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# Assessing the Feasibility of Vernacular Materials in Sustainable Housing Designs in North Eastern Nigeria: A Systematic Literature Review

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***Abstract-** North Eastern Nigeria is experiencing a severe housing problem as a result of ongoing violence and adverse weather conditions. As of February 2026, 2.33 million people were displaced, living in shelters exposed to temperatures above 40°C and frequent floods (IOM DTM Round 51; UNOCHA, 2025). Conventional cement-based building is becoming more unviable because to high embodied carbon, poor thermal efficiency, and prohibitively expensive costs in the face of annual Naira volatility of more than 30 percent. This research examines the viability of using stabilised vernacular materials specifically Compressed Stabilised Earth Blocks (CSEBs), thatch, and local timber into hybrid designs. These variants have vented hybrid roofs and CSEB walls that are linked to elevated concrete foundations via a Damp-Proof Course (DPC). Secondary data synthesis (2017-2026) shows that CSEBs provide superior passive cooling due to their large thermal mass and thermal lag (decrement factors 0.08-0.14), lowering cooling loads by 25-40% while maintaining interior temperatures of 8-12°C cooler. Economically, CSEBs provide 40-70% savings (NGN 57-60 vs. NGN 300+ for concrete) and act as a "FX-hedge" against import-driven inflation. Local sourcing avoids insecure supply-chain checkpoints in fragile and conflict-affected situations (FCAS), while the material's repairability (e.g., patching post-ballistic damage) boosts community-led resilience. These vernacular hybrids, which are embedded in circular economy and decarbonisation frameworks, reduce embodied carbon while also aligning with Nigeria's Paris Agreement obligations. The findings suggest for a hybrid vernacular revival as a culturally sensitive, low-carbon approach to closing the regional housing gap and promoting equitable recovery for displaced populations.***

***Keywords:** Vernacular architecture, North Eastern Nigeria, Fragile and Conflict-Affected Situations (FCAS), Passive Design Strategies, Decarbonization.*

## I. INTRODUCTION

North Eastern Nigeria, which includes Borno, Adamawa, and Yobe states, is facing a multidimensional housing problem exacerbated by prolonged instability, widespread relocation, and increasing climatic variability. According to UNOCHA's 2025 Humanitarian Needs and Response Plan and IOM Displacement Tracking Matrix reports (Rounds 49-51, 2024-2025), around 2.3 million persons are still internally displaced (IDPs), with Borno hosting the majority (~1.7 million). These communities live in insecure temporary shelters often improvised tents or primitive structures that are especially exposed to severe temperatures above 40°C during dry seasons, recurring droughts that increase water scarcity and food insecurity, and significant seasonal flooding. In 2024-2025, overlapping climate shocks, including devastating floods in Borno (displacing hundreds of thousands and claiming lives) and prolonged dry spells in arid zones, destroyed homes, farmlands, and livelihoods, compounding the region's humanitarian needs, which are estimated to be over 7.8 million people.

Conventional contemporary building, which relies on imported cement-based blocks and corrugated iron, is unsuitable and overpriced in this setting. These materials have high embodied carbon emissions, contribute to Nigeria's construction sector's ~23% share of national $CO_2$ output, and provide minimal passive thermal regulation in hot-arid conditions. This leads to elevated indoor heat stress and reliance on unreliable or unaffordable mechanical cooling. Economically, skyrocketing prices caused by inflation, supply-chain disruptions from conflict, and foreign exchange volatility make such dwellings unaffordable for low-income households, where poverty rates top

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67% in impacted areas. According to the Federal Ministry of Housing and Urban Development's National Housing Data Technical Committee study (January 2026 release), Nigeria's housing shortage would be at 14.925 million units by 2025, a data-driven adjustment from previous predictions of 17-28 million. The North East's shortfall is particularly acute due to displacement-induced demand, quick returnee influxes (<2.1 million returnees regionally), and limited reconstruction capability under ongoing instability. This creates a crucial gap in evidence-based routes for scalable, culturally appropriate hybrid designs that combine indigenous knowledge with modern durability requirements.

This article fills the gap by conducting a thorough synthesis of secondary sources to analyse the possibility using stabilised vernacular materials in hybrid house designs for increased climate resilience and affordability in North Eastern Nigeria. Hybrid designs include CSEB walls linked to elevated concrete foundations with a damp-proof course (DPC, such as a bituminous membrane) to reduce moisture wicking; local timber framing for seismic/flexural robustness; and vented thatch/metal hybrid roofs for enhanced insulation. These initiatives, which are aligned with Nigeria's decarbonisation goals and circular economy concepts, minimise embodied carbon, enhance recyclability, and make use of on-site resources. The analysis demonstrates the potential for 25-40% cooling energy savings, 50-70% cost savings compared to conventional builds, and increased social resilience in FCAS contexts, providing a low-carbon, culturally sensitive strategy to mitigate the regional housing crisis in the face of escalating climate and conflict pressures.

## II. LITERATURE REVIEW

Vernacular architecture in North Eastern Nigeria, notably among Hausa-Fulani and Kanuri populations, has traditionally depended on locally available materials such as mud bricks (tubali), savanna grass thatch, and acacia and neem timber. These elements directly respond to the region's Sahel-savanna climate, which is characterised by extreme diurnal temperature swings, low rainfall, and high solar radiation, using passive strategies such as thick walls (30-50 cm) for thermal mass and courtyards for natural ventilation (Danja et al., 2017; Adetoro, 2025). Historical examples, such as lasting constructions in Borno and Kano, show that mud compounds can provide cultural continuity and community spatial organization (Onyejegbu et al., 2023).

Analytically, these materials are well aligned with circular economy concepts (reduce, reuse, and recycle) and decarbonisation imperatives in building. Nigeria's built environment accounts for 23% of national $CO_2$ emissions, primarily from cement manufacturing and imported materials. This adds to environmental deterioration during increasing urbanisation (Awodele et al., 2025; Quintessence Environmental Consult, 2025; Unegbu, 2025). Vernacular techniques reduce embodied carbon by procuring clay/sand combinations on-site, reducing transport emissions to near-zero levels, and ensuring full recyclability at the end-of-life earth may return to the soil without waste. Stabilised variations, such as compressed stabilised earth blocks (CSEBs) with 5-7.5% cement or lime, improve performance while maintaining low-carbon profiles, lowering emissions by 40-50% when compared to concrete blocks (Bredenoord, 2023; Miyamoto International, 2023).

Thermal performance remains a key strength: mud bricks have low thermal conductivity (0.7-1.0 W/mK) and high thermal mass, absorbing daytime heat slowly and releasing it at night, resulting in 8-12°C cooler interiors without mechanical cooling. In hot-arid zones like North Eastern Nigeria, passive regulation beats concrete (U-value ~1.5-2.0 W/mK), with studies indicating 11-37% reduced yearly heat loads (Olaniyan et al., 2023; Wesonga, 2023). Thatch roofs provide insulation (0.2-0.4 W/mK), whereas timber framework allows for more flexibility in seismic or flood-prone locations.

In displacement and fragile situations (FCAS), CSEBs facilitate community-led production, promoting self-recovery, skill transfer, and cultural preservation among nearly 2.3 million IDPs (IOM, 2023; Modu, 2024). Projects in Borno show stabilised mud bricks with 4-10 MPa compressive strength and decreased water absorption that outperform makeshift shelters in floods (Mercy Corps, 2022).

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Unstabilized erosion caused by rain/termite damage, perceived impermanence, and regulatory stigma favouring contemporary materials are among the challenges (Danja et al., 2017; Adetoro, 2025). Stabilisation helps to address these issues, but long-term FCAS performance data, integration with renewables, and governmental incentives for wider implementation are lacking (Bredenoord, 2023; Unegbu, 2025). This literature emphasises the promise of vernacular materials as a sustainable, low-carbon approach, while also calling for hybrid solutions to combine traditional efficacy with current needs in vulnerable locations.

## III. METHODOLOGY

This study uses the Systematic Literature Review (SLR) technique to synthesise secondary data published between January 2017 and March 2026. The review process is guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021), which ensure transparency, replicability, and minimise selection bias, despite the fact that no meta-analysis is performed due to the heterogeneous nature of the sources (qualitative case studies, humanitarian reports, and empirical material tests).

The search method included three core databases: Scopus, Web of Science, and Google Scholar, as well as focused searches in open-access repositories (e.g., ResearchGate, MDPI, ReliefWeb) for grey literature from respectable organisations. Boolean strings combined core concepts: ("vernacular architecture" OR "mud brick" OR "tubali" OR "CSEB" OR "compressed earth blocks" OR "adobe" OR "thatched roof" OR "local timber") AND ("North Eastern Nigeria" OR "Borno" OR "Adamawa" OR "Yobe" OR "Sahel Nigeria") AND ("sustainable" OR "climate resilience" OR "displacement" OR "IDP" OR "housing" OR "stabilisation" OR "hybrid design" OR "circular economy" OR "decarbonisation" OR "FCAS"). There was no language filters applied other than English, and searches were date-restricted to include current stabilisation developments and FCAS context.

The selection criteria were established. Inclusion criteria included (1) peer-reviewed articles, conference proceedings, or high-credibility reports (e.g., IOM, Mercy Corps, UNOCHA) with empirical or analytical data on thermal performance, cost/economics, durability/resilience, or sustainability in North Eastern Nigeria or comparable arid/FCAS settings; and (2) relevance to vernacular/stabilized materials. Non-English sources, pre-2017 publications (with the exception of fundamental citations), research from non-arid Nigerian locations (for example, southern rainforest climates), solely theoretical pieces without data, and duplicates were all excluded.

Table 1: Inclusion and exclusion criteria for the systematic literature review

| *Criterion Type* | *Inclusion Criteria* | *Exclusion Criteria* |
|---|---|---|
| *Publication Type* | Peer-reviewed journal publications, conference proceedings, reliable humanitarian and technical reports (e.g., IOM, Mercy Corps, UNOCHA) | Non-peer-reviewed blogs, opinion articles, editorials, theses/dissertations lacking empirical evidence, and low-credibility grey literature |
| *Language* | English | Non-English publications |
| *Publication Date* | January 2017 – March 2026 (to capture recent stabilization techniques and FCAS contexts) | Pre-2017 (excluding fundamental works referenced secondary), after March 2026 |
| *Geographic Focus* | North Eastern Nigeria (Borno, Adamawa, Yobe) or comparable arid/Sahel-savanna/FCAS contexts | Studies focused only on southern/rainforest Nigeria, temperate temperatures, |

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| | | or unrelated worldwide locations. |
| *Content Relevance* | Empirical or analytical data on vernacular/stabilized materials (mud brick/tubali, CSEB, adobe, thatch, local wood) addressing thermal performance, cost/economics, durability/resilience, sustainability/decarbonization, or displacement/FCAS applications | Purely theoretical talks without data, studies on unrelated materials (e.g., steel, glass, contemporary composites), non-housing uses |
| *Data/Quality* | Contains quantitative data (e.g., U-values, compressive strength MPa, cost ratios, decrement factors, lag durations) or strong qualitative case studies/policy insights. | No verified data or metrics, anecdotal reports, duplicate records, retracted/low-quality sources. |

Criteria were adopted from PRISMA 2020 criteria (Page et al., 2021) to fit the scope of this desk-based systematic review.

After removing 45 duplicates from the initial pool of ~180 records, only 135 were left for title/abstract screening. After reviewing the whole text of 85 relevant sources, 25 were selected for synthesis. Of the 60 papers rejected at the full-text stage, 35 lacked specific quantitative performance metrics (e.g., U-values, MPa, cost ratios), 18 focused on unrelated geographic/climatic contexts (e.g., southern Nigeria or non-arid zones), and 7 were low-quality grey literature with no verifiable data or institutional support.

Data extraction focused on important factors such as material qualities (compressive strength, thermal conductivity), performance results (energy/cost savings, flood resistance), case studies (for example, Borno projects), and theme insights (FCAS benefits). Synthesis incorporated (1) theme coding to find trends in qualitative data (e.g., resilience in war zones) using a framework-based method, and (2) quantitative normalisation and cross-case comparison of measures for tabular display (see Table 1). Limitations include dependence on published secondary data (possible publication bias) and a lack of primary fieldwork; yet, the new integration of different humanitarian and academic information results in a streamlined, policy-relevant framework for North Eastern Nigeria.

## IV. RESULTS AND DISCUSSION

This section summarises the findings of the systematic literature review, which are organised around three major themes: thermal performance and energy efficiency, cost-effectiveness and affordability, and durability/climate resilience with FCAS benefits. Each subject adheres to the TECI framework (Trend, Evidence, Comparison, Implication) to guarantee systematic, evidence-based research, drawing on empirical data from North Eastern Nigeria and similar dry situations.

### Theme 1: Thermal Performance and Energy Efficiency

Stabilised vernacular materials, particularly CSEBs, provide exceptional passive cooling in hot, dry North Eastern Nigeria due to their high thermal mass and obvious thermal lag, exceeding conventional concrete in diurnal temperature swing mitigation.

CSEB walls have low thermal conductivity (0.7-1.0 W/mK) and high specific heat capacity (~800-1,000 J/kg·K), keeping interior temperatures 8-12°C lower than outside maxima during daytime extremes (>40°C in Borno/Adamawa dry season). Prototypes in Borno reduced cooling loads by 25-40% compared to uninsulated concrete structures (Mercy Corps, 2022; IOM, 2023). The thermal lag mechanism is physics-driven. High thermal mass absorbs solar and ambient heat slowly during the day due to low thermal diffusivity (10^{-6}-10^{-7} m²/s for earth), delaying peak heat flux transmission through the wall by 8-12 hours. This transfers the highest inside heat load from mid-afternoon (when outdoor temperatures peak) to late evening/night (when ambient temperatures fall dramatically, frequently by 15-20°C), flattening the diurnal temperature swing curve and lowering peak-to-trough amplitude indoors. In hot-arid models and monitoring, earthen walls exhibit decrement factors of 0.08-0.14 (amplitude decrease to 8-14% of external swing) and lag periods of 5-12 hours (Carrobé et al., 2021; Daoudi, et al., 2019; Wesonga, 2023; Belarbi et al., 2025). Recent experimental evaluations of raw earth walls across climates support these findings, with time delays of up to 12 hours and decrement factors as low as 0.08 in dry environments, considerably outperforming traditional masonry (Belarbi et al., 2025). Thatch roofs (0.2-0.4 W/mK) provide additional insulation by reducing solar gain through low emissivity and ventilation gaps, whilst timber frame facilitates cross-ventilation and night purging tactics that take use of colder nighttime air.

Local field data from Adamawa (Girei) demonstrate that mud brick homes sustain lower mean indoor temperatures than cement block counterparts (34.88°C vs. 35.44°C in dry season and 26.76°C vs. 30.16°C in rainy season), with significant differences at p0.05 (Olaniyan et al., 2023; Maimagani et al., 2023). In Maiduguri simulations, CSEB-insulated designs saved cooling energy by up to 37.9% per year, demonstrating the material's efficiency in Sahel-savanna temperatures with significant diurnal variations (Okonta et al., 2023). Comparative experiments on CDW-stabilized rammed earth indicate time delays of 50-90 minutes and decrement factors 0.85-0.95 under varying humidity, demonstrating the earth's potential to control heat transmission even in semi-arid transitions (Fouad et al., 2025).

Adobe in Mali and Yemen maintains comfort with decrement factors >0.5 and lags >8 hours, surpassing concrete's shorter lag (2-4 hours) and higher U-value (~1.5-2.0 W/mK), which allows for rapid heat ingress and larger diurnal swings (Hu et al., 2023; Rincón et al., 2019; Belarbi et al., 2025). In hot semi-arid regions (BSh/BWk categories common in the Northeast), stabilised earth offers damping 2-3 times more effectively than burnt bricks or cellular concrete, which have lower inertia and respond faster to external oscillations (Fouad et al., 2025). Nigerian-specific experiments (e.g., Maiduguri/Adamawa) demonstrate 11-37% lower yearly heat loads for adobe/CSEB versus sandcrete/concrete, with higher performance in dry seasons with diurnal variations exceeding 20°C (Olaniyan et al., 2023; Maimagani et al., 2023). Unlike contemporary insulated blocks, vernacular earth thrives at passive phase shift without the need for additional energy inputs, providing cost-free thermal buffering.

Vernacular hybrids lessen the need for mechanical cooling in electricity-scarce FCAS regions by shifting and flattening diurnal fluctuations, hence supporting decarbonisation goals (lower operating energy/carbon) and improving thermal comfort for IDPs/returnees suffering heatwaves. This passive strategy is consistent with Nigeria's Nationally Determined Contributions under the Paris Agreement and projected heatwave intensification (e.g., +2-5°C by 2100), providing scalable, zero-energy solutions that promote health equity (reduced heat stress-related illnesses such as dehydration and cardiovascular strain), productivity in displacement settings (better sleep, work capacity), and long-term climate adaptation in vulnerable arid zones. Hybrids, when combined with renewables (such as solar ventilation), have the potential to reach near-net-zero operational carbon, bridging humanitarian shelter requirements and global sustainability objectives.

Theme 2: Cost-Effectiveness and Affordability

Stabilised vernacular materials result in significant cost savings, making homes affordable for displaced and low-income Nigerians amidst inflationary and FX instability.

Evidence shows that CSEBs in Borno cost NGN 57-60 per unit (295 × 140 × 90 mm) with 7.5% cement stabilisation and manual/automatic compression (Mercy Corps, 2022). At ~NGN 1,385/USD (March 6, 2026 market rate, CBN NFEM ~1,384-1,387; parallel 1,385-1,395), this amounts to ~USD 0.041-0.043 each brick, 40-70% cheaper than cement blocks (NGN 300+/unit, ~USD 0.217+). Construction reductions of 60-70% for a two-room apartment with veranda (NGN 322,000 vs. NGN 901,000 for concrete equivalent) are achieved by local soil procurement, community labour, little cement (7.5%), and decreased transportation (Mercy Corps, 2022; Miyamoto International, 2023; Bredenoord, 2023). Locally produced thatch roofing (~NGN 300-500/m²) and timber framing are cost-effective, and manufacturing may be scaled through community cooperatives in IDP camps. Recent studies reveal that CSEBs use just 1.2 tonnes of cement per 100 m² wall, compared to 2.98-3.68 tonnes for hollow concrete blocks, resulting in 50%+ cement savings (Shiferaw, 2025). Community-led production in displacement circumstances reduces effective costs by 50-60% using self-help labour.

Conventional cement blocks rely on imported clinker/energy (priced in USD), exposing prices to currency depreciation and inflation spikes (Nigeria's Naira volatility has recently exceeded 30% per year). Vernacular materials are largely "FX-hedged" prices remain stable because inputs (clay, straw, labour) are naira-denominated and locally abundant, as opposed to imported dependencies that inflate costs 20-25 times in remote North East areas due to logistics/checkpoints (UNOCHA, 2025; Mercy Corps, 2022). Global CSEB standards in low-income dry zones indicate similar 50-70% savings (Bredenoord, 2023), but North East applications benefit specifically from displacement-driven community production models, which reduce labour costs by 50-60% through self-help programs while avoiding supply interruptions. Comparative evaluations in Nigeria demonstrate that earth blocks achieve 46% production cost reduction per unit compared to traditional (NNADI et al, 2022).

These savings enable self-build and speedy rehabilitation for more than 2.3 million IDPs/returnees, directly addressing Nigeria's 14.925-million-unit gap (2025 Federal Ministry statistics, verified 2026). FX-hedging reduces vulnerability to macroeconomic shocks (for example, further Naira depreciation), promotes equitable access, economic resilience in poverty-affected (>67%) regions, and lowers import-related carbon footprints, all of which align with circular economy principles for sustainable development and poverty alleviation in FCAS. This method strengthens local economies, produces jobs in material production/repair, and promotes inclusive growth by prioritising indigenous resources over fragile global supply chains.

Theme 3: Durability, Climate Resilience, and Conflict Advantages
Stabilisation addresses conventional weaknesses (erosion and poor strength), while vernacular excels at FCAS because to supply-chain security, fast repairability, and societal resilience.

CSEBs have a compressive strength of 4-10 MPa (7.5% cement giving ~9.98 MPa) and 15-50% reduced water absorption than unstabilized mud. More than 500 Borno units outperformed tents during the 2022 floods (Mercy Corps, 2022). DPC integration (bituminous membrane or cement layer) reduces capillary rise and increases durability in flood-prone locations. In combat settings, local sourcing avoids checkpoints (by avoiding insecure imported cement/steel routes); earth/timber permits patching (e.g., mud re-plastering or timber replacement after ballistic damage) without the need for specialised equipment or contractors. Community knowledge facilitates self-repair, decreasing external reliance and downtime. Similar earthen constructions in Yemen's mud-brick legacy have survived centuries with periodic replastering, even in the face of violence and strong rains, although maintenance gaps hasten degradation (Schwartzstein, 2023; Fire Risk legacy, 2025). Mali's Djenné Great Mosque exemplifies yearly community replastering as a traditional practice that ensures longevity against environmental conditions.

Matches low-grade concrete durability (7-15 MPa) while providing higher eco-benefits (recyclability, low embodied carbon) and exceeds tents in terms of flood and lifespan (IOM, 2023). Unlike concrete (which requires mixers/contractors for repairs and is subject to supply shortages), vernacular promotes adaptive capacity residents patch homes with local skills, ensuring continuity throughout prolonged relocation. Global earthen cases (Yemen/Mali) demonstrate similar resilience in arid/conflict zones, with mud structures frequently repaired communally following damage, but the North East's FCAS context amplifies supply-security benefits, with local materials allowing for faster recovery than imported systems (Bredenoord, 2023; Modu, 2024; Schwartzstein, 2023). Stabilised alternatives, such as CDW-CaO rammed earth, provide equivalent thermal inertia and

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strength while minimising environmental effect (Fouad et al., 2025).

Local materials improve adaptive capacity: community-based repair expertise lowers downtime, empowers inhabitants (particularly women and adolescents in IDP contexts), and decreases reliance on unstable external supply chains. This promotes social resilience, which is essential for long-term recovery in insecure situations, while also harmonising with humanitarian objectives (for example, IOM/Mercy Corps pilots). Scaling hybrids could transform displacement responses by promoting long-lasting, culturally appropriate shelter at climate/conflict intersections, contributing to SDGs 11 (Sustainable Cities) and 13 (Climate Action), and fostering community agency in fragile settings through knowledge transfer and participatory construction.

Table 1. Comparative properties of selected building materials

| *Material* | *Compressive Strength (MPa)* | *Thermal Conductivity (W/mK)* | *Cost per Unit (NGN / ~USD)* | *Durability (Years, Stabilized)* |
|---|---|---|---|---|
| *Stabilized Mud Brick* | 4–10 | 0.7–1.0 | 57–60 / ~0.041–0.043 (March 6, 2026) | 20–50 |
| *Thatch Roof* | N/A | 0.2–0.4 | Low (local, ~300–500/m²) | 5–15 |
| *Local Timber* | Variable (150–500 NGN/linear m for acacia/neem variants) | 0.1–0.2 | Variable (regional market-dependent) | 15–30 |
| *Concrete Block* | 7–15 | 1.5–2.0 | 300+ / ~0.217+ | 50+ |

Source: Mercy Corps (2022), Hu et al. (2023), Bredenoord (2023); timber cost ranges based on Nigerian market reports (2024–2025).

The TECI-structured analysis identifies vernacular hybrids as a viable, multi-benefit solution: superior passive thermal regulation flattens diurnal swings for comfort/decarbonization; FX-hedged affordability addresses economic barriers; and FCAS-specific benefits (supply security, self-repair) improve resilience. These findings go beyond individual reports to establish an integrated framework for policy/practice in vulnerable dry zones, with the potential for replication in additional Sahel/FCAS contexts and larger low-carbon housing transitions. Synergies across themes thermal savings decreasing energy poverty, economic advantages enabling scale, resilience assuring longevity place vernacular hybrids as a comprehensive approach to sustainable, egalitarian shelter in North Eastern Nigeria.

## V. CONCLUSION AND RECOMMENDATIONS

This systematic literature analysis reveals that stabilised vernacular materials, including compressed stabilised earth blocks (CSEBs), thatch, and local lumber, provide a very viable pathway for sustainable, resilient, and inexpensive house designs in North Eastern Nigeria. The TECI-structured analysis of thermal performance, cost-effectiveness, and durability/climate resilience reveals clear benefits: CSEB walls achieve superior passive cooling through high thermal mass and pronounced thermal lag (decrement factors 0.08-0.14, lags 5-12 hours), reducing cooling loads by 25-40% and flattening diurnal temperature swings for enhanced comfort in arid extremes (Mercy Corps, 2022; Belarbi et al., 2025). Local procurement and community labour produce cost savings of 40-70% each unit (NGN 57-60 vs. NGN 300+ for concrete blocks) and overall

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construction reductions of 60-70%, making hybrids "FX-hedged" against Nigeria's macroeconomic volatility (Mercy Corps, 2022; UNOCHA, 2025). In fragile and conflict-affected situations (FCAS), vernacular approaches provide unrivalled supply-chain security (bypassing checkpoints), rapid self-repairability (community patching after damage), and social resilience through the preservation of indigenous knowledge, outperforming conventional materials in long-term displacement contexts (Bredenoord, 2023; Modu, 2024; IOM, 2023).

The findings go beyond individual humanitarian reports (e.g., Mercy Corps, IOM) and academic research by presenting a unique integration of heterogeneous datasets into a unified policy framework. This paradigm connects localised material performance metrics thermal damping, cost stability, and adaptive repairability with Nigeria's pressing national housing shortfall of 14.925 million units (2025 Federal Ministry statistics) and global decarbonisation objectives under the Paris Agreement. Vernacular hybrids provide a low-carbon, culturally sensitive alternative to energy-intensive imported construction by reducing embodied and operational carbon while leveraging circular economy principles (on-site sourcing, recyclability), aligning with SDGs 11 (Sustainable Cities and Communities), 13 (Climate Action), and 7 (Affordable and Clean Energy).

Recommendations

1. Policy and Regulatory Incentives: Federal and state governments should integrate CSEB/hybrid designs into the National Housing Programme and Building Energy Efficiency Code (BEEC), providing subsidies, tax breaks and streamlined approvals for stabilised earth projects in IDP/returnee settlements (specifically in Borno, Adamawa and Yobe states).
2. Capacity Building and Training: NGOs (e.g., IOM, Mercy Corps) and local institutions should provide community-led training programs on CSEB production, DPC integration, and hybrid building techniques, with a focus on women and youths to promote social inclusion and skill transfer.
3. Scaled Pilot Projects: Conduct multi-site demonstrations (minimum 1,000 units) of vernacular hybrids with solar ventilation and rainwater collection. Monitor long-term performance (thermal, structural, social) to create empirical data for evidence-based scaling.
4. Longitudinal Research and Monitoring: Support multidisciplinary studies that follow hybrids under climate/conflict stresses, such as flood/heatwave estimates from 2025-2030. Evaluate decarbonisation impacts and adaptive ability to support policy refinement.

Adopting these strategies might hasten the shift to resilient, egalitarian housing in North Eastern Nigeria, protecting cultural heritage while promoting sustainable development in one of Africa's most vulnerable areas.

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