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Modelling Risk-sharing and Mutual Benefits in Sand Extraction Industry: Unfolding Controlled Open Access Regime (COA) in Anong Community, Abi LGA, Cross River State, Nigeria

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Abstract

The global demand for sand, driven by relentless urbanization and infrastructure development, has escalated into a multifaceted crisis, largely due to its management under an unregulated open-access paradigm. This study argues that the prevailing "Tragedy of the Commons" in sand mining necessitates a transformative governance approach. It proposes the Controlled Open Access (COA) regime as a novel, hybrid model designed to integrate structured control mechanisms from state, private, and common property frameworks. By fostering robust multi-stakeholder participation, implementing equitable benefit-sharing mechanisms, embedding adaptive management principles, and strengthening regulatory frameworks, COA offers a pathway to transcend the destructive dynamics of pure open access. This model aims to internalize the severe environmental, social, and economic externalities of sand extraction, promoting sustainable resource utilization, fostering shared responsibility, and ensuring mutual benefits for all stakeholders, thereby mitigating risks and securing the long-term viability of this critical resource.

Key words: Modelling risk-sharing; Mutual benefits; Sand extraction industry; Controlled Open Access Regime (COA); Anong community; Abi LGA; Cross River State; Nigeria

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1. INTRODUCTION

The Sand and Aggregate Extraction Industry stands as a critical and often unregulated informal sector globally. High demand, illegal operation, and poor regulatory mechanisms have caused substantial economic losses and severe environmental degradation. While the global conversation often focuses on infrastructural development and high demand for sand aggregate, excavation of sand poses a more immediate and widespread threat to coastal and riverine environments, particularly in developing nations like Nigeria.

Sand aggregates' crisis is profoundly exacerbated by the widespread perception of sand as an inexhaustible "common resource" that is "easy to reach and prohibitively expensive to regulate" (Jimmy et al, 2024). This perception aligns directly with the characteristics of an "open-access property regime," where the absence of defined ownership and control leads to a "free-for-all" scenario and, consequently, non-sustainable exploitation (Ostrom, 1990). This phenomenon is famously described as the "Tragedy of the Commons," where individual rational self-interest in an unregulated shared resource inevitably leads to its depletion (Hardin, 1968).

A critical dynamic contributing to this crisis is the pervasive "information void" concerning sand mining (UNEP, 2019). This vacuum, coupled with ineffective regulation, becomes fertile ground for "sand mafias" and corrupt actors to operate with impunity (Beiser, 2018). Therefore, the lack of information and the "common resource" perception are not merely symptoms but fundamental causes that drive and sustain illicit sand mining.

This article proposes a Controlled Open Access (COA) regime as a novel and necessary governance model for the Nigerian sand mining sector, focusing specifically on Cross River State. COA is conceptualized as a hybrid property regime that strategically blends elements of traditional open access with structured controls derived from state and common property frameworks. The paper will first conceptualize COA, then examine the crisis in Cross River State, validate the model using the Anong community as an existing prototype, and finally, operationalize the COA mechanics for broader policy application.

2. INTRODUCING CONTROLLED OPEN ACCESS: THE HYBRID MODEL

The COA regime systematically integrates elements from state, private, and common property models to impose necessary structure and ensure sustainability for sand. It is a carefully managed mix that is neither purely open nor purely state-controlled (Pretty, 2003).

For COA to be effective, it must be meticulously designed to **operationalize control** through explicit rules defining who can access the resource, how much, and under what conditions (Ostrom, 2005). This involves a clear delineation of the roles, responsibilities, and decision-making authority of governing entities (government, miners, and community leaders), drawing on the "bundle of rights" concept (Schlager & Ostrom, 1992).

Natural resource management (NRM) theory categorizes property rights based on the locus of ownership and control, each with distinct implications for resource use and sustainability (Bromley, 1991). Understanding these typologies is crucial for appreciating the innovative nature of a Controlled Open Access model (Ostrom, 1990).

i. **State Property:** In this regime, ownership and control over the use of resources are vested in the state. Individuals or groups may be granted permission to utilize these resources, but only under specific state-defined terms (Schlager & Ostrom, 1992). Examples in the United States include national forests, national parks, and military reservations.

ii. **Private Property:** This refers to any property owned by a defined individual or corporate entity. Under this regime, both the benefits derived from the resources and the duties associated with their management fall solely to the owner(s) (Ostrom, 1990). Private land serves as the most common example.

iii. **Common Property:** This constitutes a private property of a defined group, which collectively holds rights to exclude outsiders. The group then decides on the internal use and management of the resource (Ostrom, 1990). Examples include community forests or lands traditionally managed by indigenous villages. It is important to distinguish common property from open access, as common property involves a defined group with rules, whereas open access does not (Bromley, 1991).

iv. **Non-property (Open Access):** This regime is characterized by the absence of any definite owner or enforceable property rights (Hardin, 1968). Each potential user has an equal ability to exploit the resource as they wish, leading to a "free-for-all" scenario. This regime is frequently associated with severe exploitation, encapsulated by the adage "Nobody's property is Everybody's property" (Bromley, 1991).

v. **Hybrid:** A pragmatic regime that combines elements from more than one of the aforementioned property types (Schlager & Ostrom, 1992). Natural resource managers must consider the complex impacts of such mixed arrangements (Berkes, 1989). An illustrative example is native vegetation management in New South Wales, Australia, where legislation recognizes a public interest in preservation despite the vegetation primarily existing on private land (Pretty, 2003).

The "**Tragedy of the Commons**," where open access leads to exploitation, is a fundamental and well-documented problem in natural resource management (Hardin, 1968). The very existence and detailed descriptions of various property regimes and management approaches—including community-based, adaptive, and integrated strategies—are direct responses to this inherent challenge (Ostrom, 1990; Berkes, 1989). If open access inherently led to sustainable resource use, the complex theoretical and practical efforts to develop and implement these alternative governance models would be unnecessary. Therefore, the evolution and focus of NRM on these alternatives demonstrate that they are designed as solutions to overcome the inherent tendency towards exploitation under open access conditions (Ostrom, 2005). These approaches aim to establish some form of defined control, rights, or shared responsibility, thereby creating incentives for sustainable use and moving away from the destructive "free-for-all" dynamic (Pretty, 2003).

2.1 The Perils of Pure Open Access: Lessons from Theory and Practice

Under conditions of pure open access, the absence of secure property rights and effective institutional restrictions inevitably leads to the overuse and deterioration of common resources (Ostrom, 1990). This destructive dynamic occurs because no single user has a vested interest in the long-term health or sustainability of the resource (Hardin, 1968). Any conservation efforts undertaken by one individual would be immediately undermined by the continued, unregulated exploitation of others, effectively privatizing the benefits of extraction while socializing the costs of degradation (Bromley, 1991).

Economic theory provides a clear explanation for this phenomenon, demonstrating that unregulated open access invariably results in excessive rates of exploitation (Gordon, 1954). As profits or "rents" become available from a resource, more agents enter the market to extract these benefits. This influx of users, each acting in their self-interest, leads to a dissipation of these rents and ultimately, resource depletion (Ostrom, 2005). This competitive dynamic inherently incentivizes rapid, maximum extraction rather than careful, sustainable management, as individuals seek to capture as much as possible before others do (Hardin, 1968).

A critical flaw of open access is the complete lack of incentive for conservation (Ostrom, 1990). Resource users are not guaranteed to appropriate the benefits of any conservation efforts they undertake (Bromley, 1991). This absence of a direct link between investment in conservation and the accrual of personal or group benefits actively discourages any long-term planning or sustainable practices. The result is a downward spiral of resource degradation and eventual collapse (Gordon, 1954).

2.2 Evolution of Controlled Open Access: A Hybrid Governance Approach

A Controlled Open Access (COA) regime for sand mining is inherently designed to function as a hybrid property regime (Schlager & Ostrom, 1992). It systematically integrates elements from state, private, and common property models to impose necessary structure and ensure sustainability for a resource that has historically been treated as open access (Berkes, 1989). This approach acknowledges the practical difficulties of fully privatizing or centralizing control over widely distributed and often mobile resources like sand, while recognizing the imperative to move beyond the destructive "free-for-all" model (Ostrom, 2005).

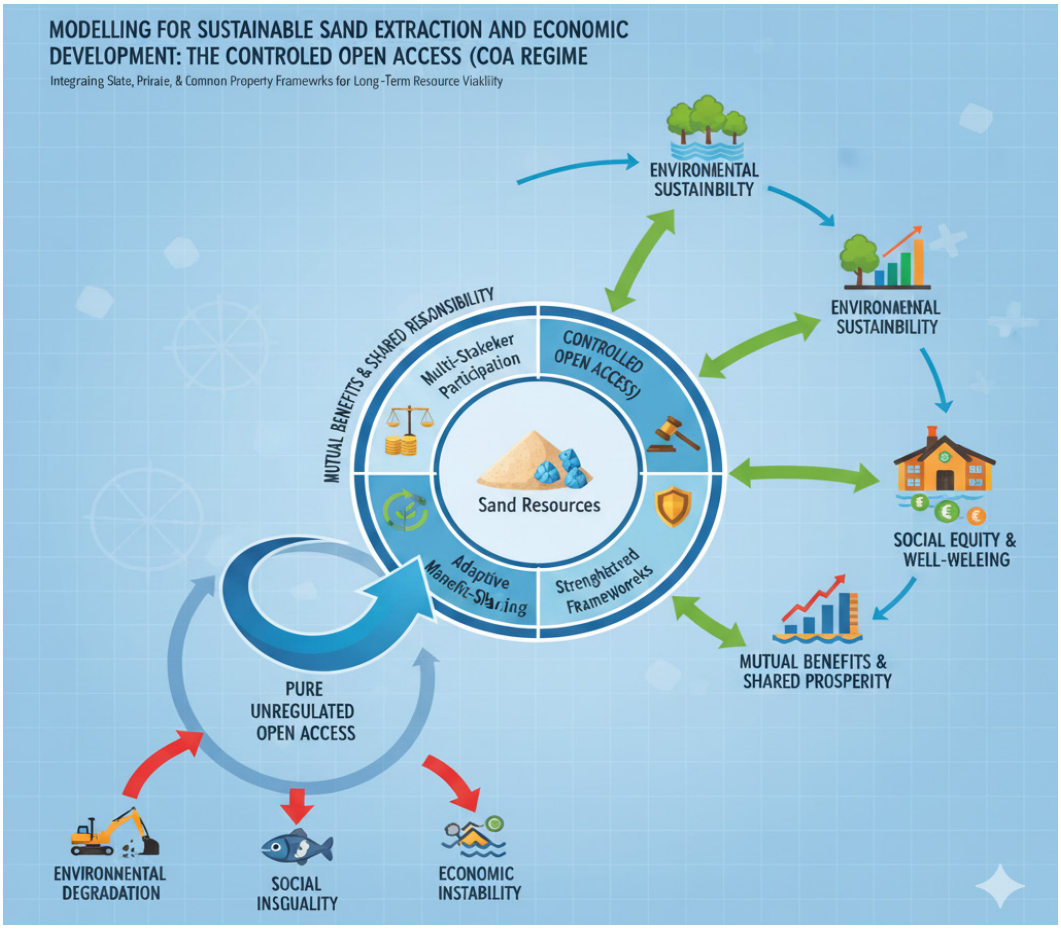

Figure 1
Conceptual Framework for Modelling Sustainable Sand Extraction and Economic Development: The Controlled Open Access (COA) Regime
Source: Author, 2025

The core objective of COA is to overcome the destructive dynamics of the "tragedy of the commons" by establishing clear rules, assigning responsibilities, and implementing robust benefit-sharing mechanisms (Pretty, 2003). This is crucial even in contexts where full private ownership or exclusive state control may not be feasible, desirable, or culturally appropriate (Berkes, 1989). The concept of a hybrid property regime is central here, as it suggests that real-world natural resource management often involves a blend of public interest (typically

associated with state or common property) and private ownership (Schlager & Ostrom, 1992). This aligns perfectly with the idea of "controlled open access"—it is neither purely open nor purely private or state-controlled, but rather a carefully managed mix (Pretty, 2003).

Furthermore, the legal and academic definitions of "regime" as rules for accessing and wielding political power, the ruling elites, or the relationship between rulers and the ruled (Krasner, 1982), combined with the "bundle of rights" concept (Schlager & Ostrom, 1992), imply that a "Controlled Open Access Regime" must involve a carefully designed set of rules, power distribution, and rights and responsibilities. For COA to be truly effective and sustainable, it cannot merely be a vague notion of "control." Instead, it must be meticulously designed to operationalize this control through explicit rules that define who can access the sand resource, how much, and under what conditions (Ostrom, 2005). This also requires a clear delineation of the roles, responsibilities, and decision-making authority of the governing entities, which could include government agencies, mining companies, and community leaders (Pretty, 2003). Moreover, a precise specification of the rights and responsibilities of all stakeholders, drawing from the "bundle of rights" concept, is essential (Schlager & Ostrom, 1992). For instance, communities might have defined rights to benefit from sand extraction and participate in its management, even if they do not hold full exclusionary ownership. This multi-dimensional understanding of "regime" and "property rights" transforms COA from a simple concept into a complex institutional design challenge requiring careful consideration of power dynamics and legal frameworks (Berkes, 1989; Ostrom, 2005).

2.3 Operationalizing the Controlled Open Access (COA) Model

To scale the Anong prototype into a formal COA regime, a clear institutional design is required:

Table 1
Operational Mechanisms and Stakeholder Roles in the Controlled Open Access (COA) Model

COA Component	Mechanism (How it works in Practice)	Stakeholder Role
Access Granting	Joint Management Committee (JMC), comprised of Community Leaders (2), Local Government Environmental Officer (1), and a Miners' Cooperative Representative (1). JMC issues non-transferable extraction permits/licenses.	JMC: Approves permits. Miners: Applies for permits. LG: Provides legal backing.
Extraction Quota Setting	Annual Environmental Audit: Quotas (e.g., maximum cubic meters per month, or total number of boat trips allowed) are set annually based on a simple geological/environmental assessment to ensure sustainable replenishment rates.	Local Government (LG): Commissions the audit. JMC: Translates audit into enforceable quotas.
Monitoring and Enforcement	Community Enforcement Unit (CEU): A paid patrol team, appointed by the JMC. Uses a graduated sanctioning system: Warning right arrow-Fine \right arrow-Permanent Exclusion (Hardin, 1968; Ostrom, 1990). Digital record keeping of all transactions and violations is mandatory.	CEU: Patrols and issues warnings/fines. JMC: Authorizes permanent exclusion.
Revenue/ Benefit Sharing	A mandatory two-part fee: 1. State Royal Fee (for the LG/State treasury). 2. Community Access Fee (directly to the Community Development Fund). Fees are collected digitally or by appointed, bonded treasury staff.	Miners: Pay fees. JMC: Manages the Community Development Fund (CDF). LG: Receives State Royal Fee.

3. FOUNDATIONS AND PRINCIPLES OF THE COA MODEL

The COA operational structure is supported by core governance principles:

i. Multi-Stakeholder Engagement and Collaborative Decision-Making

Effective NRM requires robust multi-stakeholder participation. Shared governance, or co-management, where management authority is formally shared among government, private, and community actors, is a proven approach for achieving superior conservation outcomes (Berkes, 2009; Cinner et al., 2012). The JMC in the COA model embodies this shared governance. It moves beyond issues of community unawareness and non-transparent decision-making by fostering **polycentric governance**, where power and decision-making authority are shifted closer to the affected communities (Ostrom, 1990).

ii. Designing Equitable Benefit-Sharing Mechanisms for Mining Communities

Benefit-Sharing Mechanisms (BSMs) are critical for reducing investment risk for companies and boosting the long-term sustainability of mining projects by transforming communities into "investment partners" (Larsen, 2018). In the COA model, the Community Development Fund (CDF) is the BSM. Key attributes:

- **Transparency:** A centralized system (like a publicly accessible website or notice board) for tracking fund allocation, distribution, and use must be established.
- **Participation:** Higher levels of community participation in the governance of the CDF (through the JMC) ensures that development activities are grounded and sustainable.
- **Formalization:** The COA model, including the BSM, must be formalized through local legislation or a State policy framework to establish a common understanding for all stakeholders.

4. WHY CONTROLLED OPEN ACCESS REGIME IN CROSS RIVER STATE

Unregulated sand mining is a primary driver of severe environmental degradation, leading to extensive river and coastal erosion, which manifests as retreating beaches and shrinking river banks (UNEP, 2019). This erosion significantly diminishes the natural capacity of coastlines and river systems in Cross River State and many part of Nigeria to buffer against storms and increases their vulnerability to flooding (Aderinto & Okon, 2016). The physical disruption caused by mining alters groundwater reserves and degrades water quality, further contributing to the loss of fertile land and escalating flood risks in adjacent areas (Bendixen et al., 2017).

Ecological impacts are profound and widespread, severely compromising wildlife and their habitats (UNEP, 2022). This includes the destruction of critical nesting sites for species like sea turtles and gharials (a crocodile found in India) (WWF, 2016), the disappearance of monkey groves in Nditung Nsit, Ibiono Ibom and Uruan in Akwa Ibom State, Nigeria (Jimmy et al, 2020), the obliteration of seabed habitats, and a significant reduction in overall fish diversity and abundance (Koehnken, 2018). For instance, unsustainable sand extraction in Dongting Lake has demonstrably contracted the range and restricted the habitat use of the critically endangered Yangtze finless porpoise, which actively avoids mining sites, particularly those with higher intensity (Zhao et al., 2018). The water traffic associated with sand transportation further exacerbates this problem by blocking the species' river-lake movements, affecting population connectivity and hindering genetic exchange (Zhou et al., 2021).

Sand mining profoundly impacts local livelihoods, particularly those dependent on natural resources, such as farmers, fishers, and women who traditionally fetch water for households (Pedersen et al., 2022). In severe cases, the physical removal of sand can literally erode the foundations of communities, rendering homelands unrecognizable and forcing displacement (Beiser, 2018). This leads to a loss of traditional knowledge, practices, and cultures, as well as land dispossession and a profound loss of landscape and sense of place for affected populations (Hilson & Murck, 2000).

Conflicts are a common occurrence, frequently arising between sand miners and local communities, especially when mining activities encroach upon communal lands or disrupt established traditional practices like fishing (UNEP, 2019). These disputes can sometimes escalate into violent confrontations, further destabilizing communities (Koehnken, 2018). These negative impacts disproportionately affect communities that are already vulnerable to climate change and other environmental threats, exacerbating existing inequalities and raising significant environmental justice concerns (Schlosberg, 2007).

4.1 The Sand Mining Crisis in Cross River State: The Need for COA

Unregulated sand mining is the primary driver of severe environmental degradation in Cross River State, leading to extensive river and coastal erosion, which manifests as retreating beaches and shrinking river banks (UNEP, 2019). This diminishes the natural capacity of coastlines and river systems to buffer against storms, increasing vulnerability to flooding (Aderinto & Okon, 2016).

Ecological impacts include the destruction of critical habitats, loss of fertile land, and a significant reduction in overall fish diversity (UNEP, 2022; Koehnken, 2018). Furthermore, conflicts frequently arise between sand miners and local communities when mining encroaches upon communal lands or disrupts traditional practices like fishing (UNEP, 2019). The presence of "sand mafias" further complicates governance, incentivizing illicit activities and making effective regulation prohibitively expensive (Beiser, 2018).

4.2 A Geographical Profile of Anong Community and Abi Local Government Area, Cross River State, Nigeria

Cross River State, situated in Nigeria's South-South geopolitical zone, presents a complex tapestry of ecological zones, ranging from humid tropical rainforests to derived savannas. Within this context lies Abi Local Government Area (LGA), which serves as a critical geographical zone, both for its agricultural productivity and its unique hydrological connection to the Cross River system. Abi LGA's centrality and resource endowments make it a nexus of human-environment interaction.

Abi LGA is located within the central senatorial district of Cross River State. Its physical landscape is predominantly characterized by rolling terrain and lateritic soils, transitioning between the Guinea Savannah in the north and the more humid tropical ecology to the south. The climate falls under the Tropical Wet and Dry (Aw) classification, marked by distinct rainy (April to October) and dry (November to March) seasons. This climatic regime supports the area's characteristic vegetation: the Derived Savannah, which consists of grass species interspersed with sparse trees, resulting from historical clearing of forest cover for agriculture.

Crucially, the hydrology of Abi is defined by its adjacency to the **Cross River**—one of Nigeria's largest river systems. Major tributaries and channels flow through the region, creating extensive floodplains and riverine ecosystems. This hydrological network is geographically vital as it provides fertile alluvial soils for farming and sustains diverse aquatic life. However, this same accessibility makes its riverbeds and banks prime targets for the aggregate extraction industry, placing communities like Anong directly at the environmental and economic forefront of the sand mining crisis.

The Anong community, situated within Abi LGA, exemplifies a typical rural Nigerian settlement whose livelihood is deeply tied to its immediate environment. The human geography is characterized by subsistence and small-scale commercial activities. Given its location in the Derived Savannah belt and proximity to water bodies, the dominant economic activities are:

Agriculture: Primarily involving the cultivation of staples such as yam, cassava, and maize, often conducted on the fertile floodplains (fadama lands) adjacent to the river.

Fishing: Traditional fishing practices remain a crucial source of protein and income, depending directly on the health of the river ecosystem.

Aggregate Extraction: The primary focus, however, is the increasing, often informal, extraction of sand and gravel aggregates. The readily accessible resource, perceived as "open access," has transformed sections of the riverbanks and riverbeds near Anong into intense mining zones, drawing both local labor and external commercial entities.

The geographic characteristics that support Anong's primary livelihoods—the accessible river and its rich sediments—are simultaneously the source of its greatest environmental peril. Unregulated sand mining creates a critical human-environment challenge. Geographically, the removal of stabilizing sand and gravel volumes drastically alters the riverine geomorphology. This leads to:

• **Riverbank and Coastal Erosion:** The destabilized banks near Anong retreat rapidly, causing the loss of agricultural land and, in severe cases, threatening community infrastructure, as cited in geographical literature on the topic.

• **Hydrological Alteration:** Deepening of the river channels alters groundwater reserves, impacting water quality, and increasing the community's vulnerability to intensified flooding.

• **Socio-economic Conflict:** The "open access" perception of the resource, as described by property rights theorists, fosters a "free-for-all" environment. This often leads to conflicts between sand miners (acting on individual rational self-interest) and traditional resource users (farmers and fishers) whose livelihoods are degraded, creating significant environmental justice concerns within the Local government Area.

4.3 The Anong Community: A Prototype of Controlled Open Access (COA)

In the Anong community, deliberate management initiatives have emerged to control access to their highly endowed sand aggregate resources. This system functions as an existing prototype of the COA regime:

Governance Structure and Rules:

i. Formation: A **Committee on Sand Mining Extraction** is constituted, involving **learned indigenes** on resource management—a form of locally-led co-management.

ii. Access Control: The system is open to indigenes for extraction, but under controlled conditions, with the possibility to sell to non-indigenes later, thereby granting priority access rights to the collective.

iii. Quotas and Seasonal Rules: Rules are set on the rate of harvesting, with a **regulated number of trips** (up to 20 per individual), and a crucial **period of harvesting** that *excludes the rainy season* to allow for **river rejuvenation**.

iv. Enforcement: The mere existence of the committee and rules implies local-level monitoring and enforcement, moving away from pure open access.

Benefit-Sharing and Outcomes:

• **Fee Structure:** A fee of N5,000-N10,000 (Nigerian Naira) is paid to the community, in addition to a required trip of sand, serving as a direct mechanism to internalize the costs of extraction.

• **Financial Accountability:** Proceeds received from every sale go into the community treasury. The commitment to adequate financial accountability and transparency ensures that funds are used for community development (Adepelumi & Ajayi, 2021).

• **Social Outcome:** The model widens access and availability for community members, who reserve sand for personal use or for sales during peak periods.

• **Environmental Outcome:** The implementation of the **seasonal ban** is a primary tool for environmental sustainability, indicating a conscious effort to ensure resource regeneration.

Validation of COA: The Anong model demonstrates the core principle of COA: managing a common resource through a defined, local institution to balance individual access (open access element) with collective rules and benefit-sharing (common property/state control elements).

5. CONCLUSION AND POLICY RECOMMENDATIONS

The uncontrolled extraction of sand aggregates, driven by its treatment as a pure open-access resource, presents a major ecological and social crisis in Cross River State. The Controlled Open Access (COA) regime offers a viable and hybrid institutional solution, as empirically demonstrated by the existing, albeit informal, practices of the Anong community.

The formal adoption of a COA model, with its defined JMC governance, transparent BSMs (CDF), and rule-based seasonal quotas, will effectively internalize the environmental costs of extraction, ensure equitable distribution of benefits, and establish the localized institutional foundation necessary for sustainable resource management.

Key Policy Recommendations:

Legal Formalization: The Cross River State Government should formally recognize and legalize

a Controlled Open Access framework for sand and aggregate extraction, making the Joint Management Committee (JMC) the legally mandated governance body at the Local Government Area level.

Invest in Monitoring: Invest in simple, low-cost environmental assessments to establish scientific quotas (Maximum Sustainable Yield) to replace ad-hoc extraction limits.

Mandate Transparency: Legislation must mandate the use of the Community Access Fee and require public, annual accounting of the Community Development Fund to the entire community.

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