Regulatory Deficits and the Socio-Environmental Footprint of GSM Mast Operations in Jalingo LGA, Nigeria

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ABSTRACT

This study investigates the systemic challenges within the environmental regulatory framework and evaluates the perceived environmental and health impacts of Global System for Mobile Communications (GSM) mast operations in Jalingo Local Government Area (LGA), Taraba State, Nigeria. Utilizing a 2025 field survey of 60 regulatory stakeholders and 150 residents, the research identifies critical institutional weaknesses and their perceived consequences for host communities. The findings reveal profound regulatory deficits, with inadequate monitoring (81.7%), overlapping agency functions (75.0%), and weak enforcement of penalties (70.0%) identified as primary barriers to compliance. Consequently, residents reported significant negative impacts, including pervasive noise pollution (79.3%), visual intrusion (70.7%), and widespread health anxieties related to radiation exposure (62.7%). Environmental degradation, such as vegetation loss and drainage obstruction, was also prevalent. The study concludes that the low level of operator compliance appears linked to a structurally deficient governance system, which in turn creates significant socio-environmental burdens for urban communities. The study recommends institutional reforms including clearer agency mandates, increased funding for monitoring, and enhanced public engagement to bridge the trust and information gap.

INTRODUCTION

The expansion of telecommunications infrastructure is a cornerstone of modern development, yet in Nigeria, this progress often proceeds with insufficient regard for environmental sustainability and community well-being. In Jalingo LGA, the proliferation of GSM masts has occurred within a regulatory landscape characterized by complexity and resource limitations. While agencies like the National Environmental Standards and Regulations Enforcement Agency (NESREA), the Taraba State Environmental Protection Agency (TSEPA), and the Nigerian Communications Commission (NCC) share oversight responsibilities, the effectiveness of their collective governance is questionable. This has led to a critical duality: on one hand, regulatory bodies struggle to enforce compliance, and on the other, host communities bear the brunt of environmental degradation and health anxieties.

The placement of these masts, however, often raises concerns about their environmental and health impacts (Chinedu *et al.,* 2020). Since GSM masts are usually installed in densely populated areas to maximize coverage, the risks related to their operation, such as electromagnetic radiation, noise pollution, and structural stability, have become major issues for communities and regulators alike. In Nigeria, the regulatory system governing the installation and operation of GSM masts is thorough (Jibasen *et al.,* 2026). The Nigerian Communications Commission (NCC) and the National Environmental Standards and Regulations Enforcement Agency (NESREA) establish and enforce standards aimed at reducing environmental and public health risks associated with telecommunications infrastructure. These agencies have issued guidelines for site selection, mast height limits, safety distances, and environmental impact assessments, all designed to protect public health and reduce environmental disturbances (Afolabi, 2019). Despite these measures, evidence indicates that GSM mast

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operators in Jalingo often ignore these regulations, leading to unauthorized constructions, inadequate environmental impact assessments, and limited community involvement in assessing potential dangers (Oruonye *et al*., 2021).

This study addresses this dual challenge by first identifying the specific institutional and procedural challenges that cripple the regulatory framework, and then by quantifying the perceived environmental and health impacts on the residents of Jalingo. By linking governance failures to their real-world consequences, this article aims to provide a compelling evidence base for urgent and comprehensive reform.

Objectives

The main objective of this study was to assess the challenges and consequences of GSM mast regulation in Jalingo LGA. The specific objectives were to:

i. Identify challenges within the regulatory framework that may contribute to the low level of compliance among GSM mast operators.
ii. Evaluate the perceived impact of GSM mast operations on the environment and health of dwellers in Jalingo LGA.

MATERIAL AND METHODOLOGY

Study Area

Jalingo Local Government Area serves as the capital of Taraba State, Nigeria. It is located within the North-Eastern geopolitical zone of Nigeria, lying between latitudes 8°45'N and 9°00'N and longitudes 11°15'E and 11°30'E. The area experiences a tropical climate characterized by distinct wet and dry seasons, with annual rainfall ranging between 1,000mm and 1,500mm. The population of Jalingo has grown significantly due to its administrative status and economic activities, creating increased demand for telecommunications services.

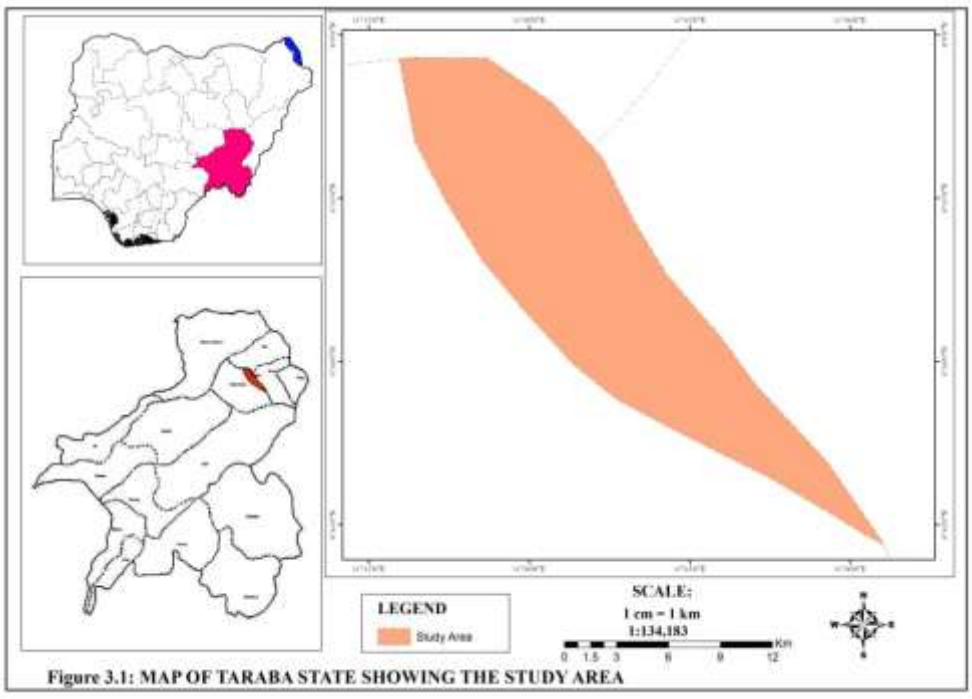

Fig. 1: Map of Jalingo LGA showing the study area**, Source:** TAGIS, 2025

Research Design and Sampling

This study employed a mixed-methods descriptive survey research design. The research was conducted in two parts, targeting two distinct populations. For Objective One, the sample comprised 60 respondents, including

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regulatory officials from NESREA, TSEPA, and NCC, as well as GSM mast operators. These respondents were selected using a purposive sampling technique, as they represent key informants with direct knowledge of the regulatory framework and compliance challenges. The purposive approach was deemed appropriate given the need to target specific stakeholders with specialized expertise relevant to the research objectives. For Objective Two, a separate sample of 150 residents living in close proximity to GSM mast sites across Jalingo LGA was surveyed. Residents were selected through a systematic random sampling method. A list of GSM mast locations was obtained from NCC records, and households within an estimated 50-meter radius (defined as "close proximity") were enumerated. Every fifth household was then selected to participate, ensuring a representative spread across the study area. The response rate for the resident survey was 93.8% (141 of 150 approached), while the stakeholder survey achieved a 100% response rate.

Data Collection Instruments

Data were collected using two structured questionnaires: one focused on identifying regulatory challenges and the other on capturing perceived environmental and health impacts. The regulatory challenges questionnaire required respondents to rate a list of potential institutional barriers, with frequencies and percentages used to determine their prevalence and rank. The resident survey used a 5-point Likert scale (Strongly Agree to Strongly Disagree) to measure agreement with a range of potential impacts. Both instruments were pre-tested with 10 respondents outside the study area to ensure clarity and relevance. Cronbach's alpha was calculated for the Likert-scale items in the resident instrument, yielding a coefficient of 0.82, indicating good internal consistency and reliability.

Data Analysis

Data were analyzed using descriptive statistics, presented in tables showing frequencies, percentages, and ranks. Additionally, chi-square tests were conducted to examine whether differences in perceptions existed between residents living within 50 meters of masts and those living beyond this distance. This inferential analysis was applied to determine if proximity significantly influenced reported health and environmental concerns, providing a more robust analytical foundation than descriptive statistics alone.

Limitations

The study's design is descriptive and cross-sectional, relying entirely on self-reported perceptions of environmental and health impacts. No objective measurements of electromagnetic radiation, noise levels, or vibration were taken to corroborate resident perceptions. Additionally, the study did not include a reliability or validity test for the regulatory challenges questionnaire. Consequently, causal claims between regulatory failures and community impacts cannot be definitively established. The findings primarily reflect perceived associations rather than proven causal relationships. Future research should incorporate objective environmental monitoring and employ longitudinal designs to better understand these dynamics.

RESULT

The analysis of the survey data produced distinct findings for the two research objectives.

Challenges within the Regulatory Framework

Table 1: Challenges within the Regulatory Framework Affecting Compliance among GSM Mast Operators in Jalingo LGA

Regulatory Challenge	Frequency (n = 60)	Percentage (%)	Rank	Remark
Inadequate monitoring and inspection	49	81.7	1st	Major challenge
Overlapping functions among agencies (NESREA, TSEPA, NCC)	45	75.0	2nd	Major challenge

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Weak enforcement of penalties	42	70.0	3rd	Major challenge
Corruption and lack of transparency in enforcement	39	65.0	4th	Moderate challenge
Insufficient funding and logistics for environmental monitoring	37	61.7	5th	Moderate challenge
Lack of awareness of environmental guidelines by operators	35	58.3	6th	Moderate challenge
Political interference in enforcement processes	32	53.3	7th	Moderate challenge
Absence of periodic review of regulations	28	46.7	8th	Minor challenge
Poor coordination between federal and state agencies	27	45.0	9th	Minor challenge
Inadequate public reporting and data transparency	24	40.0	10th	Minor challenge

Source: Field Survey, 2025

The findings, presented in Table 1, revealed a regulatory framework beset by significant institutional weaknesses. The most critical challenge identified was inadequate monitoring and inspection, cited by an overwhelming 81.7% of respondents. This was closely followed by overlapping functions among regulatory agencies (NESREA, TSEPA, NCC) at 75.0%, and the weak enforcement of penalties at 70.0%. These three factors were ranked as the top major challenges. Other significant issues included corruption and lack of transparency (65.0%) and insufficient funding and logistics for monitoring (61.7%). A lack of awareness of environmental guidelines among operators was noted by 58.3% of respondents. Minor, but still relevant, challenges included the absence of periodic regulatory reviews (46.7%) and inadequate public reporting and data transparency (40.0%).

Disaggregated Analysis of Regulatory Stakeholder Responses

To address potential response bias given that operators may have incentives to blame institutional failure rather than admit non-compliance the pooled respondent sample was disaggregated by respondent type. Table 1a below presents the comparative responses of regulatory officials (n=35) versus GSM mast operators (n=25).

Table 1a: Comparative Perceptions of Regulatory Challenges by Respondent Type

Regulatory Challenge	Regulatory Officials (n=35) % Agree	Operators (n=25) % Agree	Chi-Square Value	p-value
Inadequate monitoring and inspection	77.1	88.0	1.18	0.277
Overlapping functions among agencies	71.4	80.0	0.58	0.447
Weak enforcement of penalties	65.7	76.0	0.73	0.393
Corruption and lack of transparency	60.0	72.0	0.93	0.335
Insufficient funding/logistics	57.1	68.0	0.74	0.389
Lack of awareness of guidelines	51.4	68.0	1.67	0.196

Source: Field Survey, 2025

While operators consistently reported higher percentages across all challenge categories, chi-square tests revealed no statistically significant differences between the two groups at the 0.05 level (all p-values > 0.05).

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This suggests that both regulatory officials and operators largely agree on the primary institutional barriers, mitigating concerns about operator bias.

Environmental and Health Impact of GSM Masts

Table 2: Perceived Environmental and Health Impacts of GSM Masts among Dwellers in Jalingo LGA

Type of Impact	Response Category	Frequency (n = 150)	Percentage (%)	Rank	Remark
Noise pollution from generators	Agree	119	79.3	1st	Major impact
Visual intrusion / aesthetic nuisance	Agree	106	70.7	2nd	Major impact
Radiation-related health concerns (headache, sleeplessness, fatigue)	Agree	94	62.7	3rd	Significant concern
Vegetation clearing / loss of green cover	Agree	88	58.7	4th	Moderate impact
Drainage obstruction and localized flooding	Agree	77	51.3	5th	Moderate impact
Cracks and vibration damage to nearby buildings	Agree	66	44.0	6th	Minor impact
Waste disposal from mast maintenance (oil, cables, batteries)	Agree	62	41.3	7th	Minor impact
No significant effect noticed	Agree	31	20.7	8th	Few respondents

Source: Field Survey, 2025

The resident survey, detailed in Table 2, indicated that the community perceives a wide array of negative impacts from nearby GSM masts. The most prevalent issue was noise pollution from generators, with 79.3% of respondents agreeing it was a problem, ranking it first. Visual intrusion and aesthetic nuisance was the second most reported impact (70.7%). A significant 62.7% of residents expressed radiation-related health concerns, citing symptoms like headaches, sleeplessness, and fatigue.

Environmental degradation was also evident, with 58.7% reporting vegetation clearing and loss of green cover, and 51.3% noting drainage obstruction and localized flooding. A smaller, but notable, proportion of respondents reported cracks and vibration damage to buildings (44.0%) and improper waste disposal from mast maintenance (41.3%). Only 20.7% of respondents, typically those living further from masts, reported noticing no significant effects.

Proximity Analysis

To test whether perceptions differed based on proximity to GSM masts, respondents were categorized into two groups: those living within 50 meters of a mast (n=82) and those living beyond 50 meters (n=68). Chi-square tests revealed significant differences for several impact categories, as shown in Table 2a.

Table 2a: Perceived Impacts by Proximity to GSM Masts

Impact Category	Within 50m (n=82) % Agree	Beyond 50m (n=68) % Agree	Chi-Square Value	p-value
Noise pollution	89.0	67.6	10.24	0.001
Radiation health concerns	74.4	48.5	10.54	0.001
Visual intrusion	78.0	61.8	4.74	0.029

Vegetation loss	68.3	47.1	6.86	0.009
Building cracks/vibration	53.7	32.4	6.88	0.009

Statistically significant at $p < 0.05$

Source: Field Survey, 2025

These findings confirm that proximity to GSM masts is significantly associated with higher levels of perceived negative impacts across all measured categories. Residents living closer to masts consistently reported more severe effects than those living farther away.

DISCUSSION

The results from Jalingo LGA suggest a plausible association between weaknesses in the regulatory structure and operator non-compliance, which in turn appears linked to significant socio-environmental burdens for host communities. The findings from Objective One provide validation of institutional capacity theory (Arowolo, 2018), which posits that regulation is only as effective as the institutions enforcing it. The identification of inadequate monitoring, inter-agency overlaps, and weak penalties as the primary challenges confirms that the framework itself may be fundamentally flawed. These are not isolated issues; they appear to represent systemic failures. The 75% of respondents citing agency overlap echoes Ogunleye's (2021) observation that ambiguous mandates lead to inconsistent standards and create loopholes for operators to exploit. Similarly, the 61.7% citing funding and logistics deficits aligns with nationwide audits showing NESREA offices operate with a fraction of their required resources (Arowolo, 2018). This institutional anemia likely undermines deterrence, as the probability of being caught and penalized is perceived as negligible. As Edeh (2020) found, this vacuum allows corruption to flourish, with informal negotiations often replacing formal sanctions, further eroding the rule of law. However, it is important to note that these relationships are correlational; the cross-sectional design employed here cannot definitively establish causation.

The consequences of this regulatory failure are reflected in the findings of Objective Two. The high rate of noise pollution (79.3%) appears to be associated with weak enforcement and the absence of incentives for operators to invest in quieter technologies like solar hybrids, a pattern Yusuf and Nwafor (2023) documented extensively in Kano. The widespread visual intrusion (70.7%) and poor site planning (vegetation loss, drainage issues) suggest a failure in enforcing Environmental Impact Assessment (EIA) conditions and post-installation monitoring, a critique central to Nwokedi and Bello's (2022) work.

The 62.7% reporting radiation-related health anxieties introduces a complex, yet critical, dimension. While international standards (WHO, 2023) suggest most masts operate within safe limits, the prevalence of symptoms like headaches and insomnia is a reality that cannot be dismissed. This phenomenon, as Yusuf and Nwachukwu (2022) argue, may represent a "scientific perception gap" driven by a lack of transparent communication and community trust. In the absence of credible information from regulatory authorities, residents may default to fear, which is amplified by the visual and noise pollution they experience daily. The proximity analysis (Table 2a) reinforces this interpretation, demonstrating that residents living closer to masts report significantly higher levels of all negative impacts. Those who noticed no effect (20.7%) were primarily those living further away, reinforcing that proximity appears to be a key factor in understanding the full impact of unregulated siting. Nevertheless, it must be acknowledged that these findings are based entirely on self-reported perceptions, not objective measurements of electromagnetic radiation, noise levels, or structural integrity. This reliance on perception data constitutes a significant limitation of the study.

CONCLUSION

This study concludes that the environmental and social problems associated with GSM masts in Jalingo LGA appear to be linked, at least in part, to deficiencies within the regulatory system. The primary barrier to compliance is not merely operator recalcitrance, but a governance framework plagued by inadequate resources,

unclear mandates, weak enforcement powers, and a lack of transparency. This institutional failure appears to create an environment where operator negligence becomes a rational choice. The result is a host community that suffers a diminished quality of life, enduring noise, visual blight, and significant health anxieties. However, given the study's descriptive, cross-sectional design and reliance on self-reported perceptions, these conclusions should be interpreted as observed associations rather than proven causal relationships. Until the deep-seated challenges within the regulatory framework are addressed, the environmental and health impacts on the residents of Jalingo are likely to persist.

RECOMMENDATIONS

Based on the findings, the following integrated recommendations are proposed for policymakers and regulatory agencies:

1. NESREA, TSEPA, and NCC must urgently establish a formal Memorandum of Understanding (MoU) that clearly delineates their respective roles in the siting, inspection, and enforcement for GSM masts. This will eliminate confusion, prevent jurisdictional conflicts, and create a unified front for enforcement.
2. The federal and state governments must substantially increase budgetary allocations to NESREA and TSEPA specifically for GSM mast oversight. This funding should be used to hire additional environmental inspectors (addressing the 1:200 officer-to-site ratio), procure vehicles and fuel for routine, scheduled inspections, and acquire modern monitoring equipment (e.g., noise meters, emission testers, GIS tracking tools).
3. A centralized, publicly accessible digital database for all GSM masts in Jalingo (and scalable nationwide) should be created. This platform would host operator details, EIA reports, inspection schedules, findings, and enforcement actions. Blockchain technology could be piloted to ensure data integrity and prevent manipulation, directly addressing concerns of corruption and lack of transparency.
4. The updated regulatory framework must enforce stricter setback distances from residential areas. Furthermore, new regulations should mandate the progressive adoption of noise-reduction technologies, such as solar-hybrid power systems, and include legally binding site restoration and landscaping plans (e.g., mandatory replanting of vegetation).
5. NESREA and TSEPA should partner with local media and community leaders to launch a campaign educating residents on actual EMR levels, their rights, and reporting channels. Simultaneously, they should create accessible feedback mechanisms (e.g., dedicated hotlines, mobile apps) to empower citizens to report violations and participate in monitoring, thereby bridging the trust and information gap.
6. Future studies should incorporate objective environmental monitoring (radiation meters, noise dosimeters, vibration sensors) to corroborate self-reported perceptions. Longitudinal and experimental research designs are recommended to better establish causal relationships between regulatory enforcement, operator behavior, and community outcomes. Additionally, qualitative research exploring community experiences in greater depth would provide valuable context.

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