
Environmental Sustainability, Resource Management, and Climate Resilience in Resource-Constrained Economies: A Multidisciplinary Review of West African Evidence

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Abstract

Resource-constrained economies confront environmental pressures, accelerating waste generation, degraded land, unreliable energy, contaminated food chains and climate-driven instability under institutional and financial conditions that differ markedly from those in which mainstream sustainability frameworks were developed. This review synthesises multidisciplinary evidence on ecological stewardship, waste and materials management, renewable energy, pollution remediation, green architecture and climate adaptation, drawing on a corpus of recent West African studies and reading it against the international literature. Four themes are examined: socio-ecological stewardship and the socio-environmental drivers of instability; waste management and circular-economy material innovation; renewable energy, pollution control and chemical optimisation; and green architecture and adaptive land-use planning. Three cross-cutting findings emerge. First, the binding constraint on sustainability transitions in these settings is institutional and behavioural rather than technical: viable low-cost technologies for waste valorisation, water treatment and green coatings already exist and perform well, but fragmented governance, weak enforcement, low public awareness and financing gaps prevent their diffusion. Second, culturally embedded resources, faith-based institutions, indigenous ecological knowledge and eco-cultural communication systems are underused assets that operate where formal governance is weakest, though the evidence for their measurable environmental impact remains thin. Third, environmental degradation, poverty and climate stress interact to produce security and livelihood crises that are inseparable from sustainability policy. The review argues that technical, socio-cultural and governance interventions are complementary rather than sequential, identifies methodological weaknesses in the underlying evidence base, and sets out priorities for research capable of supporting policy.

Keywords: Environmental Sustainability, Circular Economy, Climate Resilience, Waste Management, Renewable Energy, Eco-Theology, Indigenous Knowledge, Nigeria, West Africa

1. EXECUTIVE SUMMARY AND REVIEW SCOPE

The dominant frameworks for environmental sustainability, the circular economy, risk-tiered pollution regulation, and net-zero energy transition were articulated in and for high-capacity states with reliable infrastructure, well-funded regulators and mature markets. Their transfer to resource-constrained economies is frequently theorised as a problem of technology adoption or finance. This framing is incomplete. In much of West Africa, the determinants of whether a sustainability intervention succeeds are institutional coherence, enforcement capacity, public awareness and the mobilisation of social and cultural resources, variables that vary far more across settings than the underlying technologies do.

This review synthesises multidisciplinary perspectives on ecological stewardship, waste management, green architecture, renewable energy and climate adaptation, with a geographic focus on resource-constrained settings in West Africa and a theoretical remit that deliberately bridges technical, socio-cultural, religious and macroeconomic frameworks. The rationale for that breadth is that sustainability in these settings is not partitioned along disciplinary lines: a waste crisis is simultaneously an engineering problem, a governance problem and a behavioural one; a climate shock is simultaneously an agronomic and a security event. A review confined to any single discipline would misrepresent the phenomenon.

The review is organised into four thematic sections mapped to the structure of the field. Section 4 addresses socio-ecological stewardship, faith-based environmental paradigms and the socio-environmental drivers of conflict. Section 5 addresses waste management, circular-economy models and material innovation. Section 6 addresses renewable energy, pollution control and sustainable chemical processing. Section 7 addresses green architecture and adaptive land-use planning. Sections 8 and 9 discuss synthesis, limitations and research priorities. Section 2 sets out the method; Section 3 establishes the conceptual framing.

2. REVIEW METHODOLOGY

This is a narrative thematic review, and its evidence base and limitations should be read accordingly.

The review is anchored on a defined primary corpus of recent empirical and conceptual studies published in two 2026 outlets, the *British Journal of Contemporary Research* (BJCR) and the *British Journal of Advanced Research* (BJAR), selected for their concentration of West African sustainability research across the technical, social-scientific and humanities disciplines the review's scope requires. Studies were included where they engaged substantively with an environmental-sustainability, resource-management or climate-resilience theme and were situated in a resource-constrained setting; a study on psychiatric stigma present in the source material was excluded as outside scope. The resulting corpus of seventeen studies was read thematically and mapped to the four-part structure above.

This primary corpus was then read against the international literature and authoritative policy and scientific sources, including the IPCC Sixth Assessment, the World Bank's global waste assessment, and foundational works in eco-theology, political ecology and circular-economy theory to situate the regional evidence, adjudicate its claims and identify where it converges with or departs from established findings.

Three limitations follow from the design. First, anchoring on two journals produces a convenience sample rather than a systematic or representative one; the thematic weighting below reflects the corpus, and adjacent sub-topics named in the field are under-represented where the corpus does not address them (noted explicitly in Sections 5 and 7). Second, the corpus is dominated by single-site, cross-sectional survey studies and design-stage technical models, which constrains the strength of causal and generalisable claims. Third, several corpus studies share authorship teams and, in one case, a dataset; these dependencies

are flagged where they bear on interpretation. The limitations are revisited in Section 8.

3. CONCEPTUAL FRAMING

Three organising ideas structure the synthesis.

The first is the distinction between *technical feasibility* and *systemic adoption*. A recurring pattern across the corpus is that a technology is demonstrated to work, a recycled-waste product meets strength specifications, a low-cost adsorbent removes dye, a green paint outperforms commercial equivalents, while the conditions for its diffusion at scale are absent. Sustainability failure in these settings is therefore frequently not a failure of engineering but of the institutional and market systems that would carry a proven technology into use. This distinction recurs in every section.

The second is the *circular economy* as an evaluative lens for materials and waste. In its established formulation, the circular economy reconceives waste as a feedstock and designs value-retention loops that displace virgin-material extraction and disposal (Ellen MacArthur Foundation, 2013). Applied to resource-constrained settings, the framework's promise is dual: environmental benefit and import substitution. Its limiting condition is the same institutional capacity that constrains technology adoption generally.

The third is *political ecology*, which treats environmental outcomes as inseparable from the distribution of power, poverty and access to resources. On this view, degradation, scarcity and climate stress are not free-standing biophysical facts but are mediated by social structure, and their consequences, including conflict and displacement, are distributed according to existing vulnerability (Homer-Dixon, 1999). This lens is essential to Section 4's treatment of the socio-environmental drivers of instability and to the review's overall claim that technical and social interventions cannot be separated.

4. SOCIO-ECOLOGICAL STEWARDSHIP, FAITH-BASED PARADIGMS, AND CLIMATE DRIVERS

4.1 Eco-theology and indigenous environmental ethics

A substantial strand of the corpus locates the foundations of environmental stewardship in religious and cultural value systems rather than in regulation. The premise long-standing in environmental humanities since White's (1967) argument that the ecological crisis has cultural and religious roots is that in societies where religious institutions exert strong influence over behaviour, sustainability depends on whether those value systems are mobilised for or against ecological care.

Kolade (2026) develops this textually, reconstructing the concept of dominion in Genesis 1:26–30 not as a warrant for exploitation but as a stewardship mandate, and reading it alongside Whitehead's (1929) philosophy of organism, which emphasises the interconnection of humanity and nature. The argument aligns the biblical creation narrative with Sustainable Development Goal 15 and contends that a healthy ecosystem is a precondition for human flourishing rather than an object of it. The contribution is interpretive, and its method is exegetical; it does not, and does not claim to, measure behavioural or ecological outcomes. Its value is in supplying a culturally resonant normative frame that reframes a widely cited theological source often blamed for anthropocentric attitudes.

The operational counterpart to this textual work appears in studies of faith-based organisations (FBOs). Aku et al. (2026) examine eco-spirituality among Christian and Muslim organisations in Jos Metropolis, arguing that FBOs function as environmental actors through advocacy, education, community mobilisation and value-based stewardship, and that their influence over individual behaviour and community norms makes them strategic partners where formal governance is weak. A companion study by Aku, Ashi, and

Chong (2026) assesses the architecture of faith-based institutions across Nigeria using a convergent mixed-methods design with 400 survey respondents and 25 key-informant interviews, reporting that sustainable design features natural ventilation, daylight optimisation, rainwater harvesting, solar photovoltaics, green landscaping and waste segregation significantly improve institutional environmental performance.

These studies establish that faith institutions are engaged with sustainability and command the social reach that formal agencies frequently lack. Their principal evidential weakness is shared: they measure awareness, self-reported practice and perceived impact rather than verified environmental outcomes. That FBO members report pro-environmental attitudes, or that religious buildings incorporate green features, does not establish a measurable reduction in emissions, waste or resource use attributable to faith-based action. The claim of impact is plausible, and the mechanism is credible, but the evidence remains at the level of perception. This is the central gap in the faith-and-environment literature that the corpus represents.

A distinct cultural register appears in Wodu and Eze's (2026) study of eco-cultural communication identity in the Niger Delta. Anchored in development-communication and political-ecology theory and using thematic analysis (Braun & Clarke, 2006) of interviews with 24 community stakeholders, the study finds that ecological spaces are central to indigenous identity, collective memory and livelihood, and that environmental degradation has eroded indigenous ecological knowledge and disrupted the traditional communication systems through which it is transmitted, while reinforcing anthropocentric institutional narratives that privilege economic extraction. The "anthropocentric avoidance gesture" names the discursive move by which development narratives sidestep ecological accountability. The study's importance is in identifying communication and cultural identity, not only technology or policy, as the terrain on which sustainability is contested. Its qualitative, single-region design limits generalisation, which is appropriate to its interpretive aims.

4.2 Climate stress and socio-environmental conflict

The political-ecology lens is most consequential where environmental stress becomes a security question. Mohammed and Abubakar (2026) examine the "ecology of insurgency" in Yobe State, using mixed methods spatial analysis of rainfall anomalies and land degradation, household poverty indices and community-level qualitative evidence to argue that Boko Haram and ISWAP recruitment and territorial control are sustained not by ideology alone but by accumulated environmental and economic shocks. Their careful formulation is that shrinking water availability, desertification along the Lake Chad corridor and the collapse of rain-fed agriculture have not caused insurgency directly but have removed the material and social buffers that might otherwise contain it, producing spatially concentrated overlaps between climate stress and instability.

This measured causal claim climate stress as a threat multiplier operating through livelihood collapse and weakened state presence, rather than as a direct cause, is consistent with the international environmental-security literature (Homer-Dixon, 1999) and with the IPCC's (2023) assessment that climate impacts interact with socio-economic vulnerability to compound risk. Its implication for this review is decisive: in the settings under study, environmental sustainability, poverty reduction and security are not separable policy domains. A waste, water or agricultural intervention in a fragile region is also a security intervention, and a sustainability policy that ignores this linkage will misallocate effort. The study's reliance on secondary spatial data and cross-sectional evidence means it establishes an association and a plausible mechanism rather than a tested causal pathway, a limitation it shares with most of this literature.

5. WASTE MANAGEMENT, CIRCULAR ECONOMY, AND MATERIAL INNOVATIONS

5.1 Integrated municipal solid waste systems

Municipal solid waste (MSW) in rapidly urbanising African cities is among the most visible sustainability failures, and the corpus contains a detailed diagnosis. Bello-Dange et al. (2026a, 2026b), drawing on a common evidence base of 689 valid survey responses supplemented by 23 stakeholder interviews and focus groups with informal-sector actors, characterise waste management in Abuja's Federal Capital Territory as fragmented, disposal-focused and spatially imbalanced. The quantitative findings are stark: only 42.3% of households reported door-to-door collection, 28.1% experienced irregular collection, 14.4% relied on open dumping, and 5.1% burned waste on site; source segregation stood at 26.3%, and 66.4% of households were unaware of municipal waste regulations. Institutional fragmentation across the relevant agencies was confirmed by nearly 70% of key informants. The authors estimate the current generation at approximately 1.33 million tonnes annually, rising to 1.84 million tonnes by 2035, and propose a phased Integrated Solid Waste Management System (ISWMS) built on governance reform, staged infrastructure investment, integration of the informal waste sector as cooperatives, sustainable financing and performance monitoring.

The central and well-supported argument is that Abuja's waste crisis is a systems-governance failure rather than a set of discrete operational faults, and that piecemeal technical fixes will therefore not resolve it. This reframing is the study's principal contribution, and it aligns with the international consensus that solid-waste outcomes track institutional and financing capacity more than technology (Kaza et al., 2018). Two cautions apply. First, the two papers report the same underlying dataset in two journals; readers should treat them as a single evidence base rather than as independent replications. Second, the proposed ISWMS is a design proposition derived from diagnostic data, not an evaluated intervention; its phased model is a reasoned recommendation whose real-world performance is untested. The proposal to formalise informal waste-pickers as cooperatives is particularly promising, connecting the governance diagnosis to the circular-economy and livelihood themes, but it also carries known risks (loss of income flexibility, elite capture) that the design stage cannot resolve.

5.2 Industrial waste re-utilisation and material innovation

Where Section 5.1 addresses the governance of waste flows, a cluster of technical studies demonstrates waste *valorisation*, the circular-economy move from disposal to feedstock.

Pius and Osariyekemwen (2026) recycle ceramic kiln-room waste (broken refractory bats, bricks and props), blending it with kaolin, ball clay and silica to manufacture refractory kiln props fired to approximately 1200°C. The recycled composite produced props with satisfactory strength, moderate shrinkage and resistance to warping and cracking, demonstrating that studio ceramic waste can substitute for imported refractory products. The study is a proof of concept at laboratory scale; it establishes technical feasibility and import-substitution potential without addressing production economics or scalability, which is the standard next question for such valorisation work.

Mbonu et al. (2026) developed eco-friendly acrylic emulsion paints from low-cost indigenous materials, partially substituting synthetic extenders with modified cassava starch (binder), palm-kernel-shell ash (extender) and neem-leaf extract (biocide). Tested against Nigerian, British and ASTM standards, their best formulation outperformed commercial-grade paint in scrub resistance, adhesion and water resistance, achieved a volatile-organic-compound content of 19 g/L (well below the 50 g/L eco-label threshold) and delivered production-cost savings of 55–64%. This is among the stronger technical results in the corpus because it combines environmental performance (low VOC, bio-based inputs), functional performance

against recognised standards, and a favourable cost position, the three conditions under which a green material can actually displace an incumbent. The evidence remains at bench scale, and shelf-life, weathering and industrial-batch consistency are not established, but the adoption case is more complete than is typical.

Idriss et al. (2026) characterise Fika bentonite clay as a low-cost adsorbent for the textile dyes methylene blue and methyl orange, reporting greater than 99% removal, pseudo-second-order kinetics ($R^2 = 0.9999$) indicating chemisorption, Langmuir maximum capacities of 9.11 mg/g and 12.06 mg/g, respectively, and optimal removal near neutral pH. The result adds to a large adsorption literature and supports locally abundant clay as a viable dye-removal medium. Its limitations are those endemic to the genre: near-perfect kinetic fits invite scrutiny, single-solute batch experiments do not represent multi-component real effluents, and regeneration and disposal of the spent adsorbent, the crux of whether adsorption is genuinely circular, are not addressed.

Taken together, these three studies substantiate the review's central claim in the materials domain: viable, low-cost, waste-derived or bio-based alternatives to imported and polluting products are technically achievable. The unanswered question in every case is the transition from bench demonstration to systemic adoption, the same gap identified in the governance of waste flows. (The specific sub-theme of activated carbon from agricultural residues such as sawdust and rice husk, common in this literature, is not represented in the present corpus; the bentonite study stands as the corpus's low-cost-adsorbent case, and readers should consult the dedicated activated-carbon literature for that adjacent line.)

6. RENEWABLE ENERGY, POLLUTION CONTROL, AND CHEMICAL OPTIMISATION

6.1 Renewable energy transition and optimisation

Energy sits at the centre of sustainability–development tension in resource-constrained economies, and the corpus addresses it at two scales.

At the macroeconomic scale, Chukunolu (2026) analyses Nigerian time-series data from 1990 to 2024 using Johansen cointegration and an error-correction model, finding counter-intuitively that renewable-energy consumption was associated with a statistically significant *decrease* in economic growth in the study period, while electricity generation, access and efficiency showed positive but statistically insignificant short-run effects. The author interprets the results as indicating long-run rather than short-run growth potential from power-sector improvement. This finding warrants careful reading rather than headline citation: a negative association between renewable consumption and growth in a system where traditional biomass dominates "renewable" consumption, and where the modern renewable sector is nascent, likely reflects the composition of the renewable category and the structure of the Nigerian energy economy rather than a causal drag from clean energy. It is a caution about aggregate energy statistics in transitional economies, not evidence against renewable investment, and the study's policy recommendation to intensify renewable and grid investment sits somewhat in tension with its own short-run coefficient, a tension the paper does not fully resolve.

At the building scale, Tarka et al. (2026) apply MATLAB-based linear programming to optimise energy use in a university administration building, using an energy audit to build consumption profiles and the Linprog solver to minimise consumption and cost subject to operational constraints. Air-conditioning showed the greatest saving potential, and lighting the largest combined energy and cost reduction. The study is a clean demonstration that algorithmic optimisation is a practical, low-capital decision-support tool for institutional energy management. Its scope is a single building, and its model rests on rated power and scheduling assumptions rather than metered load data, so the projected savings are modelled rather

than realised; validation against post-implementation metering is the necessary next step.

A cross-cutting governance perspective on this theme comes from Amba et al. (2026), who examine artificial intelligence and environmental sustainability in Nigeria through an international-political-economy lens, combining a 210-respondent survey with 25 key-informant interviews. They report that AI contributes most to environmental monitoring, climate prediction, energy efficiency and resource management, but that inadequate digital infrastructure, high costs, weak regulation, limited expertise and dependence on foreign AI platforms constrain adoption; correlation analysis shows a strong positive relationship between institutional capacity and the effectiveness of AI-driven sustainability initiatives. The study's most durable contribution is its framing of technological sustainability tools as embedded in dependency relations, donor reliance, foreign ownership of platforms and limited national control over environmental data, which reproduces the political-economy structures that shape adoption. This connects the energy and pollution-control themes to the review's overarching argument that institutional capacity, not technology, is the binding constraint.

6.2 Heavy-metal remediation and sustainable chemical processing

Pollution assessment and green processing form the corpus's applied-chemistry contribution.

Babagana et al. (2026) assess dietary exposure to arsenic, cadmium, chromium and nickel through fish and vegetables consumed around the Nguru Wetlands, using microwave-assisted acid digestion and atomic absorption spectroscopy to estimate daily intake, cancer risk and total cancer risk. They report elevated metal concentrations across tissues and total cancer-risk values from 0.001830 in lettuce to 0.002909 in tilapia, concluding that wetland-derived food is an important chronic exposure pathway warranting monitoring and contamination control. The study is methodologically careful in one respect that much of this literature is not: it explicitly cautions that total-chromium measurement does not distinguish carcinogenic Cr(VI) from Cr(III), and therefore that chromium risk should be interpreted conservatively, consistent with IARC (2012) classifications. This candour about a key uncertainty strengthens rather than weakens the paper. Its limitations are sample coverage and the absence of speciation analysis, which the authors acknowledge.

Yakubu (2026), in the corpus's sole formally designated review-and-modelling study, develops an integrated process model for lithium extraction from a Nasarawa-type Nigerian pegmatite (1.08% Li₂O), combining crushing, dense-medium separation, flotation, low-temperature NaOH roasting, counter-current leaching and CO₂ precipitation, with partial recovery of water, caustic and silicate residues. Response-surface optimisation identified a sustainability-adjusted optimum (333°C, NaOH-to-spodumene ratio 1.47, 83 minutes) predicting 97.5% lithium extraction and 83.5% overall recovery, with techno-economic estimates (NPV US\$80.7 million, IRR 22.9%) and an environmental screen suggesting that renewable electricity, heat recovery and caustic recycling could roughly halve climate impact. The study is valuable as an integrated treatment of technical, economic and environmental trade-offs for a critical-mineral value chain central to the energy transition. Its results are explicitly designed estimates. The author states plainly that pilot testing, residue assessment and local cost validation are prerequisites to investment, and the environmental screening is a first-order estimate rather than a life-cycle assessment. Read as a scoping model rather than a validated process, it is a credible contribution to the sustainable-processing literature.

7. GREEN ARCHITECTURE, SUSTAINABLE URBAN PLANNING, AND ADAPTIVE POLICY

7.1 Green building and indoor environmental quality

Ashi and Aku (2026) assess green architecture as a sustainability strategy in Jos Metropolis, surveying

architects, builders, planners, developers and households. They report that awareness of green architecture is rising, but practical adoption remains low, constrained by high construction costs, weak policy implementation, limited professional expertise and low public awareness; where adopted, green principles contribute to energy efficiency, improved indoor environmental quality, emissions reduction, water conservation and urban biodiversity. The awareness–adoption gap they document is the built-environment instance of the review's technical-feasibility-versus-systemic-adoption theme, and their recommendations (policy enforcement, financial incentives, awareness campaigns, professional training) target that gap appropriately.

One methodological caveat must be flagged: the study's abstract states that descriptive and inferential statistical techniques were *proposed* for analysis, language that leaves ambiguous whether the inferential analysis was executed on collected data or described as the intended method. This matters for the weight the findings can bear, and readers should consult the full analysis before treating the inferential claims as confirmed. The companion faith-based architecture study (Aku, Ashi, & Chong, 2026; Section 4.1) reports a more fully specified quantitative design and can be read alongside it on the same built-environment theme.

7.2 Climate adaptation in land management and planning

Garba et al. (2026) integrate local knowledge with decentralised land management for climate-resilient built-environment planning in semi-arid Northern Jigawa State, using a socio-spatial mixed-methods design that combines multi-temporal Landsat imagery, NDVI vegetation analysis, land-use/land-cover classification and rainfall and temperature assessment with interviews and focus groups. They find that population growth, agricultural expansion and infrastructure development have intensified land pressure, reducing vegetation cover and surface permeability and increasing exposure to heat stress, runoff and localised flooding, and that rainfall variability interacts with land-use decisions to shape vulnerability. Their conclusion that resilient planning in semi-arid areas requires not merely technical spatial planning but the integration of geospatial evidence, local knowledge, decentralised land-use control, vegetation restoration and participatory governance is the review's clearest articulation of the argument that adaptation is a socio-technical rather than purely technical undertaking.

The study's combination of remote-sensing evidence with community knowledge is a methodological strength, giving the participatory recommendation an empirical spatial foundation that community-only studies lack. Its adaptation framing connects directly to the food-security and agricultural-resilience concerns that dominate the wider West African climate literature; the specific sub-theme of indigenous cooperative strategies for flood mitigation and food security, though adjacent, is not directly represented in the present corpus and is best pursued through the dedicated agricultural-adaptation literature. As with the other spatial studies here, causal claims about the land-use/climate interaction rest on observational data.

8. DISCUSSION

Reading across the four themes, three cross-cutting findings emerge.

The binding constraint is institutional and behavioural, not technical. This is the review's most consistent result. The waste studies diagnose a systems-governance failure, not a technology deficit; the materials studies demonstrate working low-cost alternatives that have not diffused; the green-architecture study documents rising awareness alongside stalled adoption; the AI and land-management studies both find institutional capacity to be the decisive variable. The policy implication is that in resource-constrained settings, investment in enforcement capacity, financing mechanisms, public awareness and institutional coordination will frequently yield larger sustainability returns than investment in new technology, because

the technologies that matter already exist and work. This inverts the common assumption that these economies are primarily technology-takers awaiting transfer.

Cultural and social resources are an underused sustainability infrastructure. Faith-based institutions, indigenous ecological knowledge and eco-cultural communication systems operate precisely where formal governance is weakest, and command behavioural reach that state agencies lack. The corpus establishes that these resources are engaged with sustainability; it does not yet establish, with outcome data, how much measurable environmental benefit they produce. This is the field's most important evidential gap, because the policy case for integrating faith and indigenous institutions into environmental governance currently rests on plausibility and reach rather than on demonstrated impact. Closing that gap through outcome-based rather than perception-based evaluation would materially strengthen a promising and low-cost avenue.

Sustainability, poverty and security are one problem, not three. The Yobe insurgency study makes explicit what the political-ecology framing implies throughout: environmental degradation, livelihood collapse and instability are causally entangled. This has a direct design consequence. Sustainability interventions in fragile regions are simultaneously development and security interventions, and should be appraised as such; conversely, security responses that ignore the environmental and economic substrate of instability address symptoms. The integration of the corpus recommends across every theme, technical measures embedded in governance reform, participatory processes and cultural mobilisation is the coherent response to a problem that is itself integrated.

A methodological observation cuts across all three. The corpus is dominated by single-site cross-sectional surveys and design-stage technical models. These are appropriate to a young, region-specific, evidence base, and they generate valuable diagnoses and proof of concept, but they cannot yet support strong causal or generalisable claims, and several rely on self-reported or perceived outcomes as proxies for measured ones. The field's maturation depends on moving from diagnosis and demonstration toward evaluation.

9. LIMITATIONS

The review's own limitations qualify its conclusions. The primary corpus is a convenience sample drawn from two journals; its thematic weighting reflects that sample rather than a systematic survey of the field, and two named sub-themes (activated-carbon adsorbents; indigenous cooperative flood-mitigation strategies) are represented only by adjacent studies. The corpus is methodologically homogeneous in ways described above, which bounds the strength of synthesis achievable from it. Several constituent studies share authorship and, in the Abuja waste case, a dataset, so apparent convergence in places reflects common origin rather than independent corroboration. Finally, the geographic concentration in Nigeria and West Africa, appropriate to the review's stated scope, means the findings should be extended to other resource-constrained regions only with attention to differing institutional and ecological contexts.

10. CONCLUSION

Across ecological stewardship, waste and materials, energy and pollution, and the built and planned environment, the evidence converges on a single reframing: sustainability in resource-constrained economies is limited less by the availability of technology than by the institutional, financial, behavioural and cultural systems that would carry technology into use. Proven low-cost solutions for waste valorisation, water treatment, green coatings and building-energy management already exist in these settings; faith-based and indigenous institutions already reach populations that formal governance cannot; and the entanglement of environmental stress with poverty and instability is increasingly documented. What is missing is the systemic capacity to connect these elements and the outcome-based evidence to

guide that connection.

Three research priorities follow. First, evaluation research that measures the environmental outcomes of interventions and institutions, currently assessed only by awareness and perception, particularly for faith-based and indigenous-knowledge approaches. Second, scale-up and life-cycle studies that carry the corpus's bench-scale material and process demonstrations toward validated, economically and environmentally assessed production. Third, integrated analyses that treat sustainability, livelihood and security as the single coupled system the evidence shows them to be. Until the region's environmental research moves decisively from diagnosis and demonstration toward rigorous evaluation, policy will continue to be made on plausibility where it could be made on evidence.

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