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(Research Article)

Evaluation of the recovery of mangroves in Apparambie creek, Niger delta, 9 years after chronic pollution

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Abstract

This study evaluated the recovery status of mangrove vegetation in Apparanbie Creek, Niger Delta, nine years after chronic petroleum pollution. The assessment focused on mangrove structural growth, species composition, and sediment contamination in order to determine the extent of ecological recovery. Three sampling stations were established along the creek, and three mangrove trees were measured per station. Mangrove height and stem girth were measured as indicators of structural development, The results show that mangroves at Station C recorded the highest mean height (8.08 m) and girth (15.64cm), followed by Station B (6.92 m) and girth (11.73cm) , while Station A had the lowest mean height (6.31m) and girth (9.64cm). The findings indicate that Apparanbie Creek is undergoing partial ecological recovery, characterized by natural regeneration of *Rhizophora racemosa* but limited by persistent sediment contamination and incomplete species restoration. The study underscores the need for continued monitoring, effective pollution control, and active restoration strategies to enhance long-term recovery of mangrove ecosystems in the Niger Delta.

Keywords: Mangroves; Recovery; Pollution; Restoration

1. Introduction

Mangrove ecosystems are unique intertidal forests found along tropical and subtropical coastlines, where they occupy the interface between terrestrial and marine environments. They are highly productive ecosystems that provide essential ecological services such as shoreline stabilization, nutrient cycling, carbon sequestration, fisheries support, and protection against coastal erosion and storm surges (Alongi, 2015; Friess *et al.*, 2019).

The Niger Delta region of Nigeria hosts the largest mangrove forest in Africa and one of the most extensive globally. These mangroves play a crucial role in sustaining biodiversity and supporting the livelihoods of local communities through fishing, fuelwood collection, and other ecosystem services (Duke *et al.*, 2019). Dominant mangrove species in the Niger Delta include *Rhizophora racemosa* (red mangrove), *Avicennia germinans* (black mangrove), and *Laguncularia racemosa* (white mangrove).

Despite their ecological importance, mangrove ecosystems in the Niger Delta have been severely degraded due to anthropogenic activities, particularly chronic pollution from crude oil exploration, illegal refining, pipeline vandalism, and industrial effluents. These activities introduce petroleum hydrocarbons, including polycyclic aromatic hydrocarbons (PAHs), into mangrove sediments, leading to reduced soil quality, inhibited plant growth, and large-scale mangrove mortality (Nwankwoala *et al.,* 2017).

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Apparanbie Creek, located within the Niger Delta, experienced prolonged exposure to petroleum-related pollution in the past, resulting in significant mangrove degradation. However, following reduced pollution pressure and natural attenuation processes, signs of vegetation regrowth have been observed over the years. Evaluating the recovery of mangrove ecosystems after pollution is essential for understanding ecosystem resilience, guiding restoration efforts, and informing environmental management policies (Alongi, 2020).

This study therefore focuses on assessing the recovery status of mangrove vegetation in Apparanbie Creek nine (9) years after chronic pollution by examining structural growth parameters, species composition, and sediment PAH contamination levels.

1.1. Statement of the Problem

Chronic petroleum pollution has resulted in extensive degradation of mangrove ecosystems across the Niger Delta, with long-lasting ecological and socio-economic consequences. In many polluted creeks, mangrove defoliation, stunted growth, and species loss have been widely reported, often persisting for years even after pollution sources are reduced (Duke *et al*., 2019).

Although natural regeneration of mangroves can occur over time, recovery is often slow and uncertain, especially in areas where residual hydrocarbon contamination remains in the sediment. Persistent PAHs can inhibit root respiration, reduce nutrient uptake, and negatively affect seedling establishment, thereby delaying ecosystem recovery (Alongi, 2018).

In Apparanbie Creek, anecdotal observations suggest partial mangrove regrowth several years after chronic pollution; however, there is limited scientific data quantifying the extent of recovery. The absence of documented information on mangrove growth performance, species composition, and sediment hydrocarbon levels makes it difficult to determine whether the ecosystem is truly recovering or remains under ecological stress.

Without such empirical assessment, effective conservation strategies, restoration planning, and policy decisions cannot be adequately informed. This study seeks to address this gap by providing a scientific evaluation of mangrove recovery in Apparanbie Creek nine years after chronic pollution.

1.2. Scope of the Study

This study is limited to Apparanbie Creek in the Niger Delta region of Nigeria. The research focuses specifically on measurement of mangrove structural growth parameters, including height and stem girth, identification of mangrove species present in the study area. The study does not include faunal assessment or socio-economic impacts of mangrove degradation. Emphasis is placed on vegetation recovery and sediment quality as indicators of ecosystem restoration.

1.3. Aim and Objectives of the Study

The aim of this study is to evaluate the recovery status of mangrove vegetation in Apparanbie Creek, Niger Delta, nine (9) years after chronic pollution. The specific objectives of the study are:

- To measure the height of mangrove stands in the study area.
- To determine the stem girth of mangrove trees as an indicator of growth and structural development.
- To Identify the mangrove species present in the impacted areas of Apparanbie Creek.

2. Materials and methods

2.1. Description of the Study Area

This study was carried out in Apparanbie Creek, located within the Niger Delta region of Nigeria. The Niger Delta lies approximately between latitudes 4°30′–6°30′ N and longitudes 5°00′–8°00′ E and represents one of the largest wetland ecosystems in Africa. Apparanbie Creek is a tidal creek system characterized by low-energy hydrodynamic conditions, which favor the accumulation of fine sediments and organic matter typical of mangrove ecosystems.

The area experiences a humid tropical climate, with mean annual rainfall exceeding 2,500 mm and average temperatures ranging between 26°C and 30°C. The creek is influenced by both freshwater input from inland sources and saline tidal inflow from the Atlantic Ocean, resulting in fluctuating salinity regimes that support mangrove vegetation.

Historically, Apparanbie Creek was subjected to chronic petroleum pollution from oil exploration activities, pipeline leakage, and artisanal refining. These activities led to severe degradation of mangrove stands (Gijo, 2017). However, nine years after the major pollution events, observable natural regeneration of mangrove vegetation has occurred, making the creek suitable for assessing post-pollution ecosystem recovery. The dominant mangrove species encountered during the study were red mangrove (*Rhizophora racemosa*), which are characteristic species of the Niger Delta mangrove zone (Alongi, 2020).

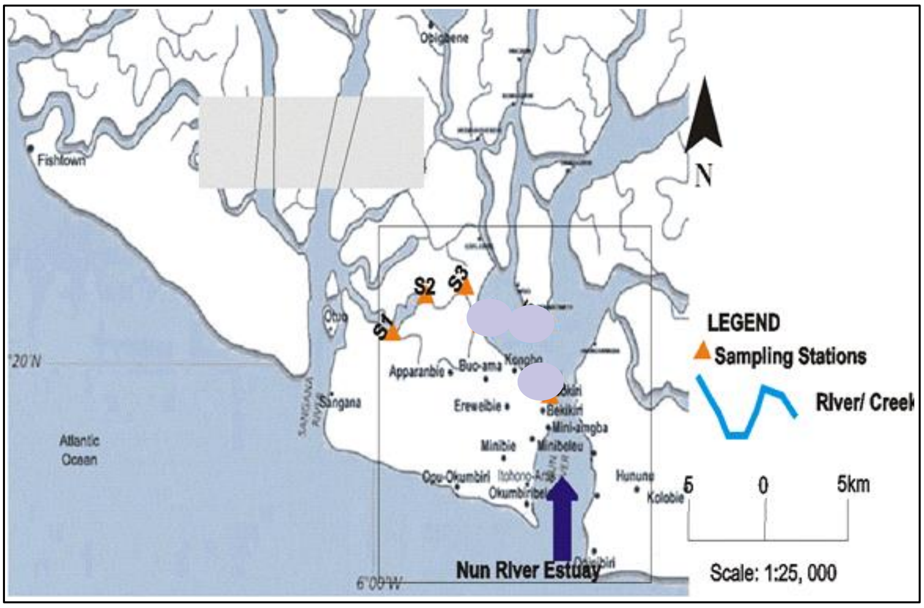

Figure 1 Map of the Study Area

2.2. Description of Sampling Stations

Three sampling stations were established based on the history of the impacts of the chronic pollution of the creek. The mangroves were seriously impacted in these areas of the creek. However, they are currently recovering.

2.2.1. Sampling station 1

This sampling station was established close to a defunct artisanal refinery established in Apparanbie Creek around Apparanbie community. The mangroves in this area were massively destroyed by the chronic pollution as reported by Gijo (2017). The Global Positioning System (GPS) coordinates of station 1 are N4^{0}21’35.3484” and E6^{0}1’46.9128”. The site currently has red mangrove vegetation. The crude oil is still persistent in the soil of this sampling station. The mangroves were measured in this sampling station.

A	B

Figure 2 A &B Sampling station 1 in 2016, shortly after the chronic pollution

A B C

Figure 3 A-C Current State of sampling station 1 (2025)

2.2.2. Sampling station 2

Sampling station 2 is situated opposite to sampling station 1, still in Apparanbie creek. The sampling station is located on latitude of N4^{0}21’54.4212” and a longitude of E6^{0}2’7.5804”. Red mangroves are present in this sampling station and an inhabited area that is without mangrove vegetation. This station also experienced massive mangrove mortality due to the chronic pollution. The area is less polluted compared to sampling station 1. The mangroves were measured in this sampling station.

A B C

Figure 4 A-C Sampling station 2 in 2016, shortly after the chronic pollution (Gijo, 2017)

A B

Figure 5 A &B Current state of sampling station 2 (2025)

2.2.3. Sampling station 3

The last sampling station, station 3, was also established in Apparanbie Creek located around Apparanbie community. This sampling station was established on one of the Makeshift oil refineries in Apparanbie Creek. The GPS coordinates of this sampling station are latitude N4^{0}21'44.5644" and longitude E6^{0}2'20.2272". The site has **red** mangrove vegetation. The site was highly polluted by crude oil and mangroves were massively destroyed, just like station 1 of the study area (Apparanbie creek).

Figure 6 A & B: Sampling station 3 in 2016, shortly after the chronic pollution (Gijo, 2017)

Figure 7 A &B : Current state of sampling station 3 (2025)

2.3. Study Design and Sampling Strategy

A randomized block experimental design was adopted to assess mangrove recovery using vegetation growth parameters and sediment quality indicators. The study employed a systematic sampling approach to ensure representative coverage of the creek.

The study area was divided into three sampling stations (Station A, Station B, and Station C) which were areas that were adversely affected by the chronic crude oil pollution. There was massive death or mortality of mangroves in these areas and the mangroves are currently recovering.

Within each station, 3 sampling points were randomly selected to minimize sampling bias. This design allowed for spatial comparison of mangrove growth performance and sediment contamination across the creek.

2.4. Identification of Mangrove Species

Mangrove species present at each sampling station were identified *in situ* using standard morphological characteristics such as leaf shape, root structure, bark texture, and growth habit. Species identification was carried out with reference to standard mangrove identification guides and regional floras (Alongi, 2015). The mangrove species that was identified in the impacted areas during the study was the Red mangrove (*Rhizophora racemosa*). The relative presence of the species at the sampling stations was recorded to assess species composition as an indicator of ecosystem recovery.

2.5. Measurement of Mangrove Growth Parameters

Mangrove growth performance was assessed using tree height and stem girth, which are widely accepted indicators of structural development and biomass accumulation in mangrove ecosystems (Duke *et al.,* 2019).

2.6. Measurement of Mangrove Height

Mangrove height was measured using a graduated measuring pole. Measurements were taken from the base of the roots at ground level to the highest apical point of the tree. Care was taken to ensure that measurements were taken vertically and accurately. Multiple individuals of the identified species were measured at each station, and the average height was calculated to represent growth conditions at that station.

2.7. Measurement of Stem Girth

Stem girth was measured at breast height (1.3 m above ground level) using a flexible measuring tape. For trees with multiple stems or prop roots, the main stem was selected for measurement. Stem girth was recorded in centimeters and used as an indicator of tree maturity and structural stability.

2.8. Data Analysis

Data obtained from mangrove height, stem girth, species composition, Mean values and standard deviations were calculated to summarize the data.

Results were presented in tables and used to evaluate the recovery status of mangrove vegetation in Apparanbie Creek nine years after chronic pollution. Interpretation of findings was carried out in relation to established ecological thresholds and relevant scientific literature.

3. Results

3.1. Mangrove Species Composition

Field observation across all sampling stations revealed the presence of only one mangrove species, the red mangrove (*Rhizophora racemosa*). This species was recorded in all three sampling stations, indicating a uniform species composition within the study area.

The height of mangrove trees measured at the three sampling stations is presented in Table 1. Three mangrove trees were measured per station. The results show that mangroves at Station C recorded the highest mean height (8.60 m), followed by Station B (6.92 m), while Station A had the lowest mean height (6.31 m). The stem girth of mangrove trees measured at the three sampling stations is presented in Table 2. Stem girth measurements followed a similar trend to height measurements. Station C recorded the highest mean stem girth (15.64 cm), while Station A had the lowest mean stem girth (9.64 cm).

Table 1 Height (m) of Mangrove Trees at the Sampling Stations

SAMPLING STATIONS	TREE 1 (m)	TREE 2 (m)	TREE 3 (m)	MEAN AND STANDARD DEVIATION
STATION A	6.40	6.74	5.80	6.31±0.47
STATION B	7.20	6.56	7.00	6.92±0.33
STATION C	8.20	7.44	8.60	8.60±0.58

Table 2 Stem Girth (cm) of Mangrove Trees at the Sampling Stations

SAMPLING STATIONS	TREE 1 (Cm)	TREE 2 (Cm)	TREE 3 (Cm)	MEAN AND STANDARD DEVIATION
STATION A	8.93	9.40	10.60	9.64±0.83
STATION B	12.80	12.20	10.20	11.73±1.30
STATION C	16.73	16.00	14.20	15.64±1.20

4. Discussion

The results obtained from the assessment of mangrove recovery in Apparanbie Creek provide important insight into the structural and ecological status of the mangrove ecosystem nine years after chronic petroleum pollution. The study evaluated mangrove growth parameters (height and stem girth), and species composition to determine the extent of ecosystem recovery.

The identification of only one mangrove species, *Rhizophora racemosa*, across all sampling stations indicates low species diversity within the study area. This condition is typical of mangrove ecosystems recovering from severe and prolonged environmental disturbances such as oil pollution. According to Duke *et al.* (2018), chronic hydrocarbon contamination often leads to selective survival of tolerant mangrove species, while sensitive species fail to re-establish even several years after pollution cessation. The dominance of *Rhizophora racemosa* in Apparanbie Creek can be attributed to its high tolerance to anoxic and contaminated sediments and extensive prop root system that enhance survival under stressful conditions.

Mangrove height and stem girth measurements revealed clear spatial variation among sampling stations. Mangroves at Station B recorded the highest mean height and stem girth, while Station A consistently recorded the lowest values. These differences reflect variations in environmental conditions, particularly sediment quality and historical pollution intensity. Height and girth are important indicators of long-term growth performance, biomass accumulation, and ecosystem productivity (Friess *et al*., 2019). The moderate values recorded in this study indicate that the mangroves are in a secondary growth stage, consistent with ecosystems undergoing natural regeneration rather than full recovery. When compared with undisturbed mangrove forests in the Niger Delta, which typically exhibit greater heights and thicker stems, the results suggest that structural development in Apparanbie Creek is still constrained.

Overall, the findings indicate that Apparanbie Creek is undergoing partial ecological recovery. Structural regeneration of *Rhizophora racemosa* is evident, demonstrating the resilience of mangroves and their capacity for natural regeneration. According to Alongi (2020), complete restoration of mangrove ecosystems following chronic oil pollution may take several decades, particularly where sediment contamination is not actively remediated.

The mangrove ecosystem in Apparanbie Creek shows positive signs of recovery nine years after chronic pollution, but the recovery remains incomplete. Continued monitoring, pollution control, and active restoration measures are required to facilitate full ecological restoration and enhance long-term sustainability of the mangrove ecosystem.

5. Summary

This study assessed the recovery of mangrove vegetation in Apparanbie Creek, Niger Delta, nine years after chronic petroleum pollution. Only one species, the red mangrove (*Rhizophora racemosa*), was observed across all three sampling stations. Mangrove height and stem girth were measured for three trees per station. The results show that mangroves at Station C recorded the highest mean height (8.08 m) and girth (15.64cm), followed by Station B (6.92 m) and girth (11.73cm), while Station A had the lowest mean height (6.31m) and girth (9.64cm). Overall, the ecosystem shows partial recovery, with natural regeneration of *Rhizophora racemosa*, but persistent sediment contamination and low species diversity continue to limit full ecological restoration.

6. Conclusion

The study has shown that Apparanbie Creek is undergoing partial ecological recovery nine years after chronic petroleum pollution. Natural regeneration of the red mangrove (*Rhizophora racemosa*) is evident, with measurable growth in height and stem girth, particularly in areas with lower sediment PAH concentrations. However, the mangrove ecosystem remains structurally and biologically constrained, as indicated by moderate growth parameters compared to undisturbed mangroves and persistent sediment contamination by polycyclic aromatic hydrocarbons (PAHs).

These findings highlight that while the ecosystem demonstrates resilience, full recovery has not been achieved, and continued human and natural pressures may further impede restoration. Therefore, targeted intervention, pollution control, and active restoration efforts are essential to accelerate ecological recovery and enhance the long-term sustainability of the mangrove ecosystem in Apparanbie Creek.

Recommendations

Based on the findings of this study, the following recommendations are proposed to enhance mangrove recovery and ensure sustainable management of Apparanbie Creek:

- Continuous Environmental Monitoring

Regular monitoring of mangrove growth parameters and sediment PAH concentrations should be conducted to assess long-term recovery trends and detect potential recontamination at early stages.

- Strict Pollution Control and Enforcement

Environmental regulations governing oil exploration, transportation, and waste disposal should be strictly enforced to prevent future petroleum spills and illegal refining activities within the creek and its surroundings.

- Community Participation and Awareness

Local communities should be actively involved in mangrove conservation through environmental education programs and community-based management initiatives to reduce anthropogenic pressure on mangrove resources.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Alongi, D. M. (2015). The impact of climate change on mangrove forests. Current Climate Change Reports, 1(1), 30–39.

[2] Alongi, D. M. (2018). Mangrove forests: Resilience, protection from tsunamis, and responses to global climate change. Estuarine, Coastal and Shelf Science, 76, 1–13.

[3] Alongi, D. M. (2020). Global significance of mangrove blue carbon in climate change mitigation. Science, 349(6250), 1327–1332.

[4] Duke, N. C., Meynecke, J. O., Dittmann, S., Ellison, A. M., Anger, K., Berger, U., Cannicci, S., Diele, K., Ewel, K. C., Field, C. D., Koedam, N., Lee, S. Y., Marchand, C., Nordhaus, I., & Dahdouh-Guebas, F. (2019). A world without mangroves? *Science*, 317(5834), 41–42.

[5] Gijo, A. H. (2017). The Impacts of Makeshift Crude Oil Refinery Activities on the Mangroves and Benthic Macro Invertebrates of the Nun River Estuary, Niger Delta. Nigeria. Ph.D. dissertation submitted to the Department of Animal and Environmental Biology, University of Port Harcourt, Choba, Nigeria. Pp. 45-50.

[6] Nwankwoala, H. O., & Ekweozor, I. K. E. (2017). Environmental degradation and mangrove ecosystem loss in the Niger Delta. *International Journal of Environmental Studies*, 74(4), 1–15.