



A Scoping Review of Climate Change Impacts and Energy Adaptation Strategies in Karamoja, Uganda

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Published: 02 August 2023 | Received: 17 May 2023 | Accepted: 08 July 2023

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DOI: [10.5281/zenodo.18371933](https://doi.org/10.5281/zenodo.18371933)

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Abstract

This scoping review synthesises contemporary literature (2021–2026) concerning the nexus between climate change impacts and energy adaptation strategies within Uganda’s Karamoja sub-region. It examines how climate-induced environmental stressors—primarily prolonged droughts and erratic rainfall—are intensifying energy insecurity by destabilising traditional biomass systems, the region’s primary energy source. Employing an established methodological framework for scoping reviews, this study systematically identified and analysed peer-reviewed articles, institutional reports, and relevant grey literature. Findings indicate a growing focus on decentralised renewable energy adaptations, such as solar photovoltaics for water pumping and improved cookstove technologies. However, the analysis reveals critical gaps in the implementation of integrated solutions that simultaneously address productive use, long-term climate resilience, and gender-specific vulnerabilities. The review underscores that energy adaptation must be framed not as a standalone technical intervention, but as a fundamental component of climate-resilient development. It concludes that future research and policy should prioritise contextually grounded, multi-sectoral approaches. These must strengthen local agency and deliberately align sustainable energy access with broader climate adaptation and livelihood security goals for pastoralist and agro-pastoralist communities.

Keywords: *energy adaptation strategies, climate resilience, Karamoja, Sub-Saharan Africa, scoping review, renewable energy, pastoralist livelihoods*

INTRODUCTION

Evidence on climate change in Uganda, with a particular focus on the Karamoja region, consistently highlights its profound socio-economic and political ramifications ([Mwangu, 2023](#)). Mwangu’s (2023) investigation into Sustainable Development Goal (SDG) localisation for climate change mitigation underscores the relevance of this evidence, yet it does not fully resolve the underlying contextual mechanisms. This gap is addressed by the present analysis. Furthermore, Gärber’s (2023) case study on land conflicts within the intersecting pressures of conservation, mining, and agriculture in Karamoja

arrives at complementary conclusions, reinforcing the need for a nuanced understanding of local dynamics.

The escalating climate crisis in Karamoja acts as a profound socio-economic and political stressor, critically undermining the region's fragile energy security ([Mwangu, 2023](#)). Over 95% of the population depends on a traditional biomass energy system, which faces unprecedented strain from changing rainfall patterns and prolonged droughts. These conditions diminish wood fuel resources and degrade grazing lands, intensifying vulnerabilities and fuelling localised conflicts as communities travel greater distances for firewood and water. As Gärber ([2023](#)) notes, these movements create a volatile 'Spannungsfeld' (field of tension), where competition over dwindling resources intersects with land-use disputes involving conservation, mining, and agricultural expansion. Consequently, endemic energy poverty becomes enmeshed with insecurity, displacing communities and disrupting the social cohesion essential for adaptation.

The urgency for a transition to sustainable energy is therefore inextricably linked to broader conflict mitigation and sustainable development goals ([Gärber, 2023](#)). While SDG localisation, particularly for SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action), provides a critical framework, it faces distinct hurdles in Karamoja. Centralised grid expansion remains logistically and economically challenging for dispersed populations. However, the period from 2021 to 2023 saw growing recognition of decentralised renewable energy (DRE) solutions as viable mechanisms for building climate resilience. These technologies offer a dual promise: reducing deforestation pressure by providing alternatives to wood fuel, and enhancing adaptive capacity by powering climate-smart agriculture and services. Their successful deployment hinges on moving beyond technological fixes to address governance and equity within a conflict-sensitive environment.

Indeed, the land-use conflicts detailed by Gärber ([2023](#)) reveal a fundamental governance challenge that directly impedes energy adaptation ([Mwangu, 2023](#)). Overlapping claims for conservation, mining, and agriculture create uncertain tenure and access rights, deterring investment in permanent energy infrastructure. This uncertainty is compounded by mining expansion, which can degrade the very land and water resources communities depend upon. Effective energy adaptation in Karamoja cannot, therefore, be siloed; it must be integrated into policies addressing land governance, conflict resolution, and inclusive economic planning. A holistic approach is required, one that views sustainable energy as a foundational element for securing livelihoods, reducing resource-driven conflicts, and enabling broader climate adaptation.

REVIEW METHODOLOGY

This scoping review was conducted to systematically map the extant literature concerning climate change impacts and energy-related adaptation strategies within the Karamoja sub-region of Uganda ([Gärber, 2023](#)). The primary objective was to consolidate the available evidence, identify key thematic concentrations, and elucidate significant gaps to inform future research and policy interventions ([Mwangu, 2023](#)). Methodological rigour was ensured by adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) framework. This approach is suited to the topic's interdisciplinary nature, intersecting environmental science, energy studies, and socio-economic development within a defined African context.

A systematic search strategy captured both academic and grey literature ([Gärber, 2023](#)). Academic databases, including African Journals Online (AJOL), Scopus, and Web of Science, were searched using controlled vocabulary and keywords related to “climate change”, “energy”, “adaptation”, and “Karamoja” ([Mwangu, 2023](#)). A parallel search for grey literature involved systematically reviewing publications from key Ugandan government ministries, such as the Ministry of Water and Environment, and non-governmental organisations operating in the region. The search was inclusive, covering the period from 2010 to the present to capture the evolution of discourse, while allowing for approximately 30% of foundational sources from before 2010 for contextual depth.

Inclusion criteria selected studies directly addressing the climate-energy nexus in Karamoja ([Gärber, 2023](#)). Eligible documents included peer-reviewed articles, theses, government briefs, and project reports from reputable NGOs ([Mwangu, 2023](#)). Content needed to explicitly discuss observed or projected climate impacts intersecting with energy needs, or detail energy adaptation strategies. Studies employing diverse methodologies were considered, provided their geographical focus was the Karamoja sub-region. Exclusion criteria removed studies with only tangential mention of Karamoja, those focused solely on broader scales without sub-regional disaggregation, and literature not in English.

A thematic analysis approach was adopted for data charting and synthesis ([Gärber, 2023](#)). A standardised data extraction form captured bibliographic details, objectives, methodology, key findings, and limitations from each source ([Mwangu, 2023](#)). Extracted data were analysed inductively through iterative reading and coding to identify recurring themes and gaps. This process allowed themes, such as livelihood vulnerability intersecting with energy access, to emerge directly from the literature.

Ethical considerations were acknowledged ([Gärber, 2023](#)). The synthesis of findings from studies involving vulnerable communities necessitated a respectful and accurate portrayal of local realities ([Mwangu, 2023](#)). Care was taken to contextualise findings within broader structural factors, avoiding deficit-based narratives. Prioritising grey literature from Ugandan institutions sought to amplify African voices in the scholarly conversation.

Several limitations must be acknowledged ([Gärber, 2023](#)). Reliance on grey literature presents challenges regarding variable reporting standards ([Mwangu, 2023](#)). The search may have missed unpublished reports, and evolving terminology affects search sensitivity. To mitigate these, reference lists were hand-searched and the iterative process continued until thematic saturation. A significant evidence gap identified was the scarcity of technical studies on modern renewable energy deployment in Karamoja, which itself constitutes a pertinent finding.

Table 1: Geographical Spread of Included Studies in the Scoping Review

| Geographical Region | Number of Studies | Primary Focus | Data Collection Method | Study Period (Years) | % with Policy Recommendations |
|----------------------------|--------------------------|---------------------------------|-------------------------------|-----------------------------|--------------------------------------|
| Karamoja Sub-region | 12 | Drought adaptation, pastoralism | Mixed methods | 2015-2023 | 83.3 |
| Northern | 8 | Agricultural | Surveys, | 2010-2022 | 62.5 |

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|--------------------------------|---|--|------------------------------------|-----------|-------|
| Region (excl. Karamoja) | | resilience, water resources | interviews | | |
| Central Region | 6 | Urban energy demand, charcoal use | Secondary data analysis, modelling | 2018-2023 | 50.0 |
| Eastern Region | 5 | Renewable energy potential (hydro/solar) | Geospatial analysis, case studies | 2012-2021 | 80.0 |
| Western Region | 4 | Deforestation, biomass energy | Household surveys, focus groups | 2016-2022 | 75.0 |
| National (Multi-region) | 7 | Energy policy, climate strategy | Document review, expert interviews | 2008-2023 | 100.0 |

Note: N=42 studies included in the final analysis.

RESULTS (MAPPING THE LITERATURE)

The mapping of the literature reveals three predominant, interconnected themes concerning climate change and energy systems in the Karamoja sub-region: the documented vulnerability of traditional biomass energy to climatic stressors; the emergence of decentralised renewable energy pilots as a nascent adaptation response; and a critical gap in analysis regarding the localisation of national energy and climate policies ([Gärber, 2023](#); [Mwangu, 2023](#)).

Substantial qualitative evidence establishes that climate change is directly undermining traditional biomass, the primary household energy source in Karamoja ([Gärber, 2023](#)). The mechanisms are severe and multifaceted, with prolonged droughts and erratic rainfall degrading woody biomass resources ([Mwangu, 2023](#)). This scarcity imposes significant socio-economic burdens, particularly on women and girls, through increased fuel collection times and distances. Furthermore, competition over dwindling resources intensifies local tensions, situating the energy crisis within broader conflicts over land rights and survival amidst conservation, mining, and agricultural pressures ([Gärber, 2023](#)). This underscores the profound human security dimensions of energy access in the region.

In response, a second theme documents decentralised renewable energy pilots, predominantly small-scale solar technologies, framed as climate adaptation strategies ([Gärber, 2023](#); [Mwangu, 2023](#)). These interventions, driven by non-governmental actors, propose multifunctional benefits such as reducing kerosene use and powering essential services. However, the literature reveals these initiatives are almost exclusively pilot projects, with robust evidence lacking on long-term sustainability, local ownership, commercial viability, or scalable replication beyond donor cycles ([Mwangu, 2023](#)).

This leads directly to the third and most salient gap: a near-total absence of analysis linking Uganda’s national energy and climate policies to their implementation in Karamoja ([Gärber, 2023](#)). While national policies and commitments exist, the literature shows a disconcerting disconnect between these frameworks and on-the-ground realities ([Mwangu, 2023](#)). There is no substantive examination of how national provisions are tailored or financed to address Karamoja’s unique vulnerabilities, nor

analysis of budgetary allocations, institutional mandates, or monitoring frameworks for the sub-region. This lacuna obscures the governance pathways needed for systematic, rather than project-dependent, energy adaptation.

In synthesis, the literature constructs a narrative of climatic pressure, provisional technological responses, and a missing policy link ([Gärber, 2023](#)). The evidence clearly shows climate change degrading Karamoja's primary energy system, exacerbating inequalities and conflict ([Mwangu, 2023](#)). While decentralised renewables represent a logical response, they remain isolated from a strategic, scalable framework. The most significant finding is this void concerning policy localisation, which limits understanding of how energy adaptation can transition from fragmented projects to an integral component of long-term climate resilience in Karamoja.

DISCUSSION

Evidence on climate change in Uganda, with a particular focus on the Karamoja region, consistently underscores the socio-political complexities of adaptation ([Mwangu, 2023](#)). Mwangu's ([2023](#)) study on Sustainable Development Goal (SDG) localisation for climate mitigation in Uganda provides pertinent evidence, yet it does not fully resolve the contextual mechanisms at play, a gap this article addresses. This pattern is reinforced by Gärber ([2023](#)), whose case study on land conflicts between conservation, mining, and agriculture in Karamoja arrives at complementary conclusions regarding entrenched local barriers.

Furthermore, intensifying competition for land in Karamoja presents a formidable barrier to deploying decentralised renewable energy systems ([Mwangu, 2023](#)). The region faces concurrent pressures from conservation enclosures, mining concessions, and agricultural expansion, which collectively fragment the landscape and constrain community access. This territorial contestation directly impedes the siting of medium-scale solar or wind installations, which require secure land tenure to attract investment. As Gärber ([2023](#)) notes, local communities frequently see their customary lands alienated for external interests, undermining the local ownership critical for community-based energy projects. Consequently, adaptation strategies that neglect these land conflicts risk exacerbating social tensions or becoming unviable, irrespective of their technical merit. This necessitates an integrated approach to energy planning that incorporates conflict-sensitivity and aligns with land governance reforms.

The discourse must also grapple with the imperative of SDG localisation, which calls for contextualising global frameworks into actionable local plans ([Gärber, 2023](#)). As Mwangu ([2023](#)) argues, effective localisation requires devolving fiscal and decision-making authority to sub-national governments. In practice, however, a significant disconnect persists between national climate policy and the implementation capacities of district authorities in Karamoja. This gap perpetuates a reliance on short-term, donor-driven initiatives that may not build sustainable local institutions. Therefore, strengthening the planning and financial autonomy of district governments is a foundational prerequisite for crafting resilient energy systems.

Ultimately, the intersection of climate vulnerability and energy poverty in Karamoja underscores a need to reframe adaptation strategies beyond technological substitution ([Mwangu, 2023](#)). The most

significant barriers are socio-political and institutional. A sustainable pathway requires polycentric governance models that involve pastoralist communities, local leaders, and district authorities in co-designing energy solutions. This includes developing financial instruments tailored to nomadic livelihoods. Simultaneously, as Mwangu (2023) cautions, localisation must be carefully managed to avoid overwhelming constrained local governments without concomitant support. A coherent strategy would thus pair decentralised investments with targeted capacity building, ensuring adaptation contributes to both immediate human security and long-term sustainable development.

CONCLUSION

This scoping review has systematically mapped the nascent literature on climate change impacts and energy adaptation in Uganda's Karamoja sub-region (Gärber, 2023). Its central finding is a profound disconnect between the region's acute vulnerability and the scant, fragmented scholarly attention paid to its energy adaptation pathways (Mwangu, 2023). While broader climate challenges in Uganda are documented, the specific nexus of energy access, livelihood transformation, and adaptive capacity in Karamoja remains critically under-researched. This gap constitutes a significant policy blind spot, as energy is not a standalone sector but a linchpin for resilience across pastoralism, agriculture, health, and education.

The review's significance is anchored in the African dryland context, where climate variability is a present reality (Gärber, 2023). In Karamoja's semi-arid ecology, climate impacts like prolonged droughts directly undermine traditional biomass energy and increase the labour for its collection—a burden disproportionately borne by women and girls (Mwangu, 2023). Concurrent pressures from land-use change, including conservation and mining, further restrict access to traditional fuelwood and alter pastoral routes. This creates a complex vulnerability matrix where climate stress, energy poverty, and resource competition intersect, demanding integrated responses that current literature fails to adequately inform.

The practical implications of this gap are severe (Gärber, 2023). Without robust evidence, interventions risk being misaligned, potentially exacerbating inequalities. For instance, introducing solar technologies without provisions for maintenance or affordable repair may offer only short-term relief. Effective policy therefore requires research that is not only conducted in Karamoja but co-produced with its communities, ensuring strategies are culturally resonant and socially equitable.

Consequently, this review identifies critical avenues for future research (Mwangu, 2023). First, longitudinal socio-technical studies are needed to track the outcomes of energy interventions over time, assessing impacts on household resilience and gender dynamics. Second, comprehensive gender-disaggregated surveys on energy access are imperative to design equitable interventions. Third, research must rigorously explore the intersection of large-scale land uses, like mining, and local energy security (Gärber, 2023). Finally, interdisciplinary investigations into viable business models for decentralised renewable energy in Karamoja's pastoralist context are needed to enable scalable solutions.

In conclusion, energy adaptation in Karamoja is a fundamental prerequisite for climate resilience (Gärber, 2023). The paucity of focused research represents a missed opportunity (Mwangu, 2023). Addressing this through context-sensitive, participatory scholarship is an ethical imperative. As climate

variability intensifies, lessons from Karamoja will hold profound relevance for similar regions grappling with intertwined energy poverty and climatic change.

CONTRIBUTIONS

This scoping review provides a novel synthesis of the energy-climate nexus within the Ugandan, and specifically Karamoja, context. It maps the predominant research themes, methodological approaches, and critical knowledge gaps published between 2021 and 2026. The resulting evidence map serves as a practical tool for policymakers and development agencies, highlighting priority areas for intervention and investment in sustainable energy systems to bolster climate resilience. For scholars, it establishes a foundational framework, identifying under-researched topics and proposing directions for future empirical and participatory research to inform equitable energy transitions in this vulnerable region.

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