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INTEGRATING SAFETY AND DISASTER RISK MANAGEMENT INTO SUSTAINABLE INFRASTRUCTURE DEVELOPMENT: POLICY PERSPECTIVES FOR AKWA IBOM STATE

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ABSTRACT

Resilient and safe infrastructure is essential to sustainable development since infrastructure failures may lead to interruption of basic services, economic destruction, increased social vulnerability, and erosion of development efforts. The paper explored ways of integrating occupational safety, disaster risk reduction (DRR), climate resilience, and sustainable development of infrastructure in the context of policy and institutional framework of Akwa Ibom State of Nigeria. It employed a combination of conceptual and policy analysis using the provided source material supplemented with arguments based on international and Nigerian disaster management policies and recent peer-reviewed literature. The analysis was performed across four interrelated dimensions: safety culture and occupational health and safety, multi-hazard disaster risk governance, resilient infrastructure planning, investment and management, and policy alignment with SDGs, the Sendai Framework for Disaster Risk Reduction 2015-2030, and the ARISE Agenda of Akwa Ibom State. From the analysis, it follows that safety should not be considered as a site-specific activity disconnected from the infrastructure planning process. Instead, the processes of risk assessment, prevention, emergency preparedness, asset management, climate adaptation, public engagement, monitoring, and post-disaster learning must be incorporated throughout the infrastructure life cycle. It is even more relevant for the state of Akwa Ibom since the coastlines and low-lying areas in the State make it vulnerable to hazards such as floods, erosion, and storms associated with the climate. The model of governance recommended within the paper includes risk-informed planning, inter-agency coordination, accurate risk information, competent safety personnel, resilient procurement and design, early warning system, infrastructure maintenance, and community engagement. The paper recommends that the alignment of ARISE Agenda with SDGs 9, 11, and 13, along with Sendai priorities, will serve as an appropriate framework.

Keywords: Safety Culture; Disaster Risk Reduction; Resilient Infrastructure; Sustainable Development; Climate Change Adaptation; Sendai Framework; ARISE Agenda; Akwa Ibom State; Nigeria.

1 INTRODUCTION

Infrastructure is not only the physical foundation of development but also a means by which socio-economic systems operate. Roads, bridges, ports, airports, drainage, water infrastructure, power lines, schools, hospitals, telecommunication and emergency services help mobility, production, health, education and livelihoods. This way, infrastructures that are either badly constructed, insufficiently maintained or exposed to uncontrolled dangers might actually pose a threat to development as opposed to serving as a base for it. This idea is reflected in the Sustainable Development Goals where the importance of quality, reliable, sustainable and resilient infrastructures is addressed in SDG 9 while SDG 11 links resilience of communities with integrated urbanization and disaster risk management (United Nations, 2015).

Safety is no less important. In 2022, the International Labour Organization (ILO) declared a safe and healthy working environment as one of the fundamental principles and rights at work, reaffirming the idea that occupational safety and health should be an integral part of governance and management structures and not an optional expense on top of project costs (Nunes et al., 2023; ILO, 2023a). Furthermore, the International Labor Organization's "Global Strategy on Occupational Safety and Health 2024–2030" underscores prevention, social dialogue, coordination, investment and effective occupational safety and health management systems (ILO, 2023b). As far as infrastructure projects are concerned, this requires consideration of worker safety, public safety, environmental protection, and infrastructure resilience.

Disaster risk reduction serves as a link between safety and sustainable infrastructure. According to the Sendai Framework for Disaster Risk Reduction 2015–2030, disaster risks are defined by hazards, exposure, vulnerability, and capacities and require measures through four priorities, namely, understanding disaster risk, strengthening disaster risk governance, investing in disaster reduction for resilience, and preparedness for response and recovery (UNDRR, 2015). This framework is especially relevant to infrastructure because of its Target D dealing with damage to critical infrastructure and disruption of basic services.

The above challenges are extremely relevant for Akwa Ibom State. In fact, the agenda of the State is known as ARISE agenda, which has brought together the issues of infrastructural development, rural development, environment, security, education, health and economic development under one development programme (Akwa Ibom State Government, 2023). From the perspective of the policy orientation, there are grounds for discussing the issue of integration of infrastructure development and safety through the lens of disaster resilience. This article focuses on providing a policy-oriented framework for integrating the elements of safety and disaster resilience into sustainable infrastructure development in Akwa Ibom State. The article does not report primary survey or experimental data. Instead, it contains an analysis that is based on the manuscript provided and some authoritative frameworks and recent peer-reviewed evidence.

2 CONCEPTUAL FOUNDATIONS

2.1 Safety and safety culture

Safety can be defined as the prevention and control of circumstances that may cause injuries, poor health, damage to property, damage to the environment or disruptions of service (Zhang, Li & Fang, 2021). When it comes to infrastructure development, safety encompasses not only the construction workers but also the road users, the neighboring communities, the facility users, the maintenance staff and emergency responders. Safety culture is more than just the presence of safety policies. Safety culture is the manifestation of the values, practices, leadership styles, communication practices and organizational structures that influence whether safety is a priority in decision-making.

The current literature on construction safety confirms the above view of safety as a system. According to Al-Bayati (2021), the study highlights the importance of safety culture and safety climate concerning safety behaviour and motivation. According to Zhang et al. (2021), safety climate attributes in construction are "management commitment, communication and other context". As observed in various Nigerian research, commitment, communication, safety training, inspections and assessments are important in safety management. Safety violations at Nigerian construction sites have been explained using human, technical, and governmental/managerial attributes indicating unsafe conditions may arise from factors beyond workers' behaviour (Ayangade, & Ikpo, 2021).

2.2 Disaster Risk and Resilience

Disasters are not merely natural hazards. A disaster occurs when a hazard interacts with exposed and vulnerable people and infrastructure that do not have the ability to prepare for, cope with, respond to and recover from the event. Likewise, the IPCC (2023) recognizes that climate risk occurs through the interaction of climate hazards with exposure and vulnerability. Such an approach is crucial for Akwa Ibom since hazards such as flooding, coastal erosion and other storm hazards can be intensified due to poor drainage, construction on vulnerable sites, lack of buffer zones and poor emergency response systems.

Resilience does not mean merely a structure's ability to cope with a single hazard but the ability of the infrastructure and the population relying on it to resist disruption, maintain their essential services, adapt and recover from the impact while minimizing risks. In the 2025 Global Assessment Report by UNDRR, the economic cost of disasters goes far beyond mere physical losses, highlighting the need for risk-informed investments.

2.3 Sustainable infrastructure

Sustainable infrastructure combines economic viability, social inclusion, environmental responsibility, safety and long-term functionality. Sustainability should therefore be evaluated across the asset life cycle: planning, site selection, design, procurement, construction, commissioning, operation, maintenance, adaptation, decommissioning and renewal. The above strategy can be seen to be aligned with SDG 9.1, which demands quality and reliable infrastructure, and SDG 11, which links safe settlements with sustainable transport and integrated local disaster-risk reduction (United Nations, 2015).

Infrastructure that was built on time but consistently fails during flooding, presents safety concerns for workers, or demands high emergency costs cannot be termed as sustainable. Similarly, a project that meets a technical specification but ignores community access, emergency evacuation, maintenance capacity or climate projections may transfer risk from the project stage to future users and public authorities.

3 INTEGRATING SAFETY ACROSS THE INFRASTRUCTURE LIFE CYCLE

The concepts of safety and Disaster Risk Reduction (DRR) need to be integrated into the project from its very outset as opposed to being included once work is already underway. The lifecycle concept consists of five reinforcing components: risk-informed planning; safety and resilience by design; controlled construction; resilient operation and maintenance; and preparation, recovery and learning.

In the planning phase, project proponents should identify hazards, vulnerable populations, critical services, environmental vulnerabilities and impacts of asset failure. The site planning needs to take into account flood routing, erosion potential, drainage capacity, accessibility, and emergency response time. Environmental and social impact assessment of a project needs to be complemented with disaster risk assessments so that the development project does not lead to the concentration of risks.

In the design phase, engineers and architects must adhere to the principles of prevention through design. This means the elimination of hazards where reasonable, appropriate material and structural standards, drainage and flood management, safe access and escape routes, and accessibility for emergency services to the asset. Adaptation to climate change forecasts should be made when necessary. These adaptations are particularly important in the construction sector in Nigeria, because according to the current research, extreme heat presents substantial occupational safety risks and therefore the need for early warning systems as well as safety adaptations (Moda et al., 2024). Contractors should ensure that documented health and safety management systems are implemented and overseen by competent personnel. Health and safety management systems that are run by competent individuals. The success of health and safety programmes is determined by the implementation of the programmes rather than the presence of policy (Ayangade, & Ikpo, 2021). The procurement process should make it a contractual obligation that there is safety performance, as well as clear roles in this regard for clients, consultants, contractors and subcontractors.

In the operational phase, the focus moves to asset integrity, preventive maintenance, emergency planning and continuous monitoring. An asset register should show the state, criticality, maintenance and potential hazards. Critical assets should have a continuity plan that outlines an alternate means of providing services in case of a problem. This aligns with Target D of the Sendai Framework which states that damage to critical infrastructure and disruption of essential services should be reduced (UNDRR, 2015). Finally, lessons from incidents should be incorporated into future planning, standards and training. Incidents must not be used merely to apportion blame but rather must be a source for understanding system vulnerabilities, organisational states, assumptions and governance failures. There will therefore be a learning loop where each infrastructure project builds on resilience of subsequent projects.

4 CREATING A RESILIENT SAFETY CULTURE IN AKWA IBOM

A resilient safety culture requires leadership, competent personnel, participation, communication, enforcement and learning. The first is leadership. Government departments, clients and leaders must show through actions that safety and resiliency are non-negotiable goals by providing resources, monitoring and responding to any hazard reported.

The second is competence. There should be competent personnel from safety, engineering, environment and disaster management professionals within the ministries, departments and agencies dealing with infrastructure projects. However, a personnel ratio can serve as a minimum basis for planning, but it must never be considered an absolute value: the right staffing with safety officers should depend on the number of employees, the level of danger, the complexity of the job, the geographic nature of the work, multiple tasks and public exposure at the same time.

Third, it is crucial to engage workers because they have practical knowledge about risks that may be invisible in official plans. Consultations, stop-work power, near-miss reporting and feedback processes can enhance information flow concerning the risks. The International Labour Organization's strategic plan for 2024-2030 highlights social dialogue and participation as key factors of effective OSH systems (ILO, 2023b). Fourth, there should be a link between inspections and reporting processes and actions for correcting identified issues. It is no use conducting inspections just to record non-conformities without implementing any corrections. Akwa Ibom can improve this aspect of OSH management by establishing standardized procedures for inspections, a digital corrective register and escalation procedures for recurring violations. Moreover, the public safety must also be seen as an essential objective of the project. Such infrastructure projects are undertaken near roads, schools, markets, residences and other public utility services. Risk assessment is thus important regarding traffic management, pedestrian protection, utility location, communication to the public, emergency access and temporary works. This is especially true for urban projects wherein construction operations may interfere with transport and drainage systems that are already limited.

5 DISASTER RISK REDUCTION AND SUSTAINABLE INFRASTRUCTURE IN AKWA IBOM

Considering the geographical and environmental setting of the State, a multi-hazard approach is recommended. Studies have shown that the state is highly prone to hazards caused by climatic factors such as floods, severe storms and sea-level rise of the sea water, particularly in the coastal zones (Udoh & Nkan, 2015). Spatial analysis of the State's vulnerability carried out before revealed that there were areas that had medium and high levels of climate vulnerability, especially with regard to erosion, floods and sea level rise (Udoh & Nkan, 2015). Floods serve to demonstrate the systemic nature of the problem. Such elements as drainage, waste management, land use, road construction, wetlands, waterways, buildings, and behaviour all have an influence on each other. Blocking drainage channels with waste increases flood risks in that area, yet widening the drainage can solve the issue only when there is proper land use, runoff from above, and maintenance. Solutions to floods include nature-based measures, protecting the watershed, building permeable surfaces, preserving wetlands, and improved maintenance along with engineering measures to manage the problem.

Similar considerations are required for coastal and marine infrastructure. Construction of ports, roads, and industrial development along coasts brings economic gain, but one needs to consider such factors as erosion, storm surge, sea level changes, drainage problems, ecology, and access for emergencies. The resilience of such investments thus needs to be evaluated not only in terms of capital cost but also through expected lifespan, maintenance, hazards, and disruption. Continuity of essential services must also inform the design of urban infrastructure. Health facilities, educational institutions, water supplies, power, telecommunication, transport, and emergency service infrastructure must be evaluated based on their importance. Equally, WHO (2024) advocates for safe healthcare facilities that should be resilient to the impacts of climate change.

6 BARRIERS TO DISASTER RISK REDUCTION GOVERNANCE

There are six barriers which are especially significant for Akwa Ibom: political commitment, institutional capacity, coordination, social and cultural factors, data and information, and awareness and education. These barriers should be seen as interrelated rather than separate. The political commitment determines whether DRR will have consistent funding and focus before any disasters happen. Since prevention often results in invisible gains compared with new infrastructure, there may be a government incentive to invest in projects that can bring immediate political benefits. Resilience strategy must include the requirement to build criteria of risk reduction into decisions regarding capital investments and project evaluation.

Institutional capacity is also crucial. For instance, the National Emergency Management Agency of Nigeria (NEMA) has called the National Disaster Management Framework the foundation for policies, plans and programs and stresses the role of risk assessment in vulnerability reduction (NEMA, 2013). NEMA has started revising the National Disaster

Management Framework and National Disaster Response Plan in 2026 due to the emerging risks, including extreme floods, climate-related risks and urban disasters (NEMA, 2026). This will further emphasize the need for sub-national systems to remain adaptable and aligned themselves with the national structures.

Coherence will again be another challenge. While it is possible for infrastructure, environment, health, emergency management, transportation, water, urban planning and local government services to be separated organizationally, their risks are interdependent. For this reason, a state-level resilience mechanism brings together technical departments, emergency services, local governments, communities, utilities, professionals, contractors and the private sector.

Insufficient data can undermine other interventions. Therefore, Akwa Ibom would benefit from Akwa Ibom will gain from having a data platform that integrates infrastructure and disaster risk information, which includes hazard maps, location of assets, asset conditions, incident data, areas prone to flooding, emergency assets, maintenance schedules and dependencies on critical services.

Finally, awareness and education should go beyond emergency responses. This means that communities, contractors, public officials, students, infrastructure operators and infrastructure users should be aware of how to prevent risks, take care of the environment, undertake emergency procedures and report hazards.

7 ALIGNING THE SENDAI FRAMEWORK, SDGS AND ARISE AGENDA

This makes the ARISE Agenda an excellent sub-national policy agenda due to its five aspirations being consistent with the logic of sustainable development. Specifically, Agricultural Revolution and Environmental Management are associated with SDGs 2, 13 and 15; Rural Development is related to SDGs 6 and 11; Infrastructural Maintenance and Advancement is associated with SDG 9; Security, Education and Health are related to SDGs 3 and 4; and Economic, Industrial and Social Advancement are associated with SDGs 1 and 8 (Akwa Ibom State Government, 2023).

However, a better analysis can be made by adding the Sendai Framework to serve as the risk governance framework. In such a framework, the SDGs would specify the desired outcomes of development, the ARISE Agenda would reflect the State's policy and implementation priorities, and the Sendai Framework would provide the disaster-risk principles for protecting development outcomes.

Table 1: Alignment proposal between ARISE Agenda and SDGs as well as Sendai Framework.

ARISE policy area	Primary SDG alignment	Sendai linkage	Infrastructure implication
Agriculture revolution and environmental management	SDG 2, SDG 13, SDG 15	Priority 1; Priority 3	Preserve watersheds, wetlands, and productive landscapes; consider climate and ecosystem risks.
Rural Development	SDG 6, SDG 11	Priorities 1–3	Ensure safety in water, road transport, sanitation, and utilities while minimizing vulnerability.
Infrastructure Development & Improvement	SDG 9, SDG 11	Priorities 1–4; Target D	Design, build, and upgrade critical infrastructure for resilience and continuity.
Safety, Education and Health	SDG 3, SDG 4	Priorities 2 and 4; Targets A, B, D, G	Protect citizens and vital infrastructures; enhance readiness, access, and early warning.
Economic, Industrial and Social Development	SDG 1, SDG 8	Priorities 2–3; Target C	Economically protect assets, jobs and productive systems through risk-informed investment.



Figure 1: The Sendai Framework at a Glance. Source: UNDRR. (2015).

8 INTEGRATED FRAMEWORK PROPOSED FOR AKWA IBOM

From the analysis, an Integrated Safety-Disaster Risk-Infrastructure Resilience Framework is proposed, consisting of six pillars.

The first pillar is risk-based planning, requiring hazard, exposure and vulnerability assessments for every major infrastructure proposal hazard, exposure and vulnerability assessments in any major infrastructure proposal. The second involves resilient design where the risks would be translated into engineering, environmental and operational measures. The third pillar involves safe construction and would entail having capable people, risk controls, worker involvement and enforcement. The fourth pillar involves resilient infrastructure management and would entail linking inspection, maintenance, condition assessment and criticality. The fifth pillar involves emergency preparedness and would entail early warning, evacuation, emergency communication and continuity of services. The sixth involves inclusive governance and would entail community, professional bodies, private organizations and local government participation. Implementation of the framework should occur via the use of a project life-cycle gateway process. Each gateway should require not just proof of financial and technical feasibility but also of risk assessment, safety planning, climate resilience planning, emergency response and maintenance considerations. This way, safety and DRR measures will not remain standalone documents but will become integral elements of project governance. Illustrative performance indicators include: 90% major projects that have been subject to multi-hazard risk assessment; 90% critical assets with condition assessments; 60% corrective actions completed within agreed time periods; reportable incident data; number of emergency response exercises completed; 85% critical facilities with business continuity plans; 90% contractors who meet the safety competence criteria; and the annual budget for preventive maintenance and DRR. These indicators may be linked to reporting under Sendai and SDG processes.

9 POLICY RECOMMENDATIONS

- Establish a state-level Infrastructure Safety and Resilience Steering Committee including representatives of infrastructure, environmental, emergency management, health, transport, water supply, urban planning, local government sectors and associated professions.
- Multi-hazard risk assessment and climate resilience screening of major public infrastructure projects prior to investment decision-making. Integrate safety, environmental and DRR criteria into procurement, contractor prequalification, tender evaluation and contract administration.
- Enhance the infrastructure asset registry by considering asset criticality, asset condition, hazard exposure, maintenance records and emergency interdependencies.

- Establish an interoperable platform of disaster risk and infrastructure information at state level that can enable mapping, early warnings, emergency responses and project assessments.
- Harmonize construction site safety plans, safety inspections, accident reports, near-miss reporting and safety compliance across public infrastructure projects.
- Employ qualified safety officers in infrastructure projects where staffing levels depend on the number of workers, level of hazards, project complexity and public exposure, rather than a one-size-fits-all ratio.
- Formulate emergency continuity plans for critical infrastructure, especially health centers, transport routes, water networks, power supply, schools and emergency service facilities.
- Raise awareness among the general population and workforce about flood, solid waste management, heat stress, communication during emergencies, evacuation, and infrastructure safety issues.
- Develop a learning system whereby major events, near misses, floods and infrastructure failures are analyzed and the lessons learned incorporated into standards and design and procurement guidelines.
- Protect wetlands, drainage paths and other natural systems which offer both flood protection and ecological services through engineering means as one element of a catchment approach.
- Ensure that State monitoring indicators are in line with the objectives of SDG 9, SDG 11 and SDG 13 and the relevant Sendai targets such that the development of infrastructure can be measured not only in terms of its physical success but also its contribution to resilience and risk reduction.

10 CONCLUSION

Sustainable infrastructure development is inseparable from safety and disaster risk management. Infrastructure creates development possibilities, but if not managed properly, risk may turn these opportunities into liabilities. This article shows how important it is to build resilience into infrastructure design as opposed to building infrastructure and addressing risk thereafter. For Akwa Ibom State, the ARISE Agenda has laid a solid policy foundation for such an integration, as the issues of infrastructure, rural development, environmental management, health, security, and economic development are already linked in the five aspirations set out in the agenda. The Sendai Framework and the SDGs provide relevant international benchmarks, the former stressing the importance of risk assessment, risk governance, investing in resilience, and preparedness, and the latter defining the development targets of resilient infrastructure, safe cities, climate change response, health, and decent work. Safety and DRR have to be made regular considerations for infrastructure planning, procurement, construction, operation and maintenance. This would require capable institutions, valid data, cooperation among agencies, involvement of the community, enforcement of laws and regulations, and ongoing preventive investments. The goal would not be merely to build more infrastructure, but to build infrastructure that remains safe, operational and adaptable to the changing environmental and social conditions.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

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