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## Abstract

This book review critically assesses a pivotal volume analysing the interconnected environmental stressors confronting South Sudan from 2021 to 2026. The work synthesises escalating climate crises—including unprecedented heat stress in Juba and recurrent catastrophic flooding in Jonglei State—with the nation's profound energy poverty, framing these as a compounded developmental challenge. The review evaluates the book's methodological rigour, scrutinising its integration of satellite data, field-based hydrological studies, and socio-economic surveys to construct a holistic vulnerability assessment. It highlights the volume's key arguments: that regional climatic shifts are intensifying hydrological extremes, and that entrenched energy poverty directly cripples adaptive capacity, trapping communities in a cycle of exposure. The review commends the work for centring African, locally grounded perspectives, thereby specifying South Sudan's unique geopolitical and ecological context beyond generic vulnerability narratives. It concludes that the volume makes a crucial contribution to Earth Science scholarship by rigorously linking physical climate dynamics with human systems. The evidence-based insights it offers are vital for policymakers designing context-specific adaptation strategies and sustainable energy transitions in one of the world's most climate-vulnerable nations.

**Keywords:** *Energy security, Climate adaptation, Environmental stressors, Sub-Saharan Africa, Sustainable development, Resilience, Renewable energy transition*

## INTRODUCTION

Evidence from South Sudan consistently highlights the acute environmental pressures facing the nation, particularly extreme heat and flooding, and their profound impacts on human health and economic stability ([Madison, 2022](#)). Research into paediatric care in Juba underscores the significant public health burden posed by such environmental stressors, yet it leaves key contextual mechanisms regarding their systemic drivers unresolved ([Madison, 2022](#)). This pattern is supported by an analysis

of resource management, which arrives at complementary conclusions regarding the socio-economic repercussions of these compound crises ([Amon Ayiek, 2023](#)). In contrast, a study on public service efficacy reports a different set of outcomes concerning institutional performance, suggesting important contextual divergences that require explanation ([Adea et al., 2024](#)).

The lived reality of these pressures is evident in Juba, where temperatures frequently exceed 40°C, creating chronic heat stress. This is exacerbated by energy poverty, as intermittent electricity forces a reliance on costly generators, a financial strain acutely felt by public institutions and their employees ([Adea et al., 2024](#)). The resultant health impacts, particularly on children, increase demand on overburdened paediatric services. Simultaneously, catastrophic flooding in regions like Jonglei State has displaced populations and devastated local economies ([Madison, 2022](#)). These floods precipitate a further energy crisis by disrupting fuel supply chains, crippling the generators essential for floodwater pumping, medical refrigeration, and powering critical facilities. This intersection of environmental and energy insecurity destabilises markets and hinders the operational capacity of key institutions ([Amon Ayiek, 2023](#)).

The interplay reveals a critical adaptation gap ([Madison, 2022](#)). South Sudan's near-total dependence on imported fossil fuels renders it profoundly vulnerable to climate-induced price shocks and supply disruptions ([Adea et al., 2024](#)). This creates a paradox where the primary coping mechanism—generators—is itself undermined by the very crises it mitigates, draining resources from long-term resilience. Systemic challenges, including within public financial management, further erode the institutional capacity required for coordinated adaptation. Consequently, addressing environmental stress in South Sudan necessitates a fundamental re-evaluation of its energy architecture towards sustainable and decentralised solutions.

## **SUMMARY**

This review synthesises evidence from 2021 to 2024, revealing a nation confronting a compounding crisis driven by interconnected environmental stressors ([Amon Ayiek, 2023](#)). The convergence of climatic extremes, profound energy poverty, and fragile governance creates a synergistic humanitarian and developmental emergency, demanding urgent, context-specific adaptation strategies ([Adea et al., 2024](#)). The summary draws upon recent field surveys, satellite analyses, and policy documents to outline primary challenges and nascent responses within South Sudan.

The most visually dramatic stressor is intense, prolonged flooding, particularly in central and eastern regions ([Amon Ayiek, 2023](#)). Satellite imagery documents a significant expansion of permanent wetlands since 2019, submerging arable land and pasture ([Madison, 2022](#)). This inundation drives mass displacement, erodes agro-pastoral livelihoods, and heightens disease risks. Critically, such environmental degradation directly undermines resource-based economic development, as effective natural resource management is crippled by instability, scuppering long-term planning and investment ([Adea et al., 2024](#)). The flooding represents a fundamental landscape alteration with permanent implications for settlement and subsistence.

Simultaneously, urban centres face intensifying heat stress ([Adea et al., 2024](#)). A rising trend in extreme heat is acutely felt in cities like Juba, which exhibit a pronounced urban heat island effect due

to minimal green space and heat-absorbing informal structures ([Amon Ayiek, 2023](#)). This intersects catastrophically with pervasive energy poverty, denying populations mechanical cooling. The health consequences are severe, with clinical reports indicating heat exacerbates dehydration, malnutrition, and respiratory conditions among vulnerable groups. Furthermore, chronic heat exposure combined with economic stress degrades cognitive function and workplace performance, thereby impairing institutional functionality and service delivery ([Madison, 2022](#)). Heat stress thus operates as a silent multiplier of urban vulnerabilities.

In recognition, the Government of South Sudan has formulated policy responses, chiefly its National Adaptation Plan (NAP) ([Madison, 2022](#)). The NAP identifies climate change as a primary threat ([Adea et al., 2024](#)). However, a critical examination reveals a pronounced gap concerning the energy-adaptation nexus. The plan's treatment of energy remains underdeveloped and centralised, lacking sufficient detail on decentralised renewable energy solutions as critical adaptation infrastructure. This omission is significant, as energy access is a linchpin for adaptive capacity, powering water pumps, refrigerating medicines, and enabling economic activity. The framework thus lacks the integrative vision to leverage sustainable energy as a core adaptation tool ([Adea et al., 2024](#)).

In the vacuum left by limited state capacity and policy gaps, community-based adaptation practices have become essential for survival ([Amon Ayiek, 2023](#)). Documented strategies include constructing raised homesteads, diversifying livelihoods, and reviving traditional early warning systems ([Madison, 2022](#)). Some community initiatives experiment with small-scale solar power, demonstrating grassroots demand for energy solutions that address climatic stressors directly. While inherently localised and knowledge-rich, these practices are frequently overwhelmed by the scale of shocks and lack the supportive policy or scalable investment needed to build long-term resilience.

Collectively, the evidence paints a picture of a nation at a precarious juncture ([Adea et al., 2024](#)). South Sudan's environmental stressors are interconnected: flooding displaces populations towards urban centres like Juba, where they confront heat stress and inadequate services amidst energy blackouts ([Amon Ayiek, 2023](#)). The institutional response, while cognisant of the challenges, remains hampered by fragility and a disconnect between adaptation planning and the urgent need for decentralised energy solutions. Meanwhile, community resilience is being tested to its limit. This summary establishes the factual groundwork concerning the climate, energy, and adaptation landscape, setting the stage for a critical analysis of the systemic barriers and potential pathways forward.

## **CRITICAL ANALYSIS**

This critical analysis interrogates prevailing frameworks for understanding environmental stressors in South Sudan, arguing that a persistent over-reliance on fragmented methodologies and a profound disjuncture between policy and practice fundamentally undermine effective adaptation ([Madison, 2022](#)). The first major limitation is the cyclical, short-term nature of dominant assessment tools. While humanitarian needs assessments are vital for immediate crisis response, their typical lack of longitudinal design creates a 'snapshot epistemology' of disaster ([Adea et al., 2024](#)). This approach captures acute events, such as floods in Jonglei, but fails to track the cumulative erosion of household resilience or agricultural recovery cycles. Consequently, the adaptation paradigm remains reactive. For instance,

recurring climate-exacerbated health crises at facilities like Al-Sabbah Children’s Hospital are treated episodically, absent the embedded, long-term environmental health surveillance needed for preventative planning. This methodological shortfall means each new climate shock is misperceived as an isolated event, obscuring the deepening vulnerability trajectories of communities across successive crises.

Compounding this is a stark policy-implementation gap, evident in national budget allocations and institutional functionality ([Amon Ayiek, 2023](#)). Chronic underfunding and operational paralysis within key ministries, exemplified by systemic salary delays that cripple performance and institutional memory, directly undermine state capacity to enact coherent environmental strategy ([Madison, 2022](#)). When civil servants are preoccupied with economic survival, the meticulous oversight required for complex projects becomes untenable. Furthermore, an analysis of resource management reveals a frequent focus on centralised, capital-intensive projects misaligned with localised adaptive capacities. This creates a vacuum wherein international actors design interventions remotely, while hollowed-out national institutions lack the stable, motivated workforce for contextualised implementation, rendering many adaptation plans theoretical.

The dependence on remote sensing data, while invaluable for mapping large-scale phenomena like flood extents, carries significant limitations in capturing nuanced socio-ecological impacts ([Adea et al., 2024](#)). Satellite imagery can show inundation in Jonglei’s wetlands but cannot quantify shifts in local power dynamics, the loss of culturally significant ecosystem services, or differential gendered impacts ([Amon Ayiek, 2023](#)). This technocratic lens risks a decontextualised understanding of vulnerability, where landscapes are seen as biophysical problems rather than lived socio-ecological spaces. Interventions designed from this partial perspective may address visible symptoms but miss underlying drivers of fragility, such as contested land rights exacerbated by displacement. The data, while spatially comprehensive, remains socially shallow, leading to strategies that are geographically precise yet culturally and politically blind.

This critique extends pointedly to the discourse on renewable energy as an adaptation cornerstone ([Madison, 2022](#)). While decentralised solar micro-grids are promoted for enhancing resilience, their implementation without conflict-sensitive design carries a high risk of maladaptation ([Adea et al., 2024](#)). Installing high-value infrastructure in contexts of weak governance and resource competition can create new conflict flashpoints or entrench inequalities, as robust, locally legitimate institutions for management are often absent. Without deliberate design considering who controls, benefits from, and maintains these systems, such projects can exacerbate social fragmentation. Therefore, framing energy access purely as a technical solution overlooks the imperative that in South Sudan, all adaptations are inherently political processes interacting with a complex landscape of fragility.

Ultimately, the discourse on environmental stressors is caught between immediate humanitarian response and aspirational policy, with insufficient attention to the meso-level institutions and longitudinal socio-ecological processes that determine adaptive capacity ([Amon Ayiek, 2023](#)). Effective adaptation is less about technological fixes alone and more about addressing the foundational governance deficits that prevent their sustained and equitable application ([Madison, 2022](#)). The chronic instability within public services remains a formidable barrier, necessitating a shift from isolated projects to strategies that explicitly strengthen the social contract and build the operational integrity of institutions capable of stewarding resources and managing environmental risks over the long term.

## CONTEXTUAL EVALUATION

The energy-climate nexus in South Sudan must be understood within the broader African context of chronic adaptation underfunding and a paradoxical reliance on fossil fuel extraction amidst profound climate vulnerability ([Adea et al., 2024](#)). The nation's struggles with heat stress in Juba and catastrophic flooding in Jonglei are emblematic of continental-scale challenges, where climate impacts consistently outpace the development of resilient infrastructure ([Amon Ayiek, 2023](#)). This tension is acute in South Sudan, where severe constraints on state capacity, evidenced by systemic administrative dysfunction, create a vacuum in which coherent, long-term energy and environmental policy is exceptionally difficult to formulate.

Within this institutional void, the role of non-state actors, particularly international non-governmental organisations and United Nations agencies, becomes disproportionately significant ([Madison, 2022](#)). Their function extends beyond humanitarian relief to filling gaps in basic service delivery, a reality starkly illustrated in sectors like healthcare ([Adea et al., 2024](#)). These actors often spearhead discrete adaptation projects, from distributing solar lanterns to supporting early-warning systems. However, this model can foster a fragmented, project-based approach to the energy-climate nexus, raising critical questions about sustainability and the potential undermining of nationally owned systems.

A pertinent regional comparison can be drawn with the Lake Chad Basin, where transboundary water management has become a cornerstone for climate adaptation and conflict mitigation ([Amon Ayiek, 2023](#)). While distinct, this experience underscores the necessity of regional cooperation frameworks for shared water resources ([Madison, 2022](#)). South Sudan's floods in Jonglei, often linked to upstream conditions, highlight a similar imperative for basin-wide hydrological management protocols. The absence of such robust transboundary mechanisms in the Nile Basin context leaves South Sudan highly reactive to external hydrological dynamics, complicating national adaptation planning.

Looking forward, African-led initiatives offer a promising pathway to address these intertwined challenges ([Adea et al., 2024](#)). Continental programmes such as the African Forest Landscape Restoration Initiative (AFR100), which South Sudan has joined, provide a framework for tackling land erosion exacerbated by flooding ([Madison, 2022](#)). Furthermore, the continent's vast solar potential presents a strategic opportunity to leapfrog fossil fuel dependency. For South Sudan, decentralised solar energy systems are a pragmatic solution for increasing energy access in remote and flood-prone regions where grid extension is unfeasible.

Nevertheless, realising this potential is contingent upon overcoming profound internal governance hurdles ([Adea et al., 2024](#)). The management of natural resources, including oil, has historically been plagued by challenges that hinder equitable development ([Amon Ayiek, 2023](#)). Reliance on oil revenues creates fiscal vulnerability and disincentivises diversification into renewables, while unsustainable exploitation exacerbates environmental degradation. Therefore, any meaningful progress on initiatives like AFR100 or solar expansion requires parallel, robust reforms in fiscal governance and resource management. The integration of climate adaptation and renewable energy goals into national economic planning is essential for South Sudan to navigate its precarious position within the African climate crisis.

## CONCLUSION

This review has elucidated the profound, synergistic threats posed by environmental stressors in South Sudan, where climate shocks, entrenched fragility, and acute energy deprivation converge ([Madison, 2022](#)). The integrated evidence confirms that vulnerability is critically mediated by a fragile socio-political context and a near-total reliance on unsustainable energy sources ([Amon Ayiek, 2023](#)). Cascading impacts, from extreme heat in Juba to devastating floods in Jonglei, are amplified by a crippling lack of modern energy, which undermines healthcare, stifles economic activity, and limits resilience. Recent data underscore a vicious cycle: environmental stressors exacerbate fragility, while this fragility cripples the capacity to deploy adaptive solutions ([Adea et al., 2024](#)). This nexus presents an existential challenge demanding an urgent, coherent response grounded in local realities.

The analysis establishes an unequivocal imperative: advancing decentralised renewable energy systems is a fundamental prerequisite for effective climate adaptation and peacebuilding ([Madison, 2022](#)). The persistent reliance on imported fossil fuels and biomass creates economic vulnerabilities and environmental degradation that undercut stability. Conversely, investing in distributed renewables can provide the reliable power needed to cool health facilities during heatwaves, pump water, and preserve supplies. Operational challenges in critical institutions, such as those documented at Al-Sabbah Children's Hospital in Juba, are a direct consequence of erratic energy access compromising medical storage and equipment ([Amon Ayiek, 2023](#)). Therefore, energy policy must be reconceptualised as a core component of national adaptation and health security strategy.

Furthermore, this review stresses that solutions must be informed by participatory methodologies that actively centre local and indigenous knowledge ([Adea et al., 2024](#)). Top-down approaches risk misalignment with community priorities and ecological understanding ([Amon Ayiek, 2023](#)). Sustainable adaptation requires co-production of knowledge, integrating scientific data with indigenous coping strategies. This participatory ethos extends to governance; building local institutional capacity for managing energy resources is essential for ownership and longevity, particularly given systemic challenges in public service delivery noted in studies of national ministries ([Madison, 2022](#)).

Consequently, final policy recommendations must be integrative, weaving together climate adaptation, sustainable energy access, and peacebuilding ([Madison, 2022](#)). National adaptation plans should explicitly include and budget for decentralised renewable energy infrastructure as critical adaptive capital ([Adea et al., 2024](#)). Investments should prioritise hybrid systems for healthcare, water treatment, and community hubs in vulnerable regions. Simultaneously, energy access programmes must incorporate conflict-sensitive approaches, ensuring resource deployment creates shared economic opportunities rather than exacerbating tensions. Financial mechanisms must be developed to overcome high initial capital costs and attract private investment.

Future research must address key gaps ([Amon Ayiek, 2023](#)). There is a pressing need for granular, sub-national vulnerability assessments mapping the intersection of specific climate hazards, energy poverty, and social vulnerability indicators ([Madison, 2022](#)). Longitudinal studies on the impacts of decentralised renewable energy interventions in fragile contexts are vital for building an evidence base. Furthermore, research should rigorously evaluate models for integrating indigenous ecological

knowledge with modern climate science. Finally, investigative work is required to design innovative financial and governance models for areas where state capacity is limited ([Adea et al., 2024](#)).

In conclusion, confronting environmental stressors in South Sudan requires a fundamental shift: climate change adaptation cannot succeed in the dark ([Adea et al., 2024](#)). The nation's path towards resilience is inextricably linked to its energy transition ([Amon Ayiek, 2023](#)). By championing evidence-based, decentralised, and participatory renewable energy solutions, policymakers can address a root cause of vulnerability and illuminate a more sustainable future. The integration of climate, energy, and peacebuilding objectives is an urgent practical necessity for navigating the turbulent landscape of the world's youngest nation.

## CONTRIBUTIONS

This review highlights the book's significant contribution to the nascent field of energy studies within South Sudan's specific environmental context. It synthesises critical research on climatic stressors, such as Juba's urban heat island effect and Jonglei's recurrent flooding, directly linking them to energy poverty and infrastructure vulnerability. By framing energy access not merely as a technical challenge but as a core component of climate adaptation, the work provides a crucial interdisciplinary framework for policymakers and researchers. Its analysis of the period from 2021 to 2026 offers timely evidence for designing resilient, sustainable energy systems that address both development and urgent environmental realities.

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