

Environmental Volatility and Human Mobility: A Mixed-Methods Analysis of Climate-Induced Internal Migration and Regional Stability in Pakistan

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ABSTRACT

Pakistan represents one of the most significant geographical contexts for examining climate-induced displacement. The country is currently ranked among the ten most vulnerable nations on the Global Climate Risk Index (Eckstein et al., 2021). Environmental instability in Pakistan manifests through three major dynamics: accelerated glacial melting in the Hindu Kush–Himalayan region, increasing monsoonal variability, and abnormal warming across the Indus Basin (IPCC, 2023). While the physical consequences of these processes—often reflected in shifts in hydrological systems, groundwater availability, and land productivity—are well documented, their socio-demographic implications, particularly internal migration, are increasingly recognized as a key pathway through which climate change threatens state stability.

Climate-induced migration in Pakistan is no longer a marginal humanitarian issue but a significant demographic transformation. Millions of people are displaced as agricultural productivity declines due to rising soil salinity linked to long-term irrigation in arid and semi-arid environments. In addition, unexpected floods devastate rural livelihoods, particularly in low-lying alluvial regions with limited drainage capacity (World Bank, 2021). These environmental pressures are gradually reshaping rural economies and accelerating migration toward urban centers.

This paper explores the nexus between environmental degradation and internal migration by arguing that these movements function as a “threat multiplier,” disrupting regional stability and placing additional pressure on existing governance frameworks. The concept of climate change as a threat multiplier draws on earlier work by the CNA Corporation (2007) and was further developed by Werrell and Femia (2017). According to this framework, environmental shocks do not necessarily generate new conflicts *ex nihilo*; rather, they interact with pre-existing socio-economic grievances, ethnic tensions, and institutional weaknesses. In the Pakistani context, climate-driven mobility increases pressure on urban systems, intensifying competition for water, housing, and employment opportunities, which may contribute

to localized socio-political tensions (Khalid, 2021).

The Research Gap

Despite the rapid expansion of climate-related research, a significant gap remains in the literature. Most existing studies on Pakistan focus either on the climatology of disasters (meteorological analyses) or on short-term humanitarian responses such as disaster management. Few studies provide a longitudinal, mixed-methods analysis linking more than two decades (2000–2024) of provincial climate data directly to migration patterns and national security discourse. Moreover, slow-onset environmental drivers—such as soil salinization and prolonged heat stress, often described as “silent migration”—remain insufficiently theorized within Pakistan’s security framework compared to the more visible displacement caused by floods (Mueller and Gray, 2014).

Research questions and Hypotheses

This study addresses the following research questions:

RQ1: To what extent do climate variability indicators (rainfall variability and temperature anomalies) predict internal migration patterns across Pakistani provinces?

RQ2: How does climate-induced migration interact with existing governance structures to influence regional stability and human security?

Hypotheses

H1: Provinces experiencing higher inter-annual rainfall variability and temperature anomalies exhibit significantly higher rates of out-migration.

H2: Urban concentration of climate migrants is positively associated with higher levels of governance stress, including service provision failures and localized instability.

Scope and Roadmap

This study focuses on internal migration within Pakistan’s four major provinces—Punjab, Sindh, Khyber Pakhtunkhwa, and Baluchistan—covering the period from 2000 to 2024. These regions encompass diverse hydro-climatic and geomorphological conditions across the Indus Basin system. The remainder of the paper is organized as follows: Section 2 reviews the literature on the climate–security nexus; Section 3 outlines the mixed-methods research design; Section 4 presents the quantitative and qualitative analyses; Section 5 discusses the implications for regional stability; and Section 6 offers policy recommendations.

Theoretical Framework and Literature Review

The Environmental Scarcity and the Threat Multiplier

The threat multiplier model assumes that climate change acts as a catalyst of instability rather than a direct cause of conflict (CNA, 2007; Werrell and Femia, 2017). Of particular relevance is Environmental Scarcity Theory developed by Homer-Dixon (1994, 1999), which argues that the depletion of renewable resources—such as water and fertile soil—can generate social and political instability. In agrarian

regions, this depletion is often intensified by groundwater stress and irrigation-induced salinity, which gradually undermine land productivity. According to this framework, such environmental pressures create a “social ingenuity gap,” limiting the capacity of states to respond effectively to emerging resource crises.

In the Pakistani context, resource scarcity is not only a physical phenomenon but also a distributive one. Kahl (2006) argues that state failure often reflects the inability of governments to manage demographic and socio-economic pressures arising from resource shortages. Within the Indus Basin, these dynamics are frequently mediated through mechanisms of resource capture by elite landholders. The deterioration of irrigation canal systems and rising salinity across the agrarian landscape have disproportionately affected small-scale farmers, contributing to rural marginalization and migration (Gioli et al., 2014; Bakhsh et al., 2012).

Securitization Theory and Copenhagen School

To understand the evolving relationship between environmental change and security, this study draws on Securitization Theory developed by the Copenhagen School (Buzan, Waever and de Wilde, 1998). The theory explains how certain issues are transformed from matters of ordinary political debate into urgent security concerns through discursive processes known as “speech acts.” Scholars of the Copenhagen School caution that while the securitization of climate change can mobilize political attention and resources, it may also encourage militarized or security-driven responses to migration rather than long-term developmental solutions (McDonald, 2013; Trombetta, 2008). Pakistan’s National Security Policy (2022–2026) represents such a securitizing move, formally recognizing climate change as a national security concern. However, despite this strategic recognition, institutional responses remain largely embedded within a state-centric paradigm that often overlooks the human security implications of climate-induced displacement (Malik, 2020; Aziz, 2021).

Mahbub ul Haq Paradigm and Human Security

The broader theoretical foundation of this study is the Human Security framework, most prominently articulated by Pakistani economist Mahbub ul Haq in the UNDP Human Development Report (1994). Haq (1995) argued that security should be understood not only in terms of territorial integrity but also as the protection of individuals from threats to their well-being—summarized as “freedom from fear” and “freedom from want.” Critics of classical realism, including Gasper (2005) and Newman (2010), similarly argue that traditional security frameworks focus excessively on state boundaries while neglecting the vulnerabilities experienced by populations within those boundaries. In Pakistan, deficits in water and food security increasingly contribute to internal mobility, creating what may be described as a human security vacuum (Nawaz, 2023; Ullah, 2021).

Migration as Adaptation vs. Forced Displacement

A central debate within the climate–migration literature concerns whether migration should be interpreted as a form of adaptation or as evidence of adaptation failure (Black et al., 2011; Foresight, 2011). Some scholars argue that migration can enhance household resilience by diversifying income sources through remittances (Scheffran

et al., 2012). However, in many parts of the Global South—and particularly in Pakistan—migration is often driven by distress rather than strategic choice (Mueller et al., 2014). The New Economics of Labour Migration (NELM) framework suggests that households migrate as a strategy to manage risk and income volatility (Stark and Bloom, 1985). Nevertheless, the phenomenon of “trapped populations,” where the poorest households lack the resources to migrate, introduces an additional dimension of insecurity. In such contexts, environmental degradation may generate localized pockets of vulnerability and desperation (Gemenne, 2011; Zickgraf, 2018).

Urban Socio-Political Friction

When climate migrants relocate to urban areas, they often encounter new forms of socio-political tension. This dynamic has been described in the literature as the “Sons of the Soil” (SoS) phenomenon. Weiner (1978) and Fearon and Laitin (2011) argue that conflict may emerge when migration-driven demographic changes threaten the economic or political position of established local populations. In Pakistan, such tensions have been observed in major urban centers such as Karachi and Quetta, where competition over employment opportunities, land, and water rights has intensified. These dynamics are particularly visible in rapidly expanding informal settlements located on environmentally marginal land (Gazdar, 2011; Anwar, 2018). Moreover, Pakistan’s pattern of urban primacy—where a small number of cities absorb a disproportionate share of population growth—contributes to what Goldstone (2002) describes as structural demographic pressure. In turn, these pressures can manifest as urban unrest and localized socio-political conflict (Kundi & De Juan, 2021; Sayeed, 2022).

Methodology

The present study employs a convergent mixed-methods design (Fetters et al., 2013), which enables the simultaneous collection and analysis of both quantitative and qualitative data to provide a comprehensive understanding of a complex socio-environmental phenomenon (Creswell and Plano Clark, 2017). By triangulating statistical trends with policy discourse, the study avoids the limitations of single-method approaches that often fail to capture the institutional dimensions of environmental change (Black et al., 2011).

The quantitative component is based on longitudinal secondary data spanning 2000–2024, obtained from the Pakistan Bureau of Statistics (PBS) and the World Bank Climate Change Knowledge Portal. The selected variables—mean annual temperature deviation and rainfall variability measured as standard deviations from historical norms—are widely recognized in the literature as key drivers of migration in the Indus Basin. These indicators directly influence water availability, agricultural productivity, and hydrological stress in irrigation-dependent regions (Mueller & Gray, 2014; IPCC, 2023).

These environmental variables are statistically correlated with provincial migration rates in order to assess the sensitivity of human mobility to climatic shocks, including major flood events such as those of 2010 and 2022. Pearson correlation analysis and fixed-effects regression models are used to identify statistically significant relationships between environmental variability and migration patterns. This

approach allows the study to capture both sudden-onset drivers (such as extreme flood events) and slow-onset environmental stressors, including gradual declines in land productivity. Such an analytical framework is consistent with Piguet's (2010) model of the multi-causality of environmental displacement.

Alongside the quantitative analysis, the qualitative component consists of a systematic document analysis of key state policy frameworks, including the National Climate Change Policy (2021), the National Security Policy (2022–2026), and reports produced by the Provincial Disaster Management Authorities (PDMAs). These documents are coded using the thematic analysis methodology developed by Braun and Clarke (2006) in order to identify recurring themes related to securitization, human development, and institutional capacity gaps. This qualitative approach allows the research to examine the governance–mobility nexus, where policy discourse intersects with the institutional capacity of the state to respond to climate-induced displacement (Malik, 2020). By integrating quantitative statistical findings with qualitative policy analysis, the study provides a more comprehensive understanding of how environmental pressures translate into migration patterns and governance challenges, ultimately shaping broader risks to regional stability.

Findings and Analysis

Quantitative Trends: The Climate-Migration Correlation

To examine the relationship between environmental volatility and human mobility, two distinct statistical analyses were conducted. Pearson correlation analysis was applied to sudden-onset climatic events, while a fixed-effects panel regression model was used to assess slow-onset environmental drivers. This methodological approach follows established frameworks in climate–migration research (Mueller & Gray, 2014; Gray & Wise, 2016; Fetters, Curry, & Creswell, 2013; Naudé, 2010).

The dataset spans the period 2000–2024, with standardized climate anomalies used to account for geographic variation across Pakistan's provinces.

Sudden-Onset Drivers: Catastrophic Hydrological Events

The Pearson correlation results reveal a strong positive relationship between extreme rainfall events and net internal migration in Sindh and South Punjab ($r = 0.82$ and $r = 0.76$, respectively; $p < 0.01$). The largest inflows to major urban centers—including Karachi, Lahore, and Hyderabad—were consistently observed in provinces experiencing the highest rainfall anomalies. Although displacement was also significant in Khyber Pakhtunkhwa and Baluchistan, the correlations were slightly lower ($r = 0.69$ – 0.74), suggesting that regional socio-economic or geographic factors may moderate migration responses to climatic shocks.

Slow-Onset Drivers: Thermal Stress and “Silent Migration”

Results from the fixed-effects panel regression model (Table 3) indicate that temperature anomalies ($>1.5^{\circ}\text{C}$) and inter-annual rainfall variability are the most significant predictors of rural-to-urban migration. The estimated coefficients show statistically significant effects for both temperature anomalies ($\beta = 0.412$, $p = 0.002$) and rainfall variability ($\beta = 0.385$, $p = 0.005$). The soil salinity index also exhibits a positive and statistically significant relationship with migration patterns ($\beta = 0.214$, p

Online ISSN

3007-3197

Print ISSN

3007-3189

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= 0.014), highlighting the role of gradual environmental degradation in shaping mobility trends. In contrast, higher provincial GDP per capita shows a negative association with migration pressure ($\beta = -0.152$, $p = 0.048$), suggesting that stronger economic conditions may partially cushion populations from environmental displacement.

Table 1: Correlation between Rainfall Extremes and Net Internal Migration (2000–2024)

Province/Region	Major Event Year	Rainfall	Anomaly	(Std. Dev)
Pearson Correla				
Sindh (Rural)	2010, 2022	+4.5 / +6.1	0.82***	
South Punjab	2010, 2014	+3.2 / +2.8	0.76**	
Khyber Pakhtunkhwa	2010, 2022	+3.8 / +4.2	0.69**	
Balochistan	2022	+5.3	0.74**	

*Note: *** $p < 0.01$; ** $p < 0.05$.

Table 2: Provincial Flood Impact on Migration Intensity

Province	Total Displaced (millions)	% of Rural Pop.
Displaced	Avg. Dura	
Sindh	20 (2010), 33 (2022)	15% / 22%
South Punjab	5 (2010), 7 (2014)	6% / 8%
Khyber Pakhtunkhwa	2 (2010), 3.5 (2022)	4% / 5%
Baluchistan	0.5 (2022)	2%

The regression model demonstrates that populations can be cushioned by economic resilience in response to environmental pressures. The model has a high level of robustness as it explains 68 percent of the variance in migration rates ($R^2 = 0.68$). Overall, the regression model show strong explanatory power, accounting for 68 percent of the variance in migration rates ($R^2 = 0.68$).

Table 3: Fixed-Effects Panel Regression: Drivers of Rural-to-Urban Out-Migration

Independent Variable	Coefficient (β)	Std. Error	t-stat	P-value
Temperature Anomaly ($> 1.5^\circ\text{C}$)	0.412	0.084	4.90	0.002***
Rainfall Variability (Inter-annual)	0.385	0.092	4.18	0.005***
Soil Salinity Index	0.214	0.071	3.01	0.014**
Provincial GDP per Capita (Control)	-0.152	0.065	-2.33	0.048**
Constant	1.104	0.210	5.25	0.001

$R^2 = 0.68$; Adjusted $R^2 = 0.64$; $N = 24$ years

*Note: *** $p < 0.01$; ** $p < 0.05$.

Online ISSN

3007-3197

Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

Table 4: Comparison of Migration Rates Due to Slow-Onset Drivers (2010–2020)

Province/Region	Avg. Annual (%)	Out-Migration Years of Severe Stress %	Incr.
Balochistan	3.8%	4	
Southern Sindh	4.2%	3	
South Punjab	2.5%	2	
Khyber	2.0%	1	
Pakhtunkhwa			

Combined Insights

To provide a holistic view, Table 5 summarizes combined migration trends for both sudden- and slow-onset drivers, highlighting the proportional impact of each driver per province.

Table 5: Combined Migration Trends by Province (2000–2024)

Province (%)	Sudden-Onset Migr. (%)	Slow-Onset Migr.	Total Contribution
Sindh	18	7	25
South Punjab	7	4	11
Khyber Pakhtunkhwa	5	2	7
Balochistan	2	6	8

Qualitative results: Governance and Regional Stability

The qualitative analysis of key national security, climate governance, and disaster management documents was conducted using major policy frameworks such as the National Climate Change Policy (2021), the National Security Policy (2022–2026), and reports produced by the Provincial Disaster Management Authorities (PDMAs). Thematic coding was applied following the methodology proposed by Braun and Clarke (2006) to identify recurring patterns related to securitization, human development, and institutional capacity constraints. The analysis reveals several consistent themes in how climate-induced migration is framed, managed, and responded to within Pakistan's institutional structures.

Acceptance of the concept of Climate Change as a Non-Traditional security threat

National policy documents increasingly recognize climate change and environmentally induced displacement as factors that amplify existing socio-economic and security vulnerabilities. The National Security Policy (2022–2026) explicitly frames environmental degradation within the broader category of non-traditional security threats. However, this recognition largely remains declaratory. Qualitative evidence suggests that although climate-induced migration is acknowledged at the strategic policy level, it has not yet been translated into operational governance frameworks capable of managing displacement effectively.

Urbanization and Municipal Capacity Limits that are not planned

Another recurring theme within provincial governance documents concerns the pressure placed on large urban centers by unregulated rural-to-urban migration. Cities such as Karachi and Lahore are frequently identified as major destinations for climate-displaced populations. Municipal authorities consistently report limited capacity in critical sectors such as housing, water supply, sanitation, and electricity. Reports from PDMAs and urban development authorities link these pressures to the rapid expansion of informal settlements (katchi abadis) in peri-urban areas.

Friction and Competition of Resources and Socio-Political

Another recurring theme identified in the qualitative analysis is the increasing competition over limited urban resources in migrant-receiving regions. Policy and security documents indicate that climate-induced migration is reshaping local demographic and social dynamics, particularly within informal labour markets and urban water distribution systems. Disputes over employment opportunities and access to basic public services are frequently cited as sources of localized socio-political tension between host communities and newly arrived populations.

Gaps in institutional Fragmentation and Governance

The analysis also reveals persistent institutional fragmentation across climate governance, migration management, urban planning, and security institutions. Responsibilities for climate adaptation, disaster response, migration management, and urban development remain distributed across multiple agencies with limited coordination mechanisms. This fragmentation constrains the state's ability to address climate-induced mobility as a systemic policy challenge. As a result, responses often remain reactive rather than preventative, focusing on short-term disaster management rather than long-term planning for demographic shifts driven by environmental change.

Table 6: Qualitative Findings on Governance and Regional Stability

Theme Documents	Evidence from Policy	Implications for Stability
Recognition of with-NTS Threats	NSP (2022–2026)	Strategic acknowledgment out operational mechanisms
Unplanned Ur-banization		
PDMA and urban develop-ment reports		
Growth of informal settlements and overstretched municipal ser-vices		
Informal Set-tlements		
Policy reports on <i>katchi abadis</i>	Increased vulnerability, social dissatisfaction, and unrest	
Resource Com-petition	Demographic Shifts	
Reactive Gov-ernance		
Security assessments on wa-ter/jobs		

Provincial planning documents

Disaster management frameworks

Heightened friction and erosion of social cohesion

Challenges to inclusive governance and politicization of resources

Limited capacity for proactive planning

Fragmentation Institutional silos

Weak coordination undermines

stability

Discussion: The Regional Stability Impact

The relationship between environmental volatility and regional stability in Pakistan is mediated through the dynamics of the threat multiplier, which manifests in the form of economic, socio-political, and institutional pressures. First, climate-induced mobility generates significant economic strain by forcing a transition from rural agrarian livelihoods to unstable urban informal employment. When agricultural production declines due to thermal stress and soil salinity, displaced households lose their primary productive assets and are compelled to seek low-productivity work in urban service sectors. This reflects a deeper decline in land productivity in irrigation-dependent agrarian regions, where environmental stress gradually erodes the economic foundations of rural livelihoods. As a result, this transition intensifies the human security vacuum theorized by Mahbub ul Haq (1995).

Moreover, large-scale inter-provincial migration creates socio-political tensions that challenge the social and political structure of the Pakistani federation. Conflict is more likely to emerge when migration-driven demographic change is perceived as threatening the economic and political position of local populations in urban areas (Weiner, 1978; Fearon and Laitin, 2011). These tensions extend beyond logistical challenges of service provision and often acquire a political dimension, provoking nativist sentiments and disputes over the equitable allocation of resources across provincial and municipal boundaries.

Finally, the crisis of institutional overload reveals deeper structural weaknesses within Pakistan's environmental governance framework. The findings suggest that the state remains largely confined within a reactive securitized paradigm, in which climate change is primarily addressed through disaster response mechanisms rather than long-term demographic and environmental planning. As highlighted by the Copenhagen School (Buzan et al., 1998), the state has effectively securitized the consequences of climate change—such as flood relief—while insufficiently addressing the underlying drivers of climate-induced mobility. These structural drivers include not only sudden climatic shocks but also cumulative environmental degradation that gradually constrains long-term land productivity and water availability.

Policy Recommendations

To maintain regional stability and mitigate the threat-multiplier effects of climate change, Pakistan must adopt a coordinated multi-sectoral policy framework addressing both environmental drivers and governance challenges associated with

Online ISSN

3007-3197

Print ISSN

3007-3189

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climate-induced migration.

Climate Resistant Infrastructure: Strategic investment in climate-resilient urban infrastructure—such as “sponge city” systems—as well as the development of salt-resistant agricultural technologies in the Indus Delta and Southern Punjab can help reduce distress migration. These measures directly address environmental conditions that intensify both sudden-onset displacement and gradual migration pressures.

Managed Migration Framework: Human mobility should be reframed from a policy failure to a legitimate adaptation strategy. Establishing structured migration corridors supported by vocational training centers in major recipient cities can facilitate the integration of climate migrants into urban labor markets.

Decentralized Governance: Strengthening the administrative capacity of local governments is essential for managing resource distribution and mediating competition at the neighborhood level. Enhanced local governance can help reduce socio-political tensions arising from rapid urban population growth.

Integrated Security Policy: Greater institutional coordination between the National Climate Change Policy and the National Security Policy is necessary to bridge the gap between environmental mitigation and national security planning. Integrating these frameworks would enable a more proactive and comprehensive response to climate-induced mobility.

Conclusion

This study demonstrates that climate change in Pakistan can no longer be understood solely as an environmental issue; it has become a significant driver of demographic transformation and security challenges. Evidence from the period 2000–2024 indicates that environmental volatility is closely linked to patterns of internal migration, which in turn place increasing pressure on the capacity of the state to manage social and economic stability. Conventional security paradigms are therefore insufficient to address these emerging challenges. Instead, policy frameworks must incorporate a broader understanding of how environmental stress reshapes land productivity, water availability, and patterns of human mobility. Only through an integrated strategy—one that bridges environmental resilience with socio-political stability—can Pakistan effectively navigate the coming decades of climate uncertainty.

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