamic observations to improve causal explanation.

Overall, the findings confirm recent evidence that Niger Delta shorelines are highly dynamic, but they also challenge broad generalisations by showing that erosion and accretion vary sharply between neighbouring communities along the same estuarine river. The study extends current knowledge by providing community-scale evidence that directly informs coastal settlement planning and adaptive shoreline management. Degema requires urgent erosion-risk reduction, Abonnema requires hotspot-specific intervention, while Idama requires conservation-oriented monitoring to maintain its accretional and buffering functions. Planning responses should therefore be spatially differentiated, combining development setbacks, risk-sensitive zoning, carefully designed embankments, mangrove restoration, riparian vegetation protection and continuous DSAS-based monitoring. Given the customary land tenure system in many Niger Delta communities, community-based land allocation policies are also needed to guide future residential expansion towards more stable inland areas while preserving vulnerable waterfront corridors as protective buffers, access routes, conservation areas and flood-compatible public spaces.

Study Limitations

The study is limited by its use of only four shoreline years (2005, 2010, 2015 and 2020), which may not capture short-term erosion, seasonal changes, floods, storms or sudden human disturbances. Its reliance on medium-resolution imagery also means that small-scale bank erosion, jetties, reclamation, minor protection works and abrupt bank failures may not be fully detected.

In addition, the study measured shoreline movement but did not directly investigate the physical or human drivers of change, such as bathymetry, current velocity, dredging, sand mining, mangrove clearance or land subsidence. Differences in transect numbers across the communities also mean that comparisons should be interpreted cautiously. Finally, the study did not include household vulnerability, infrastructure exposure or socio-economic risk analysis, so the planning recommendations should be supported by field validation, stakeholder consultation and further socio-economic assessment before major interventions are implemented.

Broader Applicability of the Methodology

The methodology has wider relevance beyond Abonnema, Degema and Idama because it provides a repeatable approach for assessing shoreline change in coastal, estuarine and riverbank settlements. By combining satellite imagery, shoreline extraction and DSAS transect analysis, the method can help identify s, accretion zones and shoreline-risk areas for planning and management.

It is especially useful in data-poor coastal regions where long-term field records are unavailable but historical satellite images exist. However, the method must be adapted to local conditions, since open coasts, riverbanks, tidal creeks, mangrove zones and barrier islands are influenced by different physical processes. Its main value is therefore not in assuming that all shorelines behave the same way, but in offering a consistent framework for comparison. When supported by field checks, local knowledge and socio-economic data, the approach can strengthen coastal-risk mapping, adaptive settlement planning and evidence-based shoreline management across the Niger Delta and similar deltaic environments.

Policy Recommendations

The varying shoreline-change patterns observed in Abonnema, Degema and Idama indicate that coastal settlement planning within the Sombreiro River corridor should adopt risk-based, location-specific management rather than uniform interventions. The DSAS results provide an evidence base for integrating shoreline dynamics into physical planning, development control and community land-use decisions.

High-risk eroding communities (Degema)

Given its severe erosion and high shoreline variability, Degema should be designated as a Priority Shoreline Management Area. The erosion hotspot at Transect 45 should be incorporated into local development plans as a shoreline hazard zone where new development is restricted. Shoreline stabilisation should combine engineered protection measures with mangrove restoration, while vulnerable infrastructure should be assessed for protection or phased relocation. Regular shoreline monitoring and community awareness programmes should support adaptive management.

Moderate-risk eroding communities (Abonnema)

Planning in Abonnema should focus on targeted management of the Transect 19 hotspot through bank stabilisation, reinforcement of existing embankments where necessary and mangrove restoration. Development setbacks should be enforced along vulnerable waterfront sections, and activities that accelerate erosion, including indiscriminate dredging, sand mining and vegetation removal, should be regulated. Periodic DSAS monitoring should be maintained to assess shoreline changes and the effectiveness of implemented interventions.

Stable and accreting communities (Idama)

The accretion observed in Idama should be managed through conservation rather than intensive waterfront development. Newly accreted land should not be allocated for permanent development until its long-term stability is confirmed. Mangroves, mudflats and other sediment-trapping environments should be protected, while precautionary development setbacks should be maintained because localised erosion remains evident around Transect 28.

Cross-cutting Planning and Institutional Measures

DSAS-derived shoreline-risk information should be integrated into physical development plans, environmental impact assessments and development control processes. Shoreline setbacks should be based on observed erosion rates and shoreline variability rather than fixed distances. Planning authorities should collaborate with traditional institutions and community development committees to discourage development within active erosion zones and promote expansion towards more stable inland areas. A coordinated shoreline management framework should also be established for the Sombreiro River corridor to ensure consistent and integrated management.

Implementation Framework for Planners and Decision-Makers

Implementation should follow a risk-based zoning approach, classifying severely eroding areas as High-Risk (No-Build) Zones, moderately eroding areas as Controlled Development Zones, and stable or accreting areas as Conservation and Managed-Use Zones. Short-term actions should include hotspot verification, shoreline-risk mapping and restriction of development within high-risk areas. Medium-term priorities should focus on shoreline stabilisation, mangrove restoration and selective relocation of highly exposed infrastructure, while long-term actions should institutionalise DSAS monitoring every three to five years and integrate shoreline data into planning and development control. Successful implementation will depend on collaboration among planning authorities, environmental agencies, traditional institutions, community organisations and local residents to promote sustainable coastal settlement planning along the Sombreiro River corridor.

Future Research Directions

Several research gaps emerge from this study. First, the analysis relied on four shoreline positions over a 15-year window; denser temporal sampling, incorporating additional epochs and higher-resolution imagery, would reduce regression confidence intervals – particularly at highly variable reaches such as Degema – and enable detection of episodic versus progressive change. Second, the present study quantified shoreline change but did not directly measure its physical drivers; coupled investigations of tidal hydrodynamics, fluvial sediment flux, bank geotechnical properties and relative sea-level change are needed to attribute the observed trends to specific processes. Third, future work should integrate shoreline-change statistics with socio-economic and infrastructure exposure data to produce quantitative vulnerability and risk indices for coastal settlements. Fourth, predictive modelling – for example using shoreline-forecasting tools and climate-change scenarios – would support proactive, anticipatory planning. Finally, extending the analysis to a larger sample of Niger Delta communities and longer time series would allow the patterns identified here to be generalised and would strengthen the regional evidence base for coastal adaptation policy.

CONCLUSION

This study quantified shoreline change in three Niger Delta communities along the Sombreiro River using the Digital Shoreline Analysis System and multi-temporal satellite imagery spanning 2005 to 2020. The analysis revealed strikingly divergent shoreline trajectories: Degema is undergoing severe and spatially variable erosion (LRR = −2.07 m/yr), Abonnema is experiencing moderate but persistent erosion (LRR = −0.75 m/yr) localised at a distinct hotspot, and Idama is dominated by accretion (LRR = +0.73 m/yr), making it the only community gaining land. The close agreement between the LRR and WLR statistics across all communities supports the robustness of the derived trends and the consistency of the historical shoreline dataset.

These findings demonstrate that shoreline behaviour in the estuarine Niger Delta is highly heterogeneous and cannot be managed effectively through uniform, one-size-fits-all interventions. Instead, the differentiated risk profiles of eroding, moderately eroding and accreting communities call for tailored, ecosystem-based and risk-informed responses, ranging from urgent stabilisation and managed retreat at Degema to conservation of favourable conditions at Idama. By providing a replicable, transect-level evidence base and translating it into actionable planning recommendations, the study contributes both to the scientific understanding of deltaic shoreline dynamics and to the practical task of building resilient coastal settlements in the Niger Delta. Sustained monitoring, the institutionalisation of shoreline-change intelligence within statutory planning, and continued research into the underlying drivers remain essential to safeguarding these vulnerable communities.

The findings should, however, be interpreted with recognition of the study's data and methodological constraints. The shoreline positions were derived from satellite imagery and are therefore subject to uncertainties associated with image resolution, tidal variation, shoreline proxy selection and the complexity of mangrove-fringed estuarine environments. While the consistency between LRR and WLR supports the reliability of the observed trends, the results should be complemented with field validation, higher-resolution imagery, hydrodynamic data and socio-economic exposure assessment in future planning applications.

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