Assessing the Impact of Seasonal Flooding on Fleet Transport Disruption and Road Infrastructure Damage in Orashi Region, Rivers State, Nigeria.

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ABSTRACT

Seasonal flooding in the Orashi Region of Rivers State, Nigeria, poses persistent challenges to transport networks, road infrastructure, and local livelihoods, yet the scale and specific impacts on affected stakeholders remain poorly documented. Recurrent overflow of the Orashi River, combined with inadequate drainage systems, frequently submerges roads, isolates communities, and disrupts daily economic activities, highlighting an urgent need for empirical assessment of these impacts. This study investigated the effects of seasonal flooding on transport operations, road conditions, and community well-being in the region. A structured survey was administered to a diverse sample of stakeholders, including fleet operators (50.0%), commuters/passengers (42.9%), local residents (28.6%), and officials/local leaders (10%). The majority of respondents were aged 20–39 years (especially 30–39 at 44.3%), representing economically active adults most vulnerable to flooding-related disruptions. Findings indicate that inadequate drainage and river overflow significantly disrupt fleet operations and accelerate road degradation through erosion, potholes, and washouts. Travel delays, economic losses, and safety hazards were commonly reported, with many respondents residing or operating within 2 km of flood-prone roads and 42.9% using affected routes daily. Road damage was predominantly critical (30.0%) or severe (41.4%), while moderate to severe erosion was reported by 64.3% of participants, reflecting widespread deterioration of transport corridors. Mean Likert scores further revealed high perceptions of flood frequency (overall 4.35) and associated impacts, with fleet operators reporting the highest severity for travel delays and the need for improved drainage. Correlation analyses demonstrated very strong positive relationships ($r = 0.894$–0.975, $p \leq 0.041$) between flood frequency and all measured impacts, including mobility disruption, economic loss, safety risks, and demand for drainage improvements. These results confirm that recurrent flooding is a primary driver of cascading negative effects on transport networks, livelihoods, and community well-being. The study underscores the urgent need for targeted flood mitigation strategies, resilient road design, and systematic drainage maintenance to enhance transport reliability, safeguard livelihoods, and improve resilience in flood-prone riverine areas of the Niger Delta.

Keywords: Seasonal flooding, Fleet transport disruption, Road infrastructure damage, Transport disruption, Climate change impacts

INTRODUCTION

Seasonal flooding remains a recurrent and significant climate hazard in Nigeria, with particularly pronounced effects in riverine and low-lying areas such as the Orashi region of Rivers State (Ann, 2024; Ogboeli et al., 2024). Situated along the Orashi River and its tributaries, the region experiences frequent rainfall-driven inundation during the wet season, which disrupts human settlements, economic activities, and critical infrastructure. These seasonal floods not only threaten lives, livelihoods, and property but also severely undermine transportation systems that are essential for regional trade, mobility, and access to essential services (Andreasen et al., 2022; Ogboeli et al., 2024). The vulnerability of these systems underscores the urgent need for targeted empirical studies on flood impacts to inform effective planning and mitigation strategies.

Transportation infrastructure, particularly road networks and fleet transport operations, constitutes the backbone of economic connectivity in the Orashi region. In flood-prone areas, roads are frequently submerged, eroded, or structurally compromised during peak rainfall periods, leading to severe mobility restrictions (Iheduru et al., 2024; Ogboeli et al., 2026). Flood events often result in pavement failures, washouts, and pothole formation, rendering many roads impassable for extended periods. The resulting consequences include prolonged travel times, increased vehicle operating costs, and heightened safety risks for commuters and freight operators (Enimola, 2020; Iheduru et al., 2024).

The socio-economic impacts of seasonal flooding are far-reaching. Submerged and damaged roads disrupt the movement of goods and services, limit access to markets, and interrupt daily commuting patterns (Ogboeli et al., 2024). Comparable studies in flood-prone African cities, such as Accra, Ghana, have shown that recurrent flooding causes significant mobility disruptions, disproportionately affecting vulnerable populations and impeding economic productivity (Andreasen et al., 2022). Similarly, in Nigeria, research from Port Harcourt and other Niger Delta areas indicates that flooding accelerates road edge erosion, damages bridges and culverts, and leads to cumulative deterioration of road surfaces (Ikechukwu, 2015; Iheduru et al., 2024; Ogboeli et al., 2026). These impacts highlight the increasing vulnerability of transportation infrastructure to extreme weather events and the critical need for proactive resilience measures.

Frequent flooding also exerts considerable pressure on infrastructure maintenance and post-flood recovery efforts. Studies examining two decades of flood management in Nigeria reveal persistent damage, high repair costs, and institutional challenges in rehabilitating critical infrastructure (Abubakar & Shafii, 2025). Furthermore, climate change-exacerbated heavy rainfall continues to compromise road foundations and drainage systems, resulting in more frequent transport disruptions and substantial economic losses (Enimola, 2020).

Understanding the specific effects of seasonal flooding on transportation systems is therefore essential for developing climate-resilient infrastructure, effective disaster response mechanisms, and sustainable economic planning in the Niger Delta. The Orashi region's heavy reliance on road transport for mobility and commerce makes it particularly susceptible to flood-induced disruptions. A detailed assessment of these impacts is crucial for providing policymakers, transport operators, and community planners with evidence-based insights to enhance planning, maintenance, and mitigation strategies (Andreasen et al., 2022).

This study aims to assess the impact of seasonal flooding on fleet transport disruption and road infrastructure damage in the Orashi region of Rivers State, Nigeria, with a view to providing evidence-based recommendations for improving infrastructure resilience, transport planning, and flood mitigation strategies.

Objectives of the Study:

1. examine the extent and patterns of road infrastructure damage caused by seasonal flooding in the Orashi region.
2. evaluate the effects of seasonal flooding on fleet transport operations, including mobility disruptions, delays, and accessibility challenges.
3. identify strategies and interventions that can enhance the resilience of road networks and transport systems against seasonal flood events.

THEORETICAL FRAMEWORK OF THE STUDY

The theoretical framework provides the conceptual lens through which the impact of seasonal flooding on fleet transport disruption and road infrastructure damage can be understood. This study is anchored on three theories that explain infrastructure vulnerability, disaster impact, and transport disruption dynamics.

1. Vulnerability Theory: Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (2004)

Vulnerability theory posits that the impacts of natural hazards, such as floods, are not solely determined by the hazard itself but by the susceptibility and exposure of the affected system or community. It emphasizes social, economic, and infrastructural factors that determine how severely a hazard affects a population or infrastructure. This theory is crucial for understanding how road infrastructure and fleet transport in the Orashi region are vulnerable to seasonal flooding. It helps the study examine why certain roads and transport operations suffer more disruptions, considering both environmental exposure and infrastructural fragility. By applying this theory, the study can identify which elements of the transport network are most at risk and prioritize interventions.

2. Systems Theory: Bertalanffy, L. (1968)

Systems theory views complex entities as interrelated components functioning together. In the context of transport, it conceptualizes roads, vehicles, traffic management, and infrastructure maintenance as a networked system where the failure of one part (e.g., roads) affects the functioning of the whole system (fleet transport). This theory is important because seasonal flooding disrupts not just isolated roads but the entire transport system in the Orashi region. By applying systems theory, the study can analyze how flood-induced damage to roads cascades into fleet transport delays, operational inefficiencies, and wider economic impacts, offering a holistic perspective for planning resilient transport networks.

3. Disaster Risk Reduction (DRR) Theory: Wisner, B., Gaillard, J.C., & Kelman, I. (2012)

DRR theory focuses on identifying, assessing, and mitigating risks from hazards before they occur. It emphasizes preparedness, risk assessment, infrastructural resilience, and strategic planning to reduce the negative effects of natural hazards. DRR theory informs strategies for managing the impact of seasonal flooding on fleet transport and road infrastructure. By framing the study through DRR, the research can highlight proactive measures, such as improved road construction, drainage systems, and emergency transport planning, that can reduce disruption and infrastructural damage, providing actionable insights for policymakers and stakeholders in the Orashi region.

By integrating Vulnerability Theory, Systems Theory, and Disaster Risk Reduction Theory, this study establishes a comprehensive theoretical foundation. Vulnerability theory identifies why infrastructure and transport are susceptible to flooding, systems theory explains the interconnectivity of transport components affected by flood events, and DRR theory guides practical mitigation and resilience strategies. Together, these theories provide a robust framework for analyzing the impact of seasonal flooding on fleet transport disruption and road infrastructure damage in the Orashi region, Rivers State, Nigeria

MATERIALS AND METHODS

The study was conducted in the Orashi region of Rivers State, Nigeria, a riverine area characterized by low-lying terrain, multiple waterways, and seasonal flooding during the rainy season. The area is an important hub for fleet transport and road-based movement of goods, services, and passengers, making it highly sensitive to flood events. Roads in the region vary from major paved highways to unpaved rural access routes, many of which are prone to erosion and damage during flood events.

The study adopted a descriptive cross-sectional research design combined with a field-based observational approach. This design enabled the collection of both quantitative and qualitative data on road infrastructure conditions, fleet transport disruptions, and seasonal flood impacts at specific points within the Orashi region. The cross-sectional approach is suitable because it captures the extent of disruption and infrastructural damage at a specific period (wet season) while allowing for comparison across multiple sites.

The population of this study comprised:

Fleet transport operators (bus drivers, vehicle owners, boat operators) who experience operational disruptions during flooding.

Commuters and passengers who rely on roads and fleet transport in the region.

Infrastructure and maintenance officials responsible for road upkeep and repair.

Local residents and traders affected by road closures and transportation delays.

The total population is estimated at approximately 1,200 active transport stakeholders within the study area.

A sample size of 140 respondents was selected using stratified random sampling to ensure representation of key stakeholder groups (fleet operators, commuters, local residents, and officials). Stratification was based on occupation and proximity to flood-prone roads to capture diverse experiences of transport disruption and road damage. Random sampling within each stratum ensured unbiased selection of respondents for questionnaire administration.

Data were collected using structured questionnaires, field observation checklists, and photographic documentation.

Questionnaires: These were administered to fleet operators, passengers, and residents to capture perceptions of transport disruption, frequency of flood events, and impacts on road infrastructure. The questionnaire included Likert-scale items and open-ended questions.

Observation checklists: Field inspections were conducted to assess road surface conditions, erosion, potholes, washouts, and accessibility during flood periods.

Photographic evidence: Photos of damaged roads, submerged areas, and affected vehicles were taken to supplement survey data.

The questionnaire was pre-tested among 10 respondents outside the study sites to ensure clarity, relevance, and reliability of items. Cronbach's Alpha was used to determine internal consistency, yielding a reliability coefficient of 0.87, indicating high reliability.

Data collection was carried out during the peak rainy season (May–July 2025) to capture the effects of seasonal flooding. Enumerators visited identified road sections and transport hubs, administering questionnaires and recording observations. Ethical considerations, including informed consent, voluntary participation, and anonymity, were strictly observed.

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Quantitative data from questionnaires were coded and analyzed using SPSS version 26. Descriptive statistics, including frequencies, percentages, and mean scores, were used to summarize responses on road infrastructure conditions and fleet transport disruption. Inferential statistics, including Chi-square tests and correlation analysis, were applied to assess relationships between flood intensity, road damage, and transport disruption.

Qualitative data from open-ended questions and field observations were analyzed thematically, identifying recurrent patterns, impacts, and suggested mitigation strategies. Photographic documentation was used to support qualitative descriptions and provide visual evidence of damage.

Ethical Considerations: Approval for the study was obtained from local community authorities, and participants were fully informed about the purpose of the study. Participation was voluntary, with respondents allowed to withdraw at any stage. Personal identifiers were excluded to ensure confidentiality, and all data were stored securely.

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Figures illustrating the severe flood-induced destruction of the Ahoada–Omoku Expressway.

RESULT

Demographics of Respondents

Respondent Category	Age Group	Frequency	Percentage (%)
Fleet Operators	20–29	15	10.7
	30–39	25	17.9
	40–49	20	14.3
	50 and above	10	7.1
Commuters/Passengers	20–29	18	12.9
	30–39	22	15.7
	40–49	15	10.7
	50 and above	5	3.6
Local Residents	20–29	10	7.1
	30–39	15	10.7
	40–49	10	7.1
	50 and above	5	3.6

Proximity Category	Frequency	Percentage (%)
Very Close (<500 m)	40	28.6
Close (0.5–2 km)	55	39.3
Moderate (2–5 km)	45	32.1

Usage Frequency	Frequency	Percentage (%)
1–2 times/week	25	17.9
3–4 times/week	35	25.0
5–6 times/week	20	14.3
Daily	60	42.9

Flood Frequency	Frequency	Percentage (%)
Rarely (1–2 times/year)	20	14.3
Occasionally (3–4 times/year)	35	25.0
Frequently (5–6 times/year)	45	32.1
Very Frequently (Annually during rainy season)	40	28.6

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Road Erosion Severity	Frequency	Percentage (%)
Minimal	25	17.9
Moderate	50	35.7
Severe	40	28.6
Very Severe	25	17.9

Key Summary Statistics

Stakeholder Group Distribution

- Fleet Operators: 35 (25%)
- Commuters/Passengers: 56 (40%)
- Local Residents: 35 (25%)
- Officials/Local Leaders: 14 (10%)

Overall, Road Damage Severity

- Critical: 42 (30.0%)
- Severe: 58 (41.4%)
- Moderate: 32 (22.9%)
- Minimal: 8 (5.7%)

Mean Likert Scores by Stakeholder Group (1–5 scale)

Stakeholder Group	Flood Frequency	Road Erosion	Potholes/ Washouts	Travel Delay	Economic Loss	Safety Hazard	Need Improved Drainage
Fleet Operators	4.6	4.5	4.7	4.8	4.7	4.6	4.9
Commuters/Passengers	4.2	4.1	4.3	4.5	4.2	4.4	4.7
Local Residents	4.4	4.3	4.4	4.3	4.4	4.5	4.8
Officials	4.1	4.0	4.2	4.2	4.1	4.6	4.9
Overall	4.35	4.25	4.40	4.48	4.35	4.52	4.82

Correlation Analysis

The primary objective was to measure the strength and direction of the linear relationships among Flood Frequency: Road Erosion, Potholes/Washouts, Travel Delay, Economic Loss, Safety Hazard, and Need for Improved Drainage.

Hypothesis:

H_0 (null): Flood frequency is not linearly related to road erosion, potholes/washouts, travel delay, economic loss, safety hazards, or the perceived need for improved drainage.

Variable X = Flood Frequency

Variable Y = Road Erosion, Potholes/Washouts, Travel Delay, Economic Loss, Safety Hazard, and Need for Improved Drainage.

Sample size n = 140

Correlation Results: Flood Frequency with Flood-Related Impacts

Variable (Y)	Pearson's r	p-value	Strength of Correlation
Road Erosion	0.947	0.015	Very strong positive
Potholes/Washouts	0.894	0.041	Very strong positive

Travel Delay	0.894	0.041	Very strong positive
Economic Loss	0.975	0.005	Extremely strong positive
Safety Hazard	0.975	0.005	Extremely strong positive
Need for Improved Drainage	0.975	0.005	Extremely strong positive

DISCUSSION

The study conducted in the Orashi Region of Rivers State revealed a diverse group of stakeholders, comprising fleet operators (25.0%), commuters/passengers (40.0%), local residents (25.0%), and officials/local leaders (10.0%). The majority of respondents were aged 20–39 years, with those in the 30–39 age bracket constituting 44.3%. This demographic represents economically active adults who are most vulnerable to the disruptive effects of seasonal flooding on transportation and livelihoods. Recurrent overflow of the Orashi River, exacerbated by inadequate drainage systems, was found to severely disrupt fleet operations and accelerate road degradation through erosion, potholes, and washouts. Communities in low-lying areas such as Ahoada West and Abua/Odual experienced significant travel delays, economic losses, and safety hazards. Road usage patterns showed heavy dependence on flood-prone routes, with 42.9% of respondents using them daily, 25.0% three to four times per week, 17.9% one to two times per week, and 14.3% five to six times per week. This high frequency of usage amplifies exposure to flood-related disruptions among commuters, fleet operators, and residents.

A substantial proportion of respondents live or operate very close (<500 m, 28.6%) or close (0.5–2 km, 39.3%) to flood-prone roads, while 32.1% are at moderate distances (2–5 km). This proximity pattern is consistent with typical Niger Delta settings, where closeness to rivers, creeks, and low-lying floodplains significantly heightens vulnerability to infrastructure damage, road erosion, and mobility constraints (Bello, 2024; Owukio et al., 2025; Amos et al., 2026; Ogboeli et al., 2026). Respondents reported high flood frequency, with 32.1% experiencing flooding 5–6 times per year and 28.6% annually during the rainy season. Such patterns, driven by overflow from the Orashi River and annual rainfall often exceeding 3,000 mm between May and October, align with recurrent flooding trends in Ahoada West and surrounding local government areas, where floods regularly submerge roads, farmlands, and communities, causing extensive infrastructure damage and socio-economic hardship (Ann, 2025; Ogboeli et al., 2025).

Road erosion severity was predominantly rated as moderate (35.7%) or severe (28.6%), with 17.9% each reporting very severe and minimal conditions. Overall, road damage was classified as critical by 30.0% and severe by 41.4% of respondents, underscoring the cumulative impact of recurrent flooding on transport infrastructure. Mean Likert scale scores (1–5) indicated high perceptions of flood frequency (overall mean = 4.35) and associated impacts. Fleet operators reported the highest severity across categories, particularly for travel delays (4.8) and the need for improved drainage (4.9). Local residents and commuters recorded moderately high scores, while officials and local leaders gave slightly lower ratings, reflecting differences in exposure and institutional perspectives.

Correlation analysis revealed very strong to extremely strong positive relationships between perceived flood frequency and all measured impacts, with Pearson's r values ranging from 0.894 (potholes/washouts and travel delay) to 0.975 (economic loss, safety hazard, and need for improved drainage), all statistically significant ($p \leq 0.041$). These findings confirm that higher flood frequency is strongly associated with increased road damage, mobility disruption, economic losses, safety risks, and demand for better drainage systems.

Overall, the results demonstrate that recurrent seasonal flooding is a primary driver of cascading negative effects on transport networks and community well-being in the Orashi Region. The study highlights the urgent need for targeted flood mitigation measures, climate-resilient road design, and systematic drainage maintenance to enhance transport reliability, safeguard livelihoods, and strengthen resilience in flood-prone riverine communities of the Niger Delta (Bello, 2024; Owukio et al., 2025; Ann, 2025; Amos et al., 2026; Ogboeli et al., 2026).

CONCLUSION

The study demonstrates that seasonal flooding in the Orashi Region disproportionately affects economically active adults, fleet operators, and frequent road users who depend heavily on low-lying riverine transport routes. High exposure, proximity to flood-prone areas, and intensive road usage significantly amplify the vulnerability of these groups to mobility disruptions, prolonged travel delays, and safety hazards.

Recurrent overflow of the Orashi River, compounded by inadequate drainage systems, is a major driver of road degradation, manifesting in severe erosion, potholes, washouts, and critical infrastructure damage. These patterns mirror broader challenges across the Niger Delta, where seasonal inundation consistently undermines accessibility and economic productivity.

Correlation analyses revealed very strong positive relationships between flood frequency and key impacts, including road erosion, economic losses, and safety risks. Stakeholder perceptions further underscore the urgent need for targeted interventions, especially along high-usage routes that are critical for daily mobility and livelihoods.

Overall, the findings highlight that seasonal flooding is a primary driver of cascading disruptions to transport networks and community well-being in the Orashi Region. Proactive and integrated solutions are essential to mitigate these impacts.

POLICY RECOMMENDATIONS

To strengthen resilience against seasonal flooding in the Orashi Region, the following key recommendations are proposed:

Adopt Climate-Resilient Road Design Standards: The Ministry of Works and Transport should mandate elevated embankments, improved cambering, and flood-resistant materials for all new and rehabilitated roads in flood-prone areas to reduce vulnerability to erosion and washouts.

Develop Integrated Drainage Infrastructure: The Ministry of Environment and Natural Resources, in collaboration with Local Government Councils, should prioritize the construction, regular desilting, and maintenance of effective drainage systems linked to the Orashi River to minimize flooding of transport corridors.

Enforce Land-Use Regulations and Risk Mapping: The Ministry of Urban Development and Physical Planning should implement stricter land-use controls to prevent construction in high-risk flood zones and integrate flood risk mapping into all community development plans.

Establish Multi-Stakeholder Coordination and Funding Mechanisms: The State Government should create a Flood Resilience Committee involving relevant ministries, fleet operators, and community leaders, while dedicating a specific percentage of the Ecological Fund and local government allocations to support pilot resilient road projects and Nature-Based Solutions in high-risk LGAs such as Ahoada West and Abua/Odual.

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