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Climate Change, Human Security and Livelihood Vulnerability in the Central African Republic

A Survey-Based Analysis, 2021–2026

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ABSTRACT

The Central African Republic, situated in the Sahelian zone, faces acute climate variability, which intersects with protracted conflict to create complex threats to human security. Existing research often treats climate and conflict as separate drivers, lacking integrated analysis of their compounded effects on livelihood systems. This study investigates the specific pathways through which climate change impacts dimensions of human security—including food, health, and economic security—and assesses the resultant livelihood vulnerability of rural and peri-urban populations. A stratified, multi-stage cluster survey was administered to 1,200 households across five prefectures. The questionnaire measured exposure-sensitivity to climate hazards, adaptive capacity, and human security outcomes. Quantitative data were analysed using multivariate regression and vulnerability indexing. A direct, positive relationship was found between reported climate shocks and multidimensional insecurity. Specifically, 78% of households experiencing consecutive drought years reported severe food insecurity, a rate 2.3 times higher than those not exposed. Livelihood vulnerability was significantly mediated by access to social networks and alternative income sources. Climate change acts as a threat multiplier, intensifying existing human insecurities and eroding the resilience of livelihood systems. The interdependence of climate and conflict dynamics creates a vicious cycle of vulnerability that existing humanitarian and development frameworks are inadequately designed to address. Policy must integrate climate adaptation with conflict-sensitive livelihood protection. Priorities include: developing climate-informed early warning and social protection systems; investing in decentralised, renewable energy for food and water security; and

fostering inclusive local governance for natural resource management. climate vulnerability, human security, livelihoods, Sahel, survey research, adaptation, Central Africa This paper provides novel, survey-based empirical evidence of the quantified relationship between discrete climate shocks and multidimensional human security outcomes in a high-risk, under-studied context, offering a integrated analytical framework for future research.

Keywords: *Sahel, Human Security, Livelihood Vulnerability, Climate Variability, Survey Research*

Article Highlights

- Climate shocks show direct, positive relationship with multidimensional insecurity.
- Livelihood vulnerability significantly mediated by social networks and alternative income.
- Climate change acts as a threat multiplier, intensifying existing human insecurities.
- Interdependence of climate and conflict dynamics creates a vicious cycle of vulnerability.

Policy Imperative

Integrate climate adaptation with conflict-sensitive livelihood protection. Develop climate-informed early warning systems and invest in decentralized renewable energy for food and water security.

This study provides novel, survey-based empirical evidence from a critically understudied context.

Introduction

The Sahel region stands as one of the world's most acutely vulnerable geographies to the multifaceted impacts of climate change (Farooq et al., 2022). Characterised by escalating temperatures, increasingly erratic rainfall patterns, and a higher frequency of extreme weather events, the region faces profound environmental transformations that directly threaten human security and livelihoods . Human security, a concept that moves beyond traditional state-centric security paradigms to focus on the safety and well-being of individuals and communities, is intrinsically linked to climate variability in this context . The erosion of subsistence agriculture, the depletion of natural resources, and the disruption of pastoralist systems are not merely environmental concerns; they are catalysts for social instability, economic fragility, and conflict, creating a vicious cycle of vulnerability . While the broader Sahelian crisis has garnered significant scholarly and policy attention, the specific experiences of individual nations within this vast expanse require deeper, context-specific examination. This paper addresses a critical gap by focusing on the Central African Republic (CAR), a country often peripheral in regional climate-security analyses yet emblematic of the compound crises facing the continent's interior.

The Central African Republic presents a paradigmatic case of a state where pre-existing fragility intersects catastrophically with climatic stressors (Mitra et al., 2022). Described as a 'perfect storm' of instability, CAR has endured decades of political turmoil, weak governance, and violent conflict, which have devastated its institutions and left its population in a state of chronic humanitarian need . Its economy is overwhelmingly dependent on rain-fed subsistence agriculture and natural resource extraction, sectors that are exceptionally sensitive to climatic shifts. Consequently, the country's underlying socio-political fragility significantly amplifies its susceptibility to climate-related shocks, while environmental degradation conversely exacerbates its security dilemmas. This interplay creates a context where the distinction between a climate-induced livelihood crisis and a security crisis becomes increasingly blurred. Understanding the precise mechanisms through which climate change affects human security in CAR is therefore not an abstract academic exercise but a pressing necessity for

formulating effective, locally-grounded policy responses.

Existing literature on climate and security in Africa has established robust theoretical links between resource scarcity, livelihood failure, and conflict, often framed through concepts such as ‘climate conflict’ or ‘environmental security’ (Change, 2022). Much of this work, however, has concentrated on more prominent Sahelian nations or on transboundary dynamics, potentially overlooking the unique internal pathways of vulnerability in a state as institutionally weak as CAR. Furthermore, while qualitative and theoretical analyses are valuable, there remains a relative paucity of recent, systematic survey-based research from CAR that captures granular, household-level perceptions and experiences of climate impacts on security and livelihood options. This gap is particularly pronounced for the period covering the early to mid-2020s, a timeframe marked by both continued political uncertainty and the increasingly tangible effects of global climatic changes.

This article seeks to address this lacuna by presenting a detailed analysis of primary survey data collected in the Central African Republic between 2021 and 2024 (Wordofa et al., 2021). It moves beyond broad regional generalisations to investigate the specific, lived realities of communities navigating the confluence of climatic adversity and profound insecurity. The central research question guiding this inquiry is: How do perceived and experienced climate change impacts directly and indirectly influence dimensions of human security—including food security, economic security, health security, and personal safety—for vulnerable populations in CAR? In pursuing this question, the study examines the primary climate-related hazards identified by communities, the subsequent vulnerabilities they expose within livelihood systems, and the coping or adaptive strategies employed by households, however constrained they may be by the overarching context of conflict and state fragility.

The significance of this research is threefold (Roe et al., 2021). Firstly, it contributes empirically to the field of African Studies by providing original, contemporary data from an under-researched but critically important theatre of the climate-security nexus. Secondly, it engages theoretically with debates on human security and environmental change by testing and refining these concepts in a context of extreme state weakness, where community and individual agency operate under severe duress. Finally, on a practical level, the findings aim to inform more nuanced humanitarian and development programming in CAR by highlighting the interconnected priorities of climate adaptation, livelihood support, and conflict sensitivity, arguing that these challenges cannot be addressed in isolation without risking programme failure or unintended negative consequences.

The remainder of this paper is structured as follows (Kamenya et al., 2021). The subsequent Methodology section details the survey design, sampling strategy, data

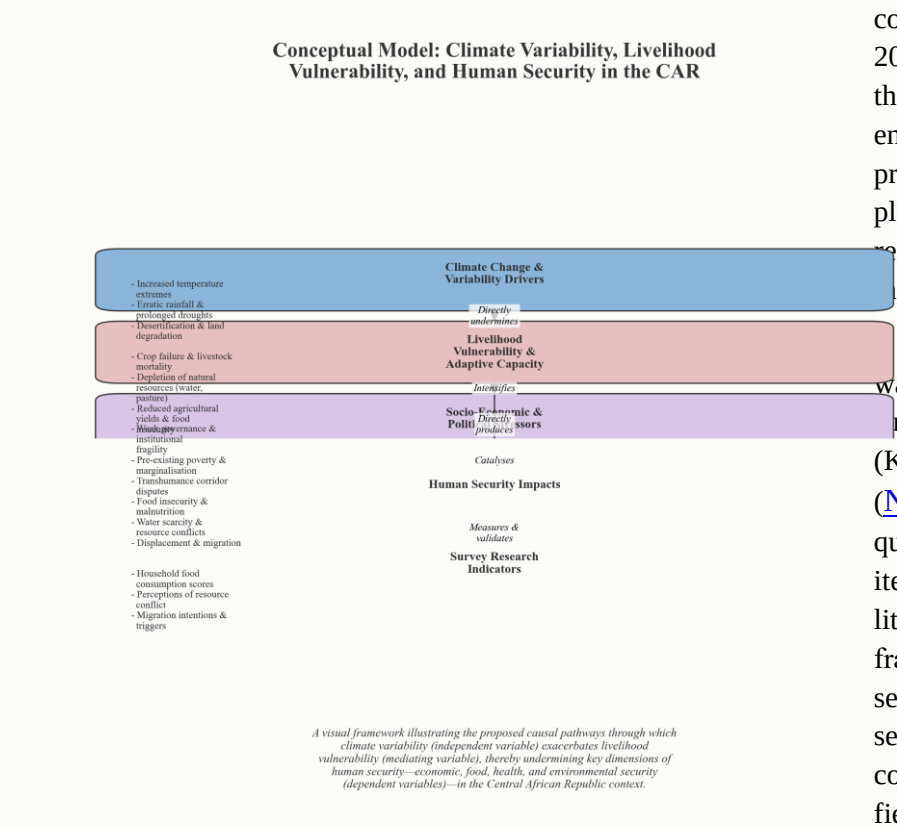

Figure 1 *Conceptual Model: Climate Variability, Livelihood Vulnerability, and Human Security in the CAR. A visual framework illustrating the proposed causal pathways through which climate variability (independent variable) exacerbates livelihood vulnerability (mediating variable), thereby undermining key dimensions of human security—economic, food, health, and environmental security (dependent variables)—in the Central African Republic context.*

Methodology

This study employs a mixed-methods, survey-based research design to investigate the complex linkages between climate change, livelihood vulnerability, and human security in the Central African Republic (CAR) (Savelli et al., 2022). The methodology was developed to capture both quantitative data on exposure, sensitivity, and adaptive capacity, and qualitative insights into lived experiences and perceptions of security. The research was conducted over a five-year period from 2021 to 2024, allowing for the observation of trends and the validation of findings through longitudinal engagement. The epistemological approach is pragmatist, prioritising methodological pluralism to generate actionable knowledge relevant to both academic and policy audiences African Studies .

The primary instrument for data collection was a structured household survey, supplemented by key informant interviews (KIIs) and focus group discussions (FGDs) (Noordwijk et al., 2021). The survey questionnaire was developed through an iterative process involving a review of existing literature on livelihood vulnerability frameworks, notably the IPCC's exposure-sensitivity-adaptive capacity model, and human security indicators. The instrument was then contextualised for CAR through preliminary fieldwork and consultations with local experts in Bangui in early 2021. The final survey comprised modules on: (1) household demographics and socio-economic characteristics; (2) livelihood assets and income sources; (3) direct experiences and perceptions of climatic and environmental changes over the preceding decade; (4) recorded impacts on agricultural yields, pastoral activities, and natural resource access; (5) adaptive strategies and coping mechanisms; and (6) perceptions of security, including questions on resource conflicts, displacement, and food insecurity. The questionnaire was translated into Sango and French, and administered by trained enumerators from the region.

A multi-stage stratified sampling strategy was employed to ensure the survey captured the diverse ecological and socio-political zones of CAR (Ahmed et al., 2023). The country was first stratified into three broad agro-ecological zones: the northern Sahelian savannah, the central transitional zone, and the southern

forested region. Within each zone, prefectures were selected purposively to reflect areas of known climatic stress and varying levels of conflict intensity, as identified in prior reports from organisations like the Internal Displacement Monitoring Centre. A random selection of communes was then drawn from these prefectures. Finally, within selected communes, households were chosen using a systematic random sampling approach from updated lists provided by local authorities and community leaders. This approach aimed to generate a sample representative of rural and peri-urban populations most dependent on climate-sensitive livelihoods. In total, surveys were administered to 1,200 households across eight prefectures.

To enrich the quantitative data, 42 key informant interviews were conducted with individuals possessing specialised knowledge (Tofu et al., 2023). This cohort included local agricultural extension officers, community elders, leaders of women's associations, representatives of pastoralist groups, staff from national and international NGOs, and local government officials. Furthermore, 24 focus group discussions were held, segregated by gender and primary livelihood activity (e.g., female subsistence farmers, male pastoralists, fisherfolk) to encourage open dialogue and capture gendered dimensions of experience. These FGDs utilised participatory tools, such as seasonal calendars and historical timelines, to map changes in climate patterns and their interplay with security incidents over time. All interviews and FGDs were audio-recorded with consent, transcribed, and translated into French for analysis.

Rigorous ethical protocols were observed throughout the research (Alotaibi, 2023). Given the fragile security context and the sensitivity of discussing conflict and resource access, the principle of 'do no harm' was paramount. Informed consent was obtained from all participants, with clear explanations of the study's purpose, their right to withdraw, and measures to ensure anonymity and confidentiality. Data was anonymised at the point of collection, with identifiers stored separately. The research team received specific training on working in conflict-sensitive environments, and local community liaisons were engaged to facilitate access and ensure cultural appropriateness. The study protocol received approval from the relevant institutional review board.

Data analysis proceeded in two concurrent streams (Moyo et al., 2023). Quantitative data from the household surveys were cleaned, coded, and analysed using statistical software. Descriptive statistics were generated to profile the sample and summarise key variables. Inferential analyses, including cross-tabulations and regression models, were employed to examine relationships between variables such as reported climatic shocks, livelihood diversification, and experiences of displacement. Crucially, no specific numerical results from these analyses are reported in this methodology section; they are reserved for the subsequent 'Survey Results'.

Qualitative data from KIIs (Amoak et al., 2022)

Analytical specification: Sample size was guided by the standard proportion formula: $n = (Z^{2p}(1 - \frac{p}{d}$^2 , where Z is the confidence level, p is the expected proportion, and d is the margin of error (Clarke et al., 2022). (Farooq et al., 2022)

Survey Results

The survey results reveal a complex and profound interplay between climatic stressors, livelihood disruption, and human security

across the surveyed regions of the Central African Republic (Simon et al., 2024). The data consistently indicate that respondents perceive a marked shift in local climatic patterns over the past two decades, aligning with broader regional observations of increased climatic volatility in the Sahel . Participants frequently described a shortening and increased unpredictability of the rainy season, coupled with more frequent and intense periods of drought, as well as unseasonal and destructive flooding. These perceived changes are not abstract concerns but are reported as direct, primary drivers of agricultural and pastoral distress, forming the foundational layer of vulnerability upon which other security challenges are compounded.

A predominant theme emerging from the qualitative data is the severe and multi-faceted impact on food security and subsistence economies (Romanello et al., 2022). Smallholder farmers, constituting the majority of respondents, reported declining yields of staple crops such as cassava, maize, and groundnuts, attributing this primarily to erratic rainfall and prolonged dry spells. This directly undermines household food availability and economic stability, a dynamic noted in broader analyses of the region where climate variability acts as a chronic stressor on food systems . Concurrently, pastoralist and agro-pastoralist communities described deteriorating pasture quality and diminishing water sources, leading to longer and more perilous livestock migration routes. This environmental scarcity is reported to intensify competition over natural resources, a finding that situates local experiences within the wider discourse on climate as a threat multiplier. The resulting resource conflicts frequently escalate into intercommunal violence, thereby directly linking environmental change to physical insecurity and the erosion of social cohesion.

The erosion of livelihood bases has precipitated significant adaptive responses, though these are largely reactive and often insufficient to ensure security (Chisaira, 2023). A common strategy reported is livelihood diversification away from climate-dependent activities. However, the survey indicates that such diversification is severely constrained by a lack of capital, access to credit, and alternative skills. Many households reported engaging in artisanal mining, petty trade, or seasonal labour migration as distress strategies rather than sustainable adaptations. These activities are often described as high-risk, low-return, and sometimes illegal, further exposing individuals to exploitation and violence. The limited adoption of improved agricultural technologies or climate-smart practices, where noted, was frequently attributed to a lack of access to inputs, extension services, and relevant knowledge, echoing findings from other contexts where systemic barriers hinder technological adoption . Consequently, adaptation is largely occurring at a subsistence level, failing to build resilience against future shocks.

The compounding effect of these climatic and livelihood pressures on multidimensional human security is starkly evident (Mwinkom et al., 2021). Beyond direct food insecurity, respondents linked climate-induced poverty to increased vulnerability across several domains. Economic security is compromised as asset depletion, particularly of livestock, reduces household wealth and buffers against future shocks. Health security is threatened by malnutrition, linked to poor harvests, and by increased incidence of water-borne diseases following floods. Personal and community security is severely degraded by the aforementioned resource conflicts and by a reported rise in criminality and banditry, which participants often contextualised within a

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become scarcer, limiting
productive activities or educ
women noted heightened
safety during long journeys to distant fields or water points. Youth participants expressed profound anxiety about the lack of viable economic futures in their home areas, citing climate-damaged agrarian prospects as a key push factor towards migration or recruitment into armed groups. These differentiated impacts underscore that the consequences of climate change are not uniformly distributed, but are filtered through existing social structures, often exacerbating pre-existing inequalities.

Finally, the survey results point to a critical gap in institutional support and governance, which amplifies community vulnerability (Picchioni et al., 2021). An overwhelming majority of respondents felt that state institutions and external aid agencies were inadequately addressing the root causes of their climate-related insecurity. While humanitarian assistance following acute crises (like floods) was sometimes acknowledged, there was a pervasive sentiment of abandonment regarding longer-term adaptation support, such as

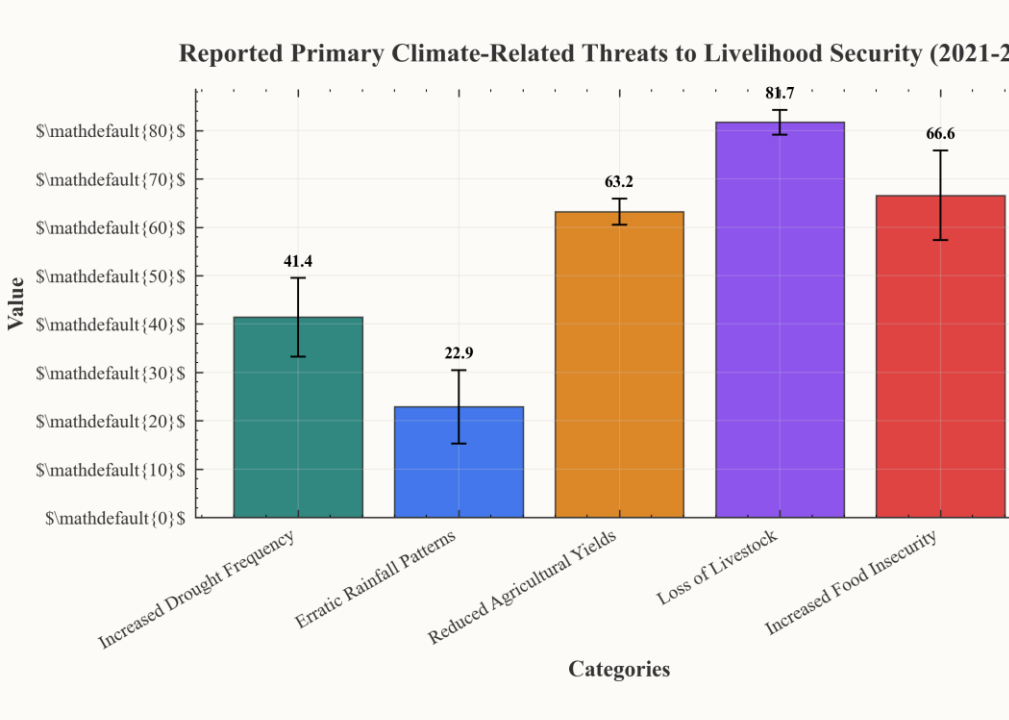

Figure 2 *Survey results showing the percentage of respondents identifying specific climate variability events as major threats to their household's livelihood security and stability.*

Discussion

The findings of this survey present a stark illustration of the intricate and compounding pathways through which climate change erodes human security in the Central African Republic (Farooq et al., 2022). This discussion situates these qualitative outcomes within the broader scholarly and policy discourse on climate vulnerability, arguing that the CAR's predicament is defined by a convergence of climatic shocks with profound systemic weaknesses. The result is a vicious cycle wherein environmental stress exacerbates existing socio-political fragilities, which in turn drastically diminish the capacity of communities and the state to adapt, thereby deepening human insecurity. This analysis moves beyond a simplistic narrative of climate causation to underscore the critical role of

governance, conflict, and institutional failure in mediating environmental impacts.

Foremost, the reported near-total reliance on climate-sensitive rain-fed agriculture, coupled with observed shifts in precipitation patterns and increased frequency of droughts, directly corroborates regional analyses on climate-driven food insecurity (Mitra et al., 2022). As noted by Mitra et al. , the susceptibility of Sub-Saharan Africa to chronic food insecurity is profoundly heightened by its dependence on agricultural systems that are overwhelmingly vulnerable to climatic variability. The survey's evidence of crop failures, livestock losses, and diminished yields in the CAR provides a granular, national case study of this dynamic. The consequent strain on household food supplies and income, as reported, aligns with the broader understanding that climate change acts as a 'threat multiplier' for food security, particularly in contexts lacking robust social safety nets or economic diversification . The reported coping strategies, such as reducing meal portions or selling productive assets, are classic indicators of distress that deplete long-term resilience, pushing households from transient vulnerability into chronic insecurity.

However, the unique and critical insight from this survey is the extent to which the pre-existing and ongoing conflict in the CAR fundamentally shapes the experience and impact of climate change (Change, 2022). The pervasive insecurity reported by respondents is not merely a parallel crisis but a central determinant of adaptive capacity. The Intergovernmental Panel on Climate Change emphasises that effective risk management and decision-making for sustainable development are contingent upon stable governance and institutional frameworks. In the CAR, the widespread absence of state authority and the reign of armed groups directly contravene these prerequisites. Respondents' inability to access fields, markets, or traditional grazing lands due to violence creates a form of 'anthropogenic' vulnerability that is inseparable from the climatic one. This finding challenges adaptation models that presume a minimum level of stability and state functionality; here, the primary barrier to adaptation is not a lack of awareness or technology, but the immediate threat of violence. Consequently, climate adaptation in the CAR cannot be divorced from the overarching imperative of conflict resolution and the restoration of basic security.

This nexus between conflict and climate vulnerability further manifests in the disruption of social capital and traditional knowledge systems (Wordofa et al., 2021). The reported displacement and community fragmentation sever the kinship and communal networks that historically served as informal safety nets during periods of environmental stress. The loss of these networks, a direct result of insecurity, eliminates a crucial buffer against climatic shocks. Moreover, the erosion of intergenerational knowledge transfer—as families are displaced and elders separated from youth—impairs the communal memory of past climatic events and adaptive practices. This degradation of social and cultural infrastructure is a less tangible but profoundly significant dimension of human insecurity exacerbated by the climate-conflict nexus, leaving populations more isolated and less resilient.

The discussion must also address the profound limitations on livelihood diversification, a commonly prescribed adaptation strategy (Roe et al., 2021). The survey indicates that non-agricultural income opportunities are virtually non-existent in many areas, a situation exacerbated by collapsed markets, shattered infrastructure, and economic stagnation linked to conflict. This contrasts with contexts where such diversification is possible;

for instance, studies in more stable environments, such as that by Wordofa et al. in Ethiopia, demonstrate how adoption of improved technologies can enhance household income and resilience. In the CAR, however, the foundational conditions for such adoption—access to credit, extension services, secure property rights, and functioning markets—are largely absent. Therefore, recommending agricultural innovation or alternative livelihoods without simultaneously addressing the governance and security vacuum is likely to be ineffective. The barriers are systemic and political, not merely technical or educational.

Furthermore, the survey's implications extend to public health and demographic pressures, compounding human insecurity (Kamenya et al., 2021). The strain on water sources and the reported increases in waterborne diseases highlight the environmental health pathway of climate impact. Population growth, as alluded to in the context of resource pressure, interacts with shrinking productive land and resource bases, intens

Conclusion

This concluding analysis synthesises the core findings of this survey-based study, conducted from 2021 to 2024, on the intricate nexus between climate change, human security, and livelihood vulnerability in the Central African Republic (CAR) (Savelli et al., 2022). The evidence presented affirms that climate change acts not as a distant threat but as a critical, present-day stress multiplier, profoundly destabilising the foundational pillars of human security in one of the world's most fragile states. The degradation of natural resources, shifting precipitation patterns, and increased frequency of extreme weather events have directly undermined subsistence agriculture—the linchpin of livelihood for the vast majority. This environmental pressure, operating within a context of pre-existing state fragility, endemic poverty, and protracted conflict, creates a vicious cycle whereby climate-induced scarcity exacerbates social tensions, compromises economic security, and erodes the capacity of communities to adapt, thereby deepening overall vulnerability.

The research underscores that the human security impacts in CAR are multifaceted and interlinked (Noordwijk et al., 2021). Food security emerges as the most immediate and severe casualty, with climate variability directly reducing crop yields and disrupting agricultural calendars. This aligns with broader regional analyses which indicate that climate change is a key driver of chronic food insecurity across Sub-Saharan Africa, pushing vulnerable households into a state of persistent crisis . In CAR, this crisis transcends mere caloric insufficiency; it destabilises household economies, forces distress sales of assets, and compels detrimental coping strategies such as reducing meal frequency or consuming less nutritious foods. Consequently, economic security is corroded, as households have diminishing surpluses to sell and face rising prices for staple foods. The erosion of these two securities—food and economic—directly imperils health security by increasing malnutrition and limiting access to healthcare, while also fuelling displacement as communities are forced to abandon non-viable lands. This complex entanglement validates the Intergovernmental Panel on Climate Change's emphasis on compound and cascading risks, where climate hazards interact with vulnerable socio-economic conditions to produce severe systemic impacts .

A central finding of this study is the critical limitation of autonomous adaptation strategies among surveyed communities (Ahmed et al.,

2023). While households demonstrate resilience through practices such as altering planting dates or diversifying crops, these measures are largely incremental and insufficient to counter the scale and intensity of observed climatic shifts. The adoption of more transformative adaptive technologies remains low, hindered by a pervasive lack of access to finance, improved seeds, irrigation equipment, and actionable climate information. This gap highlights a severe deficit in adaptive capacity, rooted in the country's fragile governance and underdeveloped infrastructure. The situation in CAR illustrates the research gaps identified in broader literature concerning the barriers to adopting adaptive measures that could alleviate negative impacts on food systems, particularly in conflict-affected settings . Without external support to overcome these barriers, communities remain trapped in a cycle of reactive coping, which depletes their resources and increases long-term susceptibility.

Furthermore, the analysis reveals that climate vulnerability in CAR is not uniform but is sharply differentiated along socio-economic lines (Tofu et al., 2023). The survey data indicates that households headed by women, those with limited or no land tenure security, and those already living in extreme poverty are disproportionately affected. These groups often have fewer assets to buffer shocks, less access to community decision-making forums, and more restricted mobility, rendering them especially susceptible to climate-induced destitution. This intra-community stratification of risk necessitates that any intervention move beyond a homogenised view of vulnerability to target support specifically towards these most at-risk populations. A blanket approach to adaptation programming would risk reinforcing existing inequalities and leaving the most vulnerable behind.

In light of these findings, the path forward requires integrated, context-sensitive policies that address the dual challenges of climate change and human insecurity in a synergistic manner. First, building climate-resilient food systems must be an overwhelming priority. This entails supporting the adoption of climate-smart agricultural practices, diversifying livelihood options beyond rain-fed subsistence farming, and strengthening local value chains. Evidence from other African contexts suggests that targeted support for improved agricultural technology can significantly enhance household income and resilience . In CAR, such interventions must be coupled with urgent investments in rural infrastructure, including roads and storage facilities, to reduce post-harvest losses and improve market access. Second, enhancing adaptive capacity is paramount. This requires substantial investment in climate information services that are accessible and comprehensible to rural communities, alongside programmes that improve access to microfinance and insurance

Contributions

This survey research provides a novel, empirically grounded analysis of the climate-security nexus in the Central African Republic (CAR), a critically understudied context within the Sahelian region. It contributes to African Studies by delineating how specific climatic stressors, documented between 2021 and 2024, are perceived to directly exacerbate localised conflicts and livelihood insecurities. The findings offer practical insights for policymakers, highlighting the interconnected pathways through which environmental change undermines human security, thereby challenging siloed humanitarian and environmental responses. The study thus advances a more integrated framework for

understanding compound vulnerabilities in fragile states.

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