

Bridging the Divide: Climate Vulnerability, Rural-Urban Disparities, and Adaptation Governance in the Global South

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ABSTRACT

Climate change acts not merely as an environmental stressor but as a profound amplifier of existing socioeconomic inequalities, particularly in the Global South. This research paper synthesizes empirical findings from four critical regions—the East African Community (EAC), Bangladesh, Nepal, and Zimbabwe—to explore the intersecting dynamics of climate vulnerability, rural-urban infrastructure disparities, and governance challenges. Drawing on comparative case studies, this paper examines how climate stressors differentially impact rural and urban populations, the efficacy of national adaptation policies, and the resulting socio-economic outcomes, including agricultural transformation and forced migration. Findings indicate that rural areas consistently bear the brunt of climate impacts due to infrastructure deficits, lower socio-economic capacity, and delayed policy implementation. In the EAC, climate variability widens rural-urban electricity gaps, severely constraining agricultural modernization. In Nepal, environmental degradation forces rural exodus and migration, while in Zimbabwe, a distinct rural-urban divide in climate awareness dictates divergent adaptation strategies. Meanwhile, Bangladesh exemplifies the complexities of climate governance, where robust national policies frequently falter at the implementation stage due to institutional fragmentation. The paper concludes that effective climate adaptation requires a paradigm shift: infrastructure must be treated as climate adaptation, governance must be decentralized and coordinated, and localized education must bridge the awareness gap. Without spatially targeted, institutionally coherent interventions, the global commitment to "leave no one behind" remains an unfulfilled aspiration.

1. Introduction

The intersection of climate variability, environmental degradation, and sustainable development constitutes one of the most urgent challenges of the twenty-first century. While climate change is a global phenomenon, its impacts are profoundly asymmetric, disproportionately affecting developing countries that possess the least adaptive capacity (Hallegatte et al., 2018; United Nations, 2024). In the Global South, climate change is not a future projection but a current reality that threatens livelihoods, disrupts agricultural systems, and exacerbates deep-seated spatial inequalities. Over 600 million people in sub-Saharan Africa remain without electricity access, and rural livelihoods across Asia and Africa face growing threats from extreme weather events (Bazilian & Pielke, 2013; Hersi et al., 2025). The persistent divide between rural and urban areas—whether in terms of infrastructure, awareness, or institutional support—perpetuates a cycle of vulnerability where those most exposed to climate risks are often the least equipped to respond.

Recent empirical evidence suggests that climate shocks do not affect all regions or demographics equally. Rural areas,

largely dependent on rain-fed agriculture and natural resources, face heightened sensitivity to climate fluctuations. However, traditional development theories often assume a linear path toward convergence, wherein infrastructure and economic benefits will eventually trickle down to rural areas (Barro & Sala-i-Martin, 1992). Emerging data challenges this assumption, showing that climate stress can actually widen existing disparities, creating "adaptation apartheid" where vulnerable communities are systematically excluded from technological and institutional coping mechanisms (Chevallier, 2023; Hersi et al., 2025). Furthermore, governance frameworks in developing nations frequently struggle to translate comprehensive national policies into localized, equitable outcomes. Institutional fragmentation, limited financial resources, and a lack of coordination among government agencies often hinder policy effectiveness, leaving marginalized communities to navigate climate impacts on their own (Rahman & Abubakar, 2024).

This research paper investigates the complex nexus of climate vulnerability, rural-urban disparities, and environmental governance in the Global South. By synthesizing data from four distinct geographical and socio-economic contexts—the East African Community (EAC), Bangladesh, Nepal, and Zimbabwe—this study explores how climate stressors interact with local infrastructure, public perception, and policy frameworks. The paper is structured around four critical questions:

1. How does climate variability exacerbate rural-urban infrastructure and agricultural disparities?
2. What role does public perception and awareness play in shaping climate adaptation strategies?
3. How do governance structures facilitate or hinder effective climate policy implementation?
4. What are the socio-economic consequences, such as forced migration, of failing to address these disparities?

By addressing these questions, this paper aims to provide a comprehensive understanding of the structural barriers to climate resilience and offer policy recommendations that integrate infrastructure development, spatial equity, and adaptive governance.

2. Literature Review

Theoretical Frameworks

This study is grounded in several intersecting theoretical paradigms. First, the **convergence hypothesis**, traditionally used in development economics, posits that poorer regions should experience faster growth than wealthier ones as capital and technology diffuse over time (Solow, 1956; Barro & Sala-i-Martin, 1992). However, recent literature suggests that external shocks, particularly climate variability, can disrupt this convergence, leading to spatial divergence (Hallegatte et al., 2018; Zhao et al., 2025).

Second, **risk perception theory** provides a lens for understanding how individuals and communities respond to climate hazards. This theory highlights the gap between objective risk assessments and subjective perceptions, which are shaped by cognitive biases, personal experience, and socio-economic factors (Dhar et al., 2023; Hoorens, 2020). Understanding these perceptions is critical, as public awareness directly influences the adoption of coping mechanisms and resilience-building strategies (Ricart et al., 2023).

Third, the concept of **climate mobility** is employed to understand migration patterns. Climate mobility refers to human movement—whether temporary, seasonal, or permanent—driven by environmental or climatic changes (Boas et al., 2019). This theory connects local environmental shocks with broader socio-economic vulnerabilities and governance mechanisms, framing migration not just as a failure of adaptation, but as an active, albeit sometimes forced, coping strategy (de Sherbinin et al., 2022).

Climate Change, Infrastructure, and Agricultural Transformation

In sub-Saharan Africa, the intersection of energy poverty and agricultural transformation is a critical research frontier. Rural areas remain structurally disadvantaged in terms of electrification, receiving fewer investments than urban centers despite facing higher climate exposure (Jessel et al., 2019). Electricity access is increasingly recognized as essential for climate-smart agriculture (CSA), supporting adaptive technologies such as irrigation, cold storage, and mechanized processing (Okoronkwo et al., 2024). However, climate shocks disproportionately damage fragile rural infrastructure. Hersi et al. (2025) demonstrate that in the EAC, rural electricity systems demonstrate significantly higher climate sensitivity than urban systems, leading to widening spatial gaps that constrain agricultural modernization and reinforce rural vulnerability.

Governance and Policy Implementation

Effective environmental governance is widely recognized as the cornerstone of climate resilience. Developing countries have made significant strides in formulating national climate strategies, such as National Adaptation Plans (NAPs) and Nationally Determined Contributions (NDCs). However, a persistent gap exists between policy formulation and implementation. In Bangladesh, for instance, despite comprehensive frameworks like the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), institutional fragmentation and weak regulatory enforcement severely hinder ground-level outcomes (Rahman & Abubakar, 2024). Effective governance requires not only robust legal frameworks but also decentralized institutional capacity, adequate financial resources, and meaningful community participation (Mangani, 2020; Sarkar et al., 2022).

Perception, Awareness, and Adaptation

The role of public perception in climate adaptation cannot be overstated. Literature indicates that communities with higher awareness of climate change exhibit better adaptation strategies (Litke et al., 2024). However, awareness levels vary significantly across rural and urban lines. Urban populations, generally possessing higher education levels and greater access to media, tend to show higher climate change awareness compared to rural populations (De Jesus, 2024; Tenbrink & Willcock, 2023). Interestingly, while rural communities may lack formal climate change awareness, they often possess rich indigenous knowledge and high resilience due to their direct reliance on natural resources (Msimanga & Mukwada, 2022). This dichotomy highlights the need for tailored communication strategies that bridge scientific knowledge with local realities.

Climate-Induced Migration

Environmental shocks, such as erratic rainfall, prolonged droughts, and glacial lake outburst floods (GLOFs), increasingly drive migration in vulnerable regions. In the Himalayas, climate change severely disrupts agricultural productivity, making migration a primary coping strategy for rural communities (Pasa et al., 2026). This rural exodus results in demographic hollowing, leaving behind aging populations

and abandoned farmlands, which in turn threatens food security and ecological balance. The literature emphasizes that climate mobility is deeply entangled with issues of climate justice, as developing nations bear disproportionate impacts of greenhouse gas emissions historically produced by industrialized nations (Burzyński et al., 2022; Whyte, 2016).

3. Methodology

This research paper employs a comparative case study methodology, synthesizing empirical data and findings from four recent, peer-reviewed studies conducted in distinct geographical regions of the Global South: the East African Community (EAC), Bangladesh, Nepal, and Zimbabwe. The comparative approach allows for the identification of cross-cutting themes and context-specific nuances regarding climate vulnerability, rural-urban disparities, and governance.

Data Sources and Study Design

The foundational data for this paper is derived from four primary studies:

1. **East African Community (EAC):** Utilizing panel data from Hersi et al. (2025), covering Kenya, Tanzania, Uganda, Rwanda, and Burundi from 2000 to 2024. The original study employed climate anomaly analysis, correlation assessment, and performance indexing to explore the links between climate shocks, rural-urban electricity gaps, and agricultural transformation. Variables included rural/urban electricity access (ELCR/ELCU), annual rainfall (RFL), and agricultural GDP (AGR).
2. **Bangladesh:** Drawing upon Rahman and Abubakar's (2024) policy evaluation, which utilized document analysis of national policies (e.g., BCCSAP, NAP, NDCs) and institutional frameworks to assess governance strategies and implementation challenges.
3. **Nepal:** Based on the qualitative study by Pasa et al. (2026) along the Lower Great Himalayan Trail. The original research utilized narrative inquiry, in-depth interviews (n=12), and focus group discussions (FGDs) within a post-humanist framework to explore climate-induced migration and livelihood disruption.
4. **Zimbabwe:** Utilizing quantitative data from Mwadzingeni et al. (2025), based on Afrobarometer Round 9 data (2022). The study employed descriptive statistics, the Mann-Whitney U test, and binary logistic regression to analyze differences in climate change awareness and perception between rural and urban households (N=1,199).

Analytical Framework

For the purpose of this synthesis, the findings from these four studies were re-analyzed through a unified analytical framework focusing on four dimensions:

- **Exposure and Vulnerability:** How physical climate impacts manifest in different regions.

- **Infrastructure and Livelihoods:** The role of physical (electricity) and social (awareness) infrastructure in mediating impacts.
- **Governance and Policy:** The effectiveness of institutional responses.
- **Adaptation Outcomes:** The resulting human actions, including agricultural transformation, coping strategies, and migration.

By juxtaposing quantitative infrastructure data from the EAC with qualitative migration narratives from Nepal, and governance evaluations from Bangladesh with perception data from Zimbabwe, this paper provides a holistic, multi-dimensional view of climate adaptation challenges in the Global South.

4. Comparative Analysis and Findings

Infrastructure Disparities and Agricultural Transformation in the EAC

The empirical evidence from the East African Community provides a stark illustration of how climate variability disrupts assumed development trajectories. Contrary to convergence theory—which predicts that rural areas will gradually catch up with urban centers—climate stress has actively widened the rural-urban electricity gap in most EAC countries. Rural electricity infrastructure demonstrates consistently higher climate sensitivity due to design limitations and lower investment priority.

Table 1

Rural-Urban Electricity Gap Evolution in Select EAC Countries (2000–2024)

Country	2000 Gap (%)	2024 Gap (%)	Change (%)	Primary Driver
Kenya	45.5	30.3	-15.2	Coordinated policy (Last Mile Project)
Tanzania	38.2	61.7	+23.5	Institutional coordination gaps
Burundi	25.1	39.1	+14.0	Political instability, low investment
Uganda	40.0	35.0	-5.0	Modest off-grid progress
Rwanda	42.0	38.0	-4.0	Uneven donor-funded projects

Note. Adapted from "Beyond convergence: climate stress, rural–urban electrification disparities, and agricultural transformation in the east African community" by Hersi et al. (2025).

Kenya emerges as an outlier, having reduced its rural-urban gap by 15.2 percentage points through coordinated rural electrification initiatives and the Energy Act of 2019. In contrast, Tanzania and Burundi experienced widening gaps of 23.5 and 14.0 percentage points, respectively. This divergence has direct implications for agricultural transformation.

Countries with larger electricity access gaps showed stronger negative correlations between climate variability and agricultural output. Burundi exhibited a strong negative correlation of -0.678 between rainfall and agricultural output, indicating severe vulnerability. Conversely, Kenya's near-zero correlation suggests that reliable electricity acts as a buffer, enabling climate-resilient technologies such as irrigation and cold storage. Electricity, therefore, must be reconceptualized not merely as a development input, but as critical climate adaptation infrastructure.

Perception, Awareness, and Adaptation Divides in Zimbabwe

While infrastructure deficits are physical barriers, cognitive and perceptual divides equally undermine climate adaptation. The analysis of Afrobarometer data from Zimbabwe reveals significant variations in climate change awareness between rural and urban communities. Urban dwellers demonstrated significantly higher awareness of climate change and its impacts on the country compared to their rural counterparts (Mwadzingeri et al., 2025).

Table 2

Mann-Whitney U Test Results: Climate Change Awareness in Zimbabwe

Variable	Urban Mean Rank	Rural Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Severe droughts perception	602.19	568.53	142,126.00	***
Climate change awareness	655.86	539.94	125,183.50	***
Govt must act to limit CC	246.47	279.23	30,250.00	***
Citizens fighting CC	282.74	213.10	21,378.00	***

Note. *** $p \leq 0.01$. Adapted from Mwadzingeri et al. (2025).

Urban populations were more likely to perceive drought severity, believe that citizens and governments must act, and recognize the efforts of developed countries. In contrast, rural populations, despite being more directly dependent on climate-sensitive livelihoods (agriculture), exhibited lower formal awareness. This dichotomy can be attributed to differential access to media, education, and government outreach. However, rural communities often possess high indigenous knowledge and necessity-driven resilience. The lack of formal awareness, though, limits their ability to advocate for climate justice or fully utilize institutional support programs. These findings underscore that adaptation policies must be tailored to the perceptual realities of the target populations, bridging the gap between scientific terminology and local understandings of environmental change.

Governance Strategies and Implementation Gaps in Bangladesh

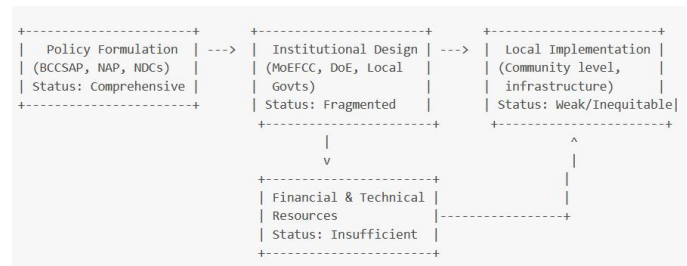
Bangladesh, located in a low-lying deltaic region, faces severe climate risks, including sea-level rise, salinity intrusion, and cyclones. The government has developed comprehensive policy frameworks, such as the Bangladesh Climate Change

Strategy and Action Plan (BCCSAP) and the National Adaptation Plan (NAP). However, evaluation of these governance strategies reveals significant implementation challenges (Rahman & Abubakar, 2024).

The primary obstacles are not policy formulation but institutional coordination and enforcement. Regulatory bodies, such as the Department of Environment (DoE), lack the capacity and resources to monitor and enforce environmental standards effectively. Institutional fragmentation leads to overlapping mandates between the Ministry of Environment, Forest and Climate Change (MoEFCC), the Ministry of Water Resources, and local governments. Furthermore, political and economic constraints often shield powerful industries (e.g., textile manufacturing, brick kilns) from stringent environmental regulations.

Figure 1

Conceptual Model of Climate Governance Challenges in Developing Nations



Note. Author's construction based on Rahman & Abubakar (2024).

Despite a strong emphasis on decentralization, local governments in Bangladesh lack the financial autonomy and technical expertise to manage large-scale adaptation projects. The result is a disconnect between national climate strategies and ground-level realities, where vulnerable coastal and rural communities continue to face disproportionate risks. Strengthening governance requires not just new policies, but enhanced institutional capacity, stricter law enforcement, and genuine community participation in decision-making.

Climate-Induced Migration and Livelihood Disruption in Nepal

In mountainous regions, the intersection of climate change and livelihood insecurity forces a specific adaptation outcome: migration. The qualitative narratives from the Lower Great Himalayan Trail in Nepal vividly illustrate this phenomenon (Pasa et al., 2026). Communities in the Koshi, Gandaki, and Karnali watersheds are witnessing severe disruptions to traditional agricultural cycles due to rising temperatures, erratic rainfall, and reduced snowfall.

Table 3

Key Climate Impacts and Community Responses in Rural Nepal

Climatic Driver	Observed Impact	Livelihood Consequence	Adaptation/Mobility Outcome
Reduced snowfall	Drying of water sources	Decline in crop yields	Youth migration to urban centers
Erratic rainfall	Disrupted planting seasons	Crop failure, food insecurity	Reliance on remittances
Forest fires	Loss of fodder/fuelwood	Livestock loss	Permanent displacement of families

Climatic Driver	Observed Impact	Livelihood Consequence	Adaptation/Mobility Outcome
Landslides	Land degradation	Loss of arable land	Abandonment of ancestral villages

Note. Adapted from Pasa et al. (2026).

The decline in agricultural productivity has made farming economically unviable. As one participant noted, "Our crops are confused by the weather... It's becoming harder to predict and plan our farming" (Pasa et al., 2026). Consequently, migration—both internal and international—has become the primary coping strategy. This rural exodus leads to the abandonment of ancestral lands, demographic hollowing (leaving the elderly behind), and a heavy reliance on remittances.

Crucially, the research highlights a disconnect between global frameworks like the Sustainable Development Goals (SDGs) and local realities. While SDG 13 calls for urgent climate action, rural Himalayan communities lack the awareness to attribute their suffering to anthropogenic global warming or to demand climate justice. They perceive these changes as inevitable environmental shifts. The "Leaving No One Behind" slogan is thus challenged by the reality of people being "forced to leave" due to structural vulnerabilities and inadequate government support for localized adaptation.

5. Discussion

The comparative analysis of the EAC, Bangladesh, Nepal, and Zimbabwe reveals several overarching themes regarding climate vulnerability and adaptation in the Global South.

First, **climate change actively dismantles convergence**. Rather than narrowing, spatial inequalities in infrastructure and development outcomes are widening under climate stress. In the EAC, rural electricity systems are failing at higher rates than urban ones, directly inhibiting agricultural modernization. In Nepal, environmental degradation is emptying rural landscapes, concentrating populations in urban areas and perpetuating cycles of poverty. This suggests that traditional development models, which assume climatically neutral infrastructure rollouts, are fundamentally flawed. Infrastructure must be designed with explicit climate resilience standards, prioritizing the most vulnerable rural areas.

Second, **the adaptation gap is both physical and cognitive**. The situation in Zimbabwe demonstrates that while urban populations may exhibit higher formal awareness of climate change, rural populations possess experiential knowledge of environmental changes. However, the lack of formal awareness limits rural communities' ability to engage with institutional support and advocate for their rights. Bridging this gap requires localized environmental education and communication strategies that validate indigenous knowledge while introducing scientific context.

Third, **governance is the critical bottleneck**. As seen in Bangladesh, having comprehensive policies like the BCCSAP is insufficient if institutional capacity is fragmented and enforcement is weak. The political economy of developing nations often prioritizes short-term industrial growth over

long-term environmental sustainability, leaving regulatory bodies underfunded and marginalized. Effective climate governance necessitates a shift from siloed, top-down approaches to integrated, decentralized frameworks ("nexus governance") where energy, agriculture, and water resource agencies coordinate effectively.

Finally, **migration is an adaptation failure masquerading as a strategy**. While labor migration is a normal economic phenomenon, the forced displacement of communities due to unmitigated climate stress—as seen in Nepal—represents a failure of proactive adaptation. When agriculture collapses and infrastructure fails, migration becomes the only viable coping mechanism. This results in severe social costs, including the loss of traditional knowledge, demographic imbalance, and reduced food security. True climate resilience requires creating conditions that allow people to remain safely in their communities through modernized, climate-resilient agriculture.

6. Policy Recommendations

Based on the synthesized findings, this paper proposes the following policy recommendations to enhance climate resilience and spatial equity in the Global South:

1. **Reconceptualize Infrastructure as Climate Adaptation:** Governments and international donors must treat rural electrification not merely as a developmental goal but as core climate adaptation infrastructure. Electrification strategies should incorporate climate-resilient design standards (e.g., decentralized renewable energy mini-grids) to withstand extreme weather. Furthermore, energy planning must be explicitly integrated with agricultural policy to power irrigation, processing, and cold storage facilities.
2. **Strengthen Decentralized Governance and Institutional Coordination:** National governments must move beyond policy formulation to strengthen institutional capacity at the local level. This requires clear delineation of responsibilities among ministries (e.g., Environment, Agriculture, Water) to reduce fragmentation. Financial resources and technical training must be devolved to local governments to enable them to implement adaptation projects tailored to local ecological contexts.
3. **Enhance Localized Climate Education and Communication:** To bridge the perception gap highlighted in Zimbabwe and Nepal, governments should implement community-based environmental education programs. These programs must translate global climate science into local languages and contexts, validating indigenous knowledge while raising awareness of anthropogenic drivers. Improved communication empowers rural communities to adopt proactive adaptation measures and demand institutional support.
4. **Proactively Manage Climate-Induced Migration:** Rather than treating migration as an inevitable fallout, governments must develop comprehensive

frameworks to manage climate mobility. This includes investing in alternative rural livelihoods, modernizing agriculture through technology and improved seeds, and establishing early warning systems. For communities that must relocate, planned resettlement strategies should ensure access to housing, employment, and social services.

5. **Enforce Environmental Regulations Equitably:** To overcome the implementation deficits seen in Bangladesh, governments must empower regulatory bodies (like the DoE) with the legal authority and financial capacity to enforce environmental laws. Stricter penalties for industrial pollution and deforestation, coupled with incentives for green technologies, are essential to halt environmental degradation.

7. Limitations of the Study

As a comparative synthesis of existing literature, this study has several limitations. First, the primary data sources originate from four distinct studies with different methodological approaches (quantitative panel data, qualitative narratives, policy evaluation, and survey analysis). While this provides a rich, multi-dimensional view, direct statistical comparison across regions is not possible. Second, the study relies heavily on national-level data, which may obscure significant sub-national variations. For instance, rural areas in Kenya showed different outcomes than those in Burundi, just as coastal regions in Bangladesh face different threats than mountainous regions in Nepal. Finally, the rapid pace of climate change means that the empirical data, though recent, may quickly become outdated as new climate thresholds are breached.

8. Conclusion

The intersection of climate change, rural-urban disparities, and governance presents a defining challenge for sustainable development in the Global South. This comparative analysis of the East African Community, Bangladesh, Nepal, and Zimbabwe demonstrates that climate variability is not a neutral stressor; it is a catalyst that amplifies existing inequalities. Whether through the widening electricity divide in East Africa, the perceptual gaps in Zimbabwe, the governance bottlenecks in Bangladesh, or the forced migration in Nepal, the pattern is clear: rural and marginalized communities bear the heaviest burdens.

Achieving the Sustainable Development Goals and fulfilling the promise to "leave no one behind" requires a fundamental shift in how development and climate adaptation are conceptualized. Infrastructure investments must be climate-proof and spatially targeted. Governance must transition from fragmented policy formulation to coherent, decentralized implementation. And public awareness must be cultivated to empower communities as active agents of adaptation rather than passive victims. Only by addressing the structural drivers of vulnerability can developing nations build true resilience against the escalating climate crisis.

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