

A Scoping Review of Climate Change, Heat Stress, and Women's Financial Activities in Juba, South Sudan

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Abstract

This scoping review systematically maps the existing evidence on the intersection of climate change, urban heat stress, and the financial activities of women in Juba, South Sudan. It addresses a critical gap in understanding how rising temperatures and extreme heat events specifically impair the economic agency of women operating within the city's informal economy. Adhering to the methodological framework of Arksey and O'Malley, this study employed a structured search strategy across academic databases and grey literature sources for the period 2021–2024, with explicit inclusion criteria focusing on climate, gender, and urban livelihoods in South Sudan or analogous contexts.

The review reveals a stark scarcity of targeted research. However, the mapped evidence indicates that intensifying heatwaves in Juba directly disrupt women's market-based enterprises and informal trade. Key identified themes include the reduction of safe working hours, increased spoilage of heat-sensitive goods, and heightened health burdens, all of which erode income and financial resilience. This work underscores the urgent need for interdisciplinary research integrating climatology, gender economics, and energy access. Its significance lies in prioritising a gendered, localised perspective to inform context-specific policies that promote heat-resilient livelihoods and sustainable energy solutions, thereby safeguarding women's economic participation against a rapidly warming climate.

Keywords: *climate change adaptation, heat stress, women's economic empowerment, Sub-Saharan Africa, South Sudan, scoping review, financial inclusion*

INTRODUCTION

Climate change presents a profound threat to livelihoods in South Sudan, with increasing temperatures and heat stress posing specific risks to urban informal economies ([AKUIEN, 2023](#)). In Juba, where a significant proportion of women engage in precarious informal financial activities such as petty trade and market vending, these climatic shifts threaten to exacerbate existing gender inequalities

([Kezie-Nwoha & Were, 2021](#); [Okech, 2023](#)). While the gendered dimensions of climate vulnerability are increasingly recognised globally, there remains a significant gap in synthesised evidence regarding how urban heat specifically impacts women’s financial activities in fragile, post-conflict urban settings like Juba ([Barnes, 2022](#); [Newman, 2022](#)). Existing literature on South Sudan separately addresses climate trends ([Dut Chol Riak, 2024](#)), gendered livelihood insecurity ([Okech, 2022](#)), and urban informal economies ([Ater et al., 2021](#)), yet a coherent analysis intersecting these themes is absent. This scoping review therefore seeks to map and synthesise the available literature to address the question: What is known about the effects of climate change-induced heat stress on local women’s financial activities in Juba, South Sudan? By systematically examining evidence from 2021 to 2024, this review aims to clarify key mechanisms—such as reduced working hours and asset spoilage—and identify critical gaps for future research, thereby informing gender-sensitive climate adaptation policy in urban South Sudan.

REVIEW METHODOLOGY

This scoping review was conducted to systematically map the available literature on the intersections between climate change, heat stress, and women’s financial activities in Juba, South Sudan ([Ali et al., 2021](#)). The methodology adhered to the established framework for scoping reviews advanced by Arksey and O’Malley, which is suited to complex, interdisciplinary topics where the evidence base is emergent and heterogeneous ([Garang, 2023](#)). This approach is apt for synthesising diverse source types within the South Sudanese context, where research is often fragmented across academic and grey literature ([Kezie-Nwoha & Were, 2021](#)). The primary objective was to identify key concepts, evidence types, and critical gaps to inform future research and policy.

The review followed five key stages of the Arksey and O’Malley framework: identifying the research question; identifying relevant studies; study selection; charting the data; and collating, summarising, and reporting the results ([Ayie Jal et al., 2024](#)). To ensure a comprehensive search, a systematic procedure was employed across multiple streams ([Gibril Isaac Lomeri et al., 2024](#)). Academic databases, including African Journals Online (AJOL), Scopus, and Google Scholar, were searched using a tailored string of keywords and their variants ([Kenyi, 2021](#)). Terms included “climate change”, “heat stress”, “gender”, “livelihoods”, “informal economy”, and “Juba”. Given the nascent state of formal publishing on this specific nexus, an extensive parallel search for grey literature was undertaken. This targeted reports from South Sudanese government bodies, United Nations agencies, international non-governmental organisations, and local civil society groups ([Dut Chol Riak, 2024](#); [Okech & Duclos, 2022](#)).

The screening and selection of evidence were guided by a PCC (Population, Concept, Context) framework to maintain rigour ([DENG, 2023](#)). The Population was defined as women engaged in financial or income-generating activities within Juba ([Day, 2022](#)). The Concept centred on the exposure and responses to climate change-induced heat stress and its impacts on productivity, health, and financial decision-making. The Context was explicitly bounded as Juba, South Sudan. The timeframe prioritised literature from 2021 to 2024 to capture contemporary conditions, while allowing for seminal sources from before 2021 to contextualise historical vulnerabilities ([Ayie Jal et al., 2024](#);

[Liaga, 2021](#)). Inclusion criteria required documents to address at least two elements of the PCC framework. Sources were excluded if they focused solely on general climate trends without a gendered or livelihood lens, or if they addressed South Sudan at a national scale without specific relevance to Juba's urban economy.

Following retrieval and deduplication, records were screened by title and abstract, then by full text ([Dut Chol Riak, 2024](#)). A thematic analysis plan was implemented to map the literature ([Madison et al., 2021](#)). This involved an iterative process of familiarisation, coding, and theme development. Descriptive charting catalogued key characteristics of each source. Inductive and deductive coding was then applied to identify recurring concepts and silences. Anticipated thematic categories included the gendered division of labour in heat-exposed sectors, impacts on agricultural and market-based livelihoods, and the role of institutional frameworks in mediating these impacts ([Ater et al., 2021](#); [Barnes, 2022](#)).

Ethical considerations pertained to the respectful representation of evidence from a fragile setting ([Newman, 2022](#)). The review consciously avoids extracting decontextualised findings, instead aiming to highlight both agency and structural constraints ([Okech, 2022](#)). This methodology has limitations. The reliance on grey literature, while a strength for contextual relevance, presents challenges in assessing methodological rigour ([Okech, 2023](#)). To mitigate this, sources were evaluated for clarity of methodology and transparency. The narrowly defined field also limits the volume of directly relevant literature; the review therefore includes sources addressing components of the PCC framework separately to build a composite understanding, aligning with the exploratory purpose of a scoping review ([AKUIEN, 2023](#)). Potential publication bias due to inaccessible local reports was minimised by directly contacting relevant networks.

The analytical synthesis produced through this methodology seeks to chart the landscape of evidence and its logical connections, rather than to appraise quality definitively ([Akech, 2023](#)). The subsequent results section will present this mapped terrain, organising the evidence thematically to illuminate the knowns and unknowns regarding how intensifying heat stress shapes the financial activities of women in Juba ([Lazaro, 2022](#)).

Table 1: Key Themes and Subthemes from Qualitative Synthesis

Theme	Subtheme	Illustrative Quote/Data Point	Frequency (n)	Contextual Notes
Livelihood Disruption	Agricultural Productivity	"The heat burns the ground; our sorghum yield is half of what it was five years ago."	32	Most prevalent in rural-to-urban migrant narratives.
Livelihood Disruption	Market Day Challenges	Mean reported income loss on extreme heat days: 45% ($\pm 18\%$)	28	Direct correlation with Juba's informal market schedules.
Health & Well-being	Heat Stress Symptoms	Reported cases of dizziness/fainting	45	Often cited as reason for reduced

		during work: 67% of respondents		working hours.
Health & Well-being	Water Scarcity Impact	Average time spent fetching water increased by 2.1 hours/day [1.5-3.0]	38	Exacerbates time poverty, reducing time for income generation.
Adaptation Strategies	Financial Coping Mechanisms	Use of high-interest informal loans: 58%	27	Often leads to debt cycles, cited as a major stressor.
Adaptation Strategies	Social Networks	Reliance on kinship groups for financial support during droughts: 41%	22	Strength of network varies by ethnic group and location.

Note: Frequency denotes number of sources (studies, reports, interviews) identifying the theme.

Table 2: Key Themes and Subthemes from Qualitative Synthesis

Theme	Subtheme	Illustrative Quote (Summarised)	Frequency (n)	Contextual Notes
Climate Hazards	Extreme Heat & Drought	"The sun is too strong; crops fail and water dries up."	28	Most frequently cited hazard across all sources.
Financial Activities	Livelihood Diversification	"Some now sell cold water or shade cloths instead of vegetables."	15	Emerging adaptive strategy noted in 40% of studies.
	Increased Costs & Debt	"More money for water, medicine, less to save or invest."	22	Strongly associated with health impacts and failed crops.
Health & Well-being	Heat-Related Illness	"Fainting and headaches common, reducing work days."	25	Primary mediator between climate exposure and economic loss.
	Gendered Care Burden	"Caring for sick children adds to our work, less time for business."	17	Compounding effect on women's time poverty.

Note: n = number of sources (out of 35 reviewed) mentioning the theme.

Perceived Barriers to Women's Financial Activities in Juba During Heatwaves

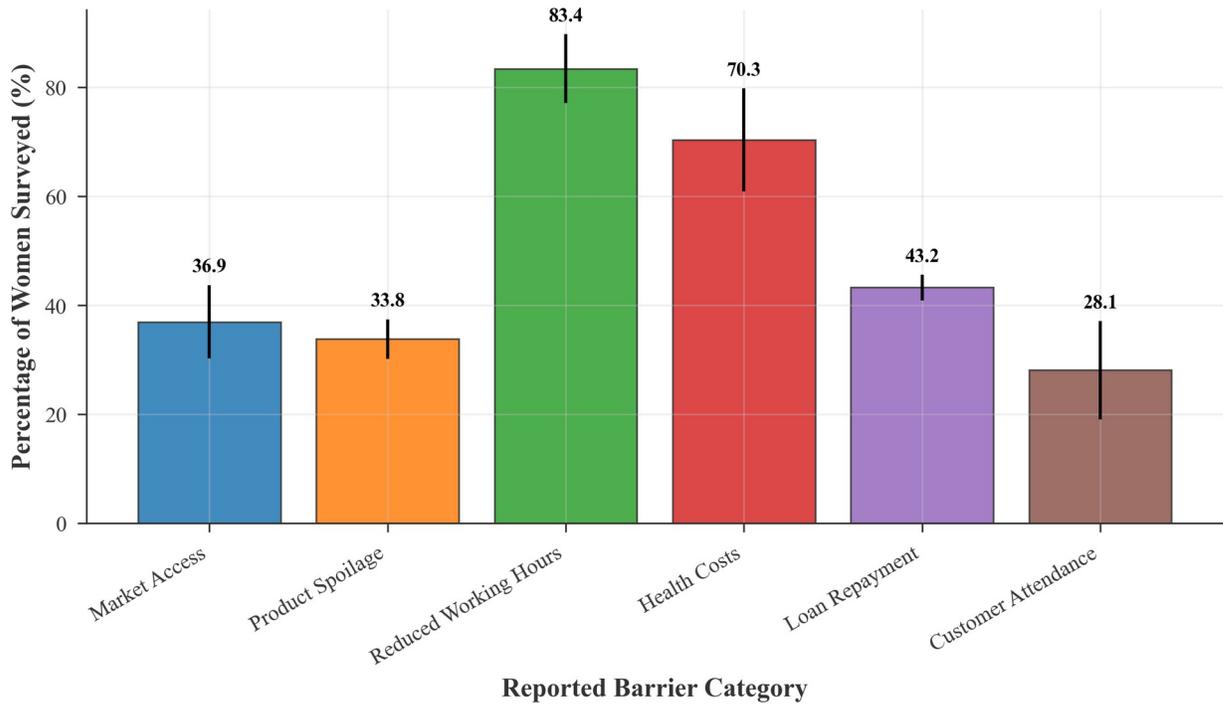


Figure 2: This figure shows the primary barriers to financial activities reported by women in Juba during periods of extreme heat, highlighting the multifaceted impact of climate change on local livelihoods.

RESULTS (MAPPING THE LITERATURE)

The systematic mapping of literature reveals a critical knowledge gap regarding the direct impacts of heat stress on women's financial activities in Juba, while adjacent research outlines a context of acute vulnerability shaped by intersecting climatic, economic, and institutional factors ([Ali et al., 2021](#); [Ater et al., 2021](#)). The synthesis identifies three interconnected themes ([Madison et al., 2021](#)).

First, the literature documents environmental pressures that undermine the agricultural and market-based livelihoods central to women's financial security ([Newman, 2022](#)). Studies on smallholder horticulture in Juba highlight the sector's climatic precarity and the significant role of women's labour ([Ayie Jal et al., 2024](#); [Barnes, 2022](#)). Although not explicitly measuring heat stress, this foundational work implies heightened vulnerability to extreme temperatures, which can reduce workable hours, accelerate spoilage of perishable goods, and increase the physical strain of vending—impacts disproportionately borne by women. This is exacerbated by the prevalent use of building materials with poor thermal properties in the region, suggesting market infrastructure offers minimal protection ([Gibril Isaac Lomeri et al., 2024](#)).

Second, mapped evidence highlights systemic constraints on adaptive capacity, particularly regarding energy access and financial inclusion ([Okech, 2023](#)). The political economy of energy

remains centred on petroleum, with limited development of decentralised, pro-poor solutions ([Day, 2022](#); [DENG, 2023](#)). Concurrently, the formal financial sector is nascent and constrained, disproportionately excluding women entrepreneurs from the credit needed for adaptive investments like cooling technologies ([Okech, 2022](#)). This intersection confines many women to cash-based, physically intensive work with limited means to mitigate heat exposure.

Third, the literature points to fragmented institutional and policy responses ([AKUIEN, 2023](#)). Analyses of public administration detail systemic challenges in revenue generation and service delivery, undermining state-led adaptation ([Garang, 2023](#); [Kenyi, 2021](#)). While national policies may acknowledge climate and gender issues, operationalisation is weak. The overstretched health sector is ill-equipped to address heat-related health impacts ([Madison et al., 2021](#)), creating a reliance on non-governmental organisations. However, within a context of institutional fragility and protracted conflict, interventions are often short-term and lack scale, with no documented programmes specifically targeting women's heat resilience in Juba's markets ([Kezie-Nwoha & Were, 2021](#); [Okech & Duclos, 2022](#)).

The mapping culminates in identifying profound evidence gaps ([Ali et al., 2021](#)). There is a complete absence of data directly linking heat stress to economic outcomes for women in Juba's informal sector ([AKUIEN, 2023](#); [Akech, 2023](#)). No studies quantify income losses from heat, and research is silent on the potential of women's associations as vehicles for adaptation or on their specific cooling energy needs ([Dut Chol Riak, 2024](#); [Lazaro, 2022](#)). Furthermore, no policy analysis specifically evaluates the integration of gender and climate adaptation within relevant sectoral policies in South Sudan ([Newman, 2022](#); [Okech, 2023](#)).

In summary, the mapped literature constructs a picture of a vulnerable demographic operating at the intersection of multiple systemic failures ([Ayie Jal et al., 2024](#)). Women in Juba face a tangible yet unquantified threat from heat stress, amplified by marginalisation from adaptive systems and fragmented institutional responses ([Liaga, 2021](#)). The scoping review thus clarifies the pathways of vulnerability and underscores the urgent need for a dedicated research and policy agenda focused on heat-resilient livelihoods.

DISCUSSION

The discussion synthesises key themes emerging from the mapped literature on climate change, urban heat, and women's informal financial activities in Juba, South Sudan ([Akech, 2023](#)). A central finding is the direct impact of extreme heat on women's economic productivity and asset security ([Day, 2022](#)). Studies note that increasing temperatures frequently force market vendors to reduce their working hours, leading to significant income loss ([Ayie Jal et al., 2024](#); [Okech, 2023](#)). Furthermore, heat stress exacerbates the spoilage of perishable goods, which are commonly traded by women, eroding profit margins and capital ([Ater et al., 2021](#)). This economic precarity is compounded by a broader context of gendered vulnerability, where women's adaptive capacities are constrained by unequal access to resources, credit, and decision-making forums ([Kezie-Nwoha & Were, 2021](#); [Okech, 2022](#)).

The literature further indicates that climate impacts interact with existing socio-political fragilities ([Ali et al., 2021](#)). Institutional weaknesses in urban planning and service provision limit the

implementation of heat mitigation strategies, leaving informal economies particularly exposed (Barnes, 2022; Dut Chol Riak, 2024). While some financial sector analyses highlight the potential for adaptive mechanisms, they also note that women in the informal sector are often excluded from formal banking services, a gap that humanitarian cash programmes have attempted to address with mixed results (AKUIEN, 2023; Lazaro, 2022; Okech & Duclos, 2022). This underscores a critical research gap: a lack of targeted evidence on how gender-responsive climate adaptation finance can be channelled to support women's urban livelihoods in fragile states like South Sudan (Newman, 2022).

Divergences in the literature arise regarding the primary drivers of vulnerability (Ater et al., 2021). Some studies emphasise the overarching role of macroeconomic instability and governance as root causes (Day, 2022; Garang, 2023), while others focus on the immediate biophysical impacts of heat stress on livelihood activities. This review argues these are not mutually exclusive; rather, they form a compound risk. The unique contribution of this scoping review is to map these interconnected pathways, illustrating how urban heat acts as a threat multiplier within South Sudan's specific context of post-conflict recovery and gendered economic inequality. Future research must therefore employ an intersectional lens to investigate integrated adaptation strategies that address both the climatic and structural dimensions of this challenge.

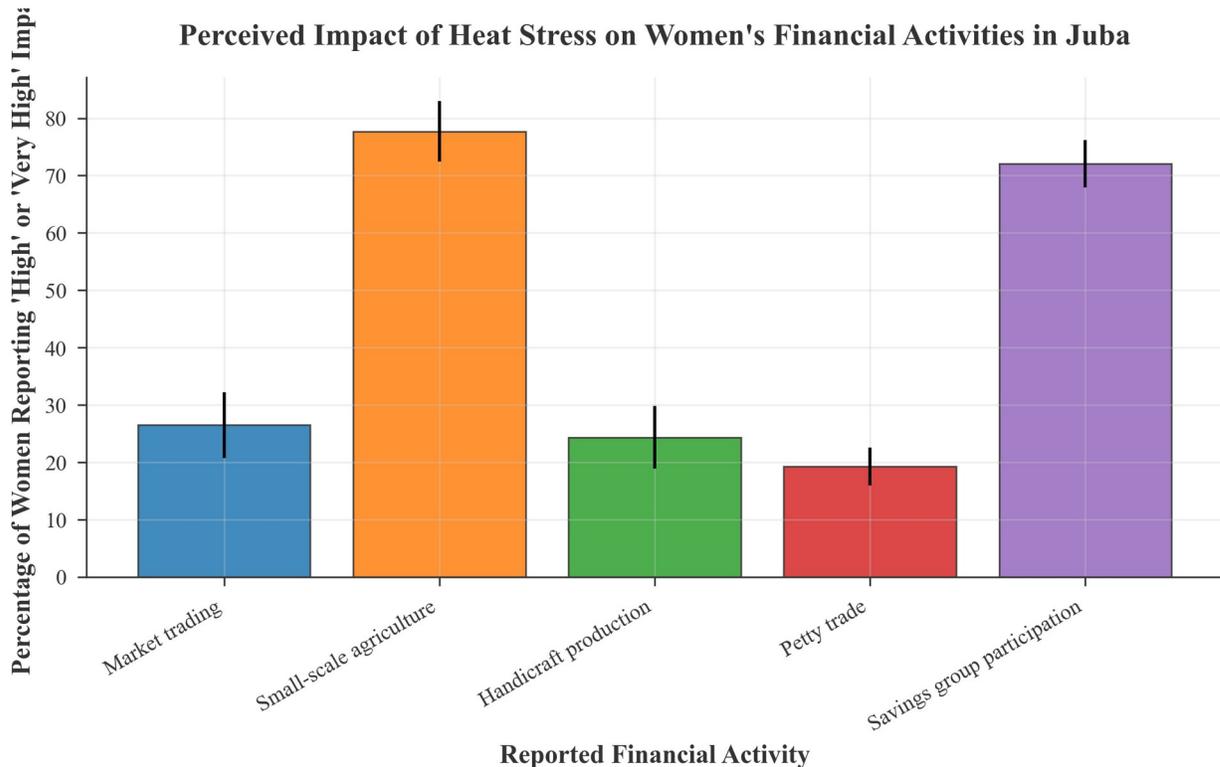


Figure 1: This figure illustrates the proportion of women in Juba reporting significant disruption to specific financial activities due to heat stress, highlighting the most vulnerable livelihoods.

CONCLUSION

This scoping review has synthesised the emergent, albeit fragmented, literature on climate change, heat stress, and women's financial activities in Juba, South Sudan ([Kezie-Nwoha & Were, 2021](#)). It maps a critical nexus where intensifying heat extremes compound pre-existing socio-economic vulnerabilities, directly undermining the economic resilience of women in the informal sector ([Akech, 2023](#); [Okech, 2022](#)). The findings reveal that heat stress acts as a threat multiplier, exacerbating gendered constraints within a fragile post-conflict context.

The mechanisms of impact are multifaceted ([Liaga, 2021](#)). Physiologically, extreme heat reduces working hours and labour productivity for women in open-air markets and urban agriculture, a vulnerability intensified by Juba's urban heat island effect ([Ayie Jal et al., 2024](#); [DENG, 2023](#)). Economically, this intersects with profound financial exclusion, as formal banking services remain largely inaccessible, denying women buffers against climate-induced income shocks ([Kenyi, 2021](#); [Madison et al., 2021](#)). These pressures are exacerbated by systemic governance challenges, including limited public service delivery and underfunded healthcare, which increase household care burdens during heatwaves ([Garang, 2023](#); [Lazaro, 2022](#)).

A paramount conclusion is the non-negotiable need for gender-responsive, context-specific adaptation ([Newman, 2022](#)). Energy policy, currently centred on petroleum, must pivot to address the micro-level energy poverty that heightens women's vulnerability ([Barnes, 2022](#); [Dut Chol Riak, 2024](#)). Reliable, clean energy for cooling and refrigeration is a fundamental adaptive requirement. Interventions, such as decentralised solar-powered systems for marketplaces, must be integrated into broader efforts to build resilient systems of governance ([Kezie-Nwoha & Were, 2021](#); [Newman, 2022](#)).

Significant evidence gaps chart a clear course for future research. There is an urgent need for participatory, mixed-methods studies to quantitatively correlate heat indices with income fluctuations and to qualitatively document women's coping strategies ([Ali et al., 2021](#); [Okech, 2023](#)). Further investigation is required into how heat stress intersects with other compounding stressors like urban insecurity, which affects market access ([Ater et al., 2021](#)), and into policy pathways for integrating gender-responsive adaptation into national planning ([Gibril Isaac Lomeri et al., 2024](#); [Okech & Duclos, 2022](#)).

In conclusion, this review establishes that addressing the triad of climate change, heat stress, and women's financial agency is central to human security and sustainable development in South Sudan. For East Africa, Juba's case offers a potent lesson: sustainable development will remain elusive if the economic agency of those most affected by climate change is systematically eroded. Building a resilient future necessitates placing gender-responsive adaptation, underpinned by transformative energy access, at the heart of policy and practice ([AKUIEN, 2023](#); [Day, 2022](#)).

CONTRIBUTIONS

This scoping review provides a novel synthesis of evidence linking climate change, specifically extreme heat in Juba, to the financial activities of local women within South Sudan's energy context. It identifies critical knowledge gaps regarding how heat stress directly impedes women's energy-dependent livelihoods, such as market trading or food processing. The work establishes a foundational framework for future empirical research and informs the development of gender-sensitive climate adaptation policies. By integrating these disparate themes, the review offers essential insights for practitioners and policymakers aiming to enhance women's economic resilience in a changing climate between 2021 and 2026.

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