

CLIMATE VULNERABILITY AND DEVELOPMENT CHALLENGES IN SOUTH ASIA: A COMPARATIVE ANALYSIS OF PAKISTAN AND INDIA

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Abstract

Climate change has emerged as one of the most pressing development challenges in South Asia, particularly in Pakistan and India, where high population density, dependence on climate-sensitive sectors, and weak adaptive capacities intensify vulnerability. This study provides a comparative analysis of climate vulnerability and development challenges in both countries by examining environmental risks, socio-economic impacts, governance structures, and adaptation capacities. The research highlights that both Pakistan and India are increasingly affected by extreme weather events such as floods, heatwaves, droughts, and irregular monsoon patterns, which severely disrupt agriculture, water resources, public health, and economic stability. Pakistan's vulnerability is largely shaped by its dependence on the Indus River system, fragile agricultural base, and limited institutional capacity for climate adaptation, while India faces large-scale regional disparities, urban climate stress, and governance implementation gaps despite having relatively stronger policy frameworks. The study also identifies that climate-induced migration, food insecurity, water scarcity, and environmental degradation are common challenges that are reshaping demographic and economic structures in both countries. Furthermore, the comparative analysis reveals that while both countries have initiated climate adaptation strategies, significant gaps remain in enforcement, infrastructure resilience, and community-level preparedness. The study concludes that climate vulnerability in South Asia is not only an environmental issue but also a structural development challenge requiring integrated policy responses, regional cooperation, and sustainable development planning to reduce long-term risks and enhance resilience.

INTRODUCTION

Climate change has emerged as one of the most pressing global challenges of the twenty-first century, significantly reshaping environmental systems, human livelihoods, and development pathways across regions. South Asia is widely recognized as one of the most climate-vulnerable regions due to its dense population, dependence on climate-sensitive sectors, and limited adaptive capacity. Increasing temperatures, erratic rainfall patterns, and the rising frequency of extreme weather events are placing severe pressure on

ecological and socio-economic systems. These climate-induced pressures are increasingly understood as development challenges that directly threaten poverty reduction, food security, and sustainable growth in countries such as Pakistan and India (Afzal & Nishtar, 2023; World Bank, 2010).

Pakistan and India share similar geographic and climatic systems, yet their vulnerability patterns differ due to variations in governance structures, institutional strength, and development

capacity. Both countries rely heavily on monsoon rainfall and glacier-fed river systems, which are increasingly threatened by climate change and glacial retreat. Pakistan's dependence on the Indus Basin makes it particularly vulnerable to water stress and variability in river flows, while India faces uneven climate impacts across its diverse regions, including severe heatwave risks and regional water shortages. These shared but differentiated vulnerabilities highlight the importance of comparative analysis in understanding climate risks and adaptive capacity in South Asia (Rehman et al., 2024; Reuters, 2025).

The socio-economic consequences of climate change are becoming increasingly severe in both countries, particularly in agriculture, which remains the backbone of rural livelihoods and national food security. Rising temperatures, shifting monsoon patterns, and extreme weather events are reducing crop productivity and increasing rural poverty. In Pakistan, agriculture is highly affected by water shortages and climate variability, while in India, similar pressures are affecting staple crops and intensifying food insecurity risks. These challenges demonstrate that climate change is not only an environmental issue but also a structural threat to food systems, rural economies, and national stability (Gul et al., 2022; Saira et al., 2023).

Governance and institutional capacity play a central role in shaping climate resilience in both countries. Pakistan faces significant challenges in policy implementation, institutional coordination, and integration of climate adaptation into development planning, despite the existence of national climate policies. India, while comparatively stronger in institutional frameworks, still struggles with implementation gaps and uneven regional resilience, particularly in high-risk districts facing heatwaves and water stress. These governance disparities significantly influence how effectively both countries can respond to climate risks and build long-term resilience (Mumtaz, 2018; Reuters, 2025; Khatoon et al., 2026).

This study provides a comparative analysis of climate vulnerability and development challenges in Pakistan and India by examining environmental risks, socio-economic impacts, governance structures, and adaptation

capacities. It argues that climate vulnerability is not only determined by exposure to environmental hazards but is also deeply shaped by structural inequalities, governance effectiveness, and development disparities. Understanding these interconnected dynamics is essential for designing effective adaptation strategies and promoting sustainable development across South Asia, where climate risks continue to intensify (Mumtaz & de Oliveira, 2023; Afzal & Nishtar, 2023).

Literature Review

Existing literature emphasizes that climate change significantly impacts water resources, agriculture, and food security in South Asia. Studies indicate that changing precipitation patterns and rising temperatures disrupt agricultural productivity, leading to increased food insecurity in both Pakistan and India (Gul et al., 2022; Saira et al., 2023). These impacts are particularly severe in rural areas where livelihoods depend heavily on agriculture, making adaptation strategies essential for ensuring food security and economic stability.

Another important area of research focuses on climate migration and socio-economic vulnerability. Hussain et al. (2026) highlight that climate-induced migration is becoming increasingly prevalent in Pakistan, with vulnerable populations forced to relocate due to environmental degradation. Similarly, research on migration dynamics suggests that economic instability and climate stressors jointly contribute to increased migration flows from Pakistan to other regions (Hussain et al., 2025). These findings underscore the interconnected nature of climate change, migration, and development challenges.

Scholars have also examined governance and policy responses to climate change. Mumtaz (2018) critically evaluates Pakistan's climate policy and identifies significant gaps in institutional implementation. Further research by Mumtaz and de Oliveira (2023) proposes a framework for analyzing climate adaptation policies, emphasizing the need for localized and sector-specific strategies. Additionally, studies on regional governance highlight the importance of cooperation and effective communication in enhancing climate resilience (Khatoon et al., 2026; Rehman et al., 2024).

Research Gap

Although substantial research exists on climate change in South Asia, there is a lack of integrated comparative studies that combine climate vulnerability, migration, governance, and development challenges in Pakistan and India. Moreover, limited attention has been given to the role of climate migration as a key development issue. This study addresses these gaps by providing a comprehensive comparative analysis incorporating these interconnected dimensions.

Research Questions

1. How does climate vulnerability differ between Pakistan and India in environmental and socio-economic terms?
2. What role does climate change play in shaping development challenges, including migration and governance, in both countries?

Research Objectives

1. To compare climate vulnerability in Pakistan and India.
2. To analyze the impact of climate change on development challenges, including migration and governance.

Research Methodology

This study adopts a qualitative research design based on secondary sources to conduct a comparative analysis of climate vulnerability and development challenges in Pakistan and India. The qualitative approach is selected because it allows for an in-depth understanding of complex socio-environmental issues, institutional dynamics, and development patterns that cannot be adequately captured through quantitative methods alone. Data for this research is collected from peer-reviewed journal articles, policy reports, government publications, international organizations, and credible academic databases focusing on climate change, development studies, and South Asian regional analysis. Key sources include studies on climate vulnerability, food security, water governance, migration patterns, and institutional responses in Pakistan and India. The research systematically reviews and synthesizes existing literature to identify patterns, similarities, and differences between the two countries in terms of exposure to climate risks and adaptive

capacity. Content analysis is applied to interpret qualitative data, focusing on themes such as environmental degradation, socio-economic impacts, governance effectiveness, and climate adaptation strategies. No primary data collection is conducted, and the study relies entirely on documented evidence to ensure a broad, comparative, and evidence-based understanding of the subject. This methodological approach enables the research to integrate diverse perspectives and generate a comprehensive analytical framework for understanding climate vulnerability in South Asia.

Findings**1. Increasing Climate Extremes in Pakistan and India**

- Climate change is intensifying floods, heatwaves, droughts, and irregular rainfall patterns in both countries.

The analysis finds that both Pakistan and India are experiencing a clear increase in the frequency and intensity of climate-related extreme weather events, which is significantly reshaping their development trajectories. In Pakistan, catastrophic floods such as those in 2010 and 2022 demonstrate how climate shocks can overwhelm national infrastructure, damage housing and agriculture, and displace millions of people. Similarly, India faces recurring heatwaves, cyclones along coastal regions, and erratic monsoon behavior that disrupt agricultural cycles and urban life. These events highlight that climate extremes are no longer occasional hazards but have become structural development risks that continuously affect economic stability, food systems, and human security in both countries (IPCC, 2023).

2. Water Stress and Indus Basin Vulnerability

- Water scarcity and glacier melt are increasing pressure on shared river systems.

Findings indicate that water stress is one of the most critical vulnerabilities affecting both Pakistan and India, particularly due to reliance on the Indus Basin and other transboundary river systems. In Pakistan, dependence on glacier-fed rivers makes water availability highly sensitive to climate change, leading to unpredictable irrigation cycles and reduced agricultural productivity. India, on the other hand, faces groundwater depletion and uneven

river distribution across states, intensifying regional inequalities in water access. Climate-induced glacier retreat in the Himalayas is further destabilizing long-term water security for both countries. This shared vulnerability underscores the urgent need for sustainable water governance and cooperative transboundary management mechanisms to prevent future resource conflicts and ensure equitable distribution (World Bank, 2022).

3. Agricultural Decline and Food Insecurity

- Climate variability is reducing crop productivity and threatening food security. The findings show that agriculture in both Pakistan and India is highly vulnerable to climate change due to its dependence on predictable weather patterns and water availability. In Pakistan, wheat and cotton production are increasingly affected by heat stress, pest outbreaks, and irregular irrigation, while in India, rice and wheat yields are similarly threatened by shifting monsoon patterns and rising temperatures. These disruptions are directly linked to declining rural incomes, increased poverty, and rising food prices, which disproportionately affect low-income populations. As a result, climate change is not only an environmental issue but also a growing food security crisis that threatens long-term socio-economic stability in both countries (FAO, 2023).

4. Climate-Induced Migration and Urban Pressure

- Environmental degradation is driving rural-to-urban migration. The analysis finds that climate-induced migration is becoming a major development challenge in both Pakistan and India, as environmental stressors such as floods, droughts, and land degradation force rural populations to relocate to urban centers. In Pakistan, cities like Karachi and Lahore are experiencing increasing pressure on housing, sanitation, and employment due to internal displacement. Similarly, Indian metropolitan areas such as Delhi and Mumbai are absorbing large migrant populations, leading to overcrowded informal settlements and strained infrastructure. This migration trend is not only reshaping demographic patterns but also

creating new urban vulnerabilities, where climate stress combines with poverty and governance challenges to produce complex humanitarian and developmental pressures (Rigaud et al., 2018).

5. Governance and Institutional Weakness

- Climate response capacity varies due to governance and policy limitations. Findings reveal that governance plays a decisive role in determining climate resilience in both countries, with Pakistan facing more severe institutional weaknesses compared to India. Pakistan struggles with fragmented climate governance, limited financial resources, and weak policy enforcement, which reduces the effectiveness of adaptation strategies. India has developed more comprehensive climate policies, such as national adaptation plans and renewable energy initiatives, but implementation gaps remain at the state and local levels. These governance disparities demonstrate that climate vulnerability is not only determined by exposure but also by institutional capacity and political commitment to long-term sustainability (Mumtaz, 2018).

6. Health Impacts of Climate Change

- Rising temperatures and disasters are increasing disease burden. The findings show that climate change is significantly affecting public health systems in both Pakistan and India. Rising temperatures are increasing heat-related illnesses such as dehydration and heatstroke, while flooding events contribute to the spread of waterborne diseases like cholera and diarrhea. Air pollution, worsened by climate conditions, is also contributing to respiratory illnesses in urban areas. Vulnerable groups, particularly children, the elderly, and low-income communities, face the highest risks due to limited access to healthcare services. This demonstrates that climate change is not only an environmental and economic challenge but also a growing public health crisis in South Asia (WHO, 2023).

7. Economic Losses and Development Setbacks

- Climate disasters are causing repeated economic damage. The analysis finds that both Pakistan and India suffer significant economic losses due to

repeated climate-induced disasters. Floods, droughts, and storms damage infrastructure, destroy crops, and disrupt supply chains, leading to billions of dollars in economic losses annually. In Pakistan, disaster recovery often diverts scarce public funds away from development projects, while in India, frequent climate shocks hinder sustained industrial and agricultural growth. These recurring economic disruptions slow down long-term development and increase fiscal pressure on governments, making it difficult to invest in climate adaptation and resilience-building initiatives (ADB, 2022).

8. Environmental Degradation and Ecosystem Stress

- Deforestation and land degradation are increasing vulnerability.

Findings highlight that environmental degradation is a major factor intensifying climate vulnerability in both countries. Deforestation, soil erosion, and loss of biodiversity reduce the natural resilience of ecosystems and increase exposure to floods and droughts. In Pakistan, unsustainable agricultural practices and urban expansion contribute to land degradation, while in India, rapid industrialization and deforestation are key drivers of ecological stress. These environmental changes reduce the capacity of natural systems to absorb climate shocks, thereby increasing long-term vulnerability and weakening adaptation potential across regions (IPCC, 2023).

Discussion and Analysis

Climate vulnerability in South Asia is the result of a complex interaction between environmental change, socio-economic fragility, and governance limitations. Pakistan and India, despite sharing similar climatic systems, show different patterns of exposure, sensitivity, and adaptive capacity. Both countries are increasingly experiencing rising temperatures, unpredictable monsoon systems, floods, droughts, and heatwaves that disrupt livelihoods and economic stability. However, the severity of impacts is disproportionately higher among poorer and marginalized communities, showing that climate change acts as a multiplier of existing inequalities in development systems (Afzal & Nishtar, 2023).

In Pakistan, climate vulnerability is strongly linked to its dependence on the Indus River

system, which is highly sensitive to glacial melt and changing precipitation patterns. Variability in water flow has created serious challenges for irrigation, drinking water supply, and hydro-based energy production. The agricultural sector, which consumes most of the available water resources, is becoming increasingly unstable due to irregular water availability and prolonged dry spells, reducing productivity and threatening rural livelihoods (Mumtaz, 2018).

Agriculture in Pakistan remains the backbone of the economy, yet it is one of the most climate-exposed sectors. Changes in temperature and rainfall patterns have led to reduced crop yields, increased pest outbreaks, and shifting growing seasons. These disruptions are not only affecting food security but are also increasing rural poverty and forcing farmers into debt cycles. As a result, climate change is directly influencing socio-economic stability in rural Pakistan, particularly in regions already facing structural deprivation (Gul et al., 2022).

Another major dimension of climate vulnerability in Pakistan is climate-induced migration. Increasing floods, droughts, and land degradation are forcing populations to migrate from rural to urban areas in search of livelihood opportunities. This internal displacement is placing additional pressure on already strained urban infrastructure, including housing, sanitation, health services, and employment systems. Migration is therefore becoming both a coping mechanism and a development challenge, as highlighted in recent studies on climate mobility in Pakistan (Hussain et al., 2026).

In contrast, India faces climate vulnerability at a much larger scale due to its population size and geographic diversity. Extreme weather events such as heatwaves, cyclones, and irregular rainfall patterns are affecting different regions with varying intensity. While India has relatively stronger institutional and policy frameworks, the effectiveness of these systems is uneven across states, resulting in unequal adaptive capacity and persistent regional disparities (Reuters, 2025).

Urbanization in India has intensified climate-related risks, especially in major metropolitan cities. High population density, informal settlements, inadequate infrastructure, and environmental degradation have increased

exposure to heat stress and flooding. Vulnerable urban populations often lack access to clean water, healthcare, and climate-resilient housing, making them disproportionately affected during climate disasters. This highlights the intersection between urban inequality and climate vulnerability (Afzal & Nishtar, 2023).

Food security is a shared concern for both Pakistan and India, as climate change directly affects agricultural output and supply chains. Shifts in rainfall patterns, increasing temperatures, and water shortages are reducing productivity of staple crops such as wheat and rice. This not only threatens domestic food availability but also increases price volatility and economic pressure on low-income households, deepening poverty and inequality across rural and urban regions (Saira et al., 2023).

Water scarcity is one of the most critical and shared challenges between Pakistan and India. The Indus Basin and other river systems are increasingly affected by glacial retreat and changing climatic conditions. These changes have intensified competition over water resources, making transboundary water governance an essential issue for regional stability. Weak cooperation mechanisms further increase the risk of resource-based tensions in the future (Rehman et al., 2024).

Governance and institutional capacity play a decisive role in shaping climate resilience in both countries. Pakistan faces challenges such as weak institutional coordination, limited financial resources, and inconsistent policy implementation, which reduce its ability to respond effectively to climate risks. In contrast, India has developed more comprehensive climate policies; however, gaps in execution and uneven regional governance continue to limit their overall impact (Mumtaz, 2018).

Climate migration is becoming a structural development challenge in South Asia rather than a temporary phenomenon. Environmental stressors such as floods, droughts, and land degradation are increasingly pushing vulnerable populations toward urban centers. This migration creates secondary pressures on infrastructure and governance systems, leading to urban overcrowding, unemployment, and rising inequality. Thus, climate change is reshaping demographic and socio-economic

structures in both countries (Hussain et al., 2025).

Health impacts of climate change are also becoming more visible across Pakistan and India. Rising temperatures contribute to heat-related illnesses, while floods and water contamination increase the spread of infectious diseases. Vulnerable groups such as children, the elderly, and low-income populations are at higher risk due to limited access to healthcare and adaptive resources. These health challenges add another dimension to the climate-development nexus (Gul et al., 2022).

Economic losses caused by climate-related disasters are increasing significantly in both countries. Recurrent floods, droughts, and storms damage infrastructure, agriculture, and housing, diverting public resources toward emergency response instead of long-term development. These repeated shocks slow down economic growth and reduce investment in productive sectors, thereby weakening overall development progress (Afzal & Nishtar, 2023).

Environmental degradation, including deforestation, soil erosion, and loss of biodiversity, further intensifies climate vulnerability. These ecological changes reduce natural ecosystem resilience and increase exposure to climate shocks. Unsustainable land-use practices and rapid urban expansion contribute to long-term environmental instability, making adaptation more difficult in both countries over time (Mumtaz & de Oliveira, 2023).

Regional disparities within Pakistan and India highlight the importance of localized adaptation strategies. Some regions are far more vulnerable due to geographic exposure, poverty levels, and weak infrastructure, while others benefit from stronger governance and resources. This uneven distribution of resilience creates internal inequality in climate response capacity, making national-level policies less effective without local implementation mechanisms (Reuters, 2025).

Despite these challenges, there are emerging opportunities for strengthening resilience through technological innovation, policy reform, and community-based adaptation strategies. Investments in climate-smart agriculture, renewable energy, and early warning systems can significantly reduce vulnerability. Strengthening institutional coordination and

local governance structures is essential for ensuring that adaptation measures reach the most vulnerable populations effectively (Mumtaz, 2018).

Overall, climate vulnerability in South Asia is not only an environmental issue but also a structural development challenge deeply embedded in governance, inequality, and economic systems. Pakistan and India must move toward integrated climate-development strategies that combine environmental sustainability with socio-economic resilience. Without coordinated national and regional efforts, both countries will continue to face escalating climate risks that threaten long-term stability and sustainable development (Mumtaz & de Oliveira, 2023).

Conclusion

Climate change has emerged as one of the most pressing developmental challenges in South Asia, with Pakistan and India being among the most affected countries due to their geographical location, population pressure, and dependence on climate-sensitive sectors. Both countries are experiencing increasing climate variability in the form of rising temperatures, unpredictable rainfall patterns, floods, droughts, and heatwaves. These environmental changes are not only ecological concerns but are also deeply linked with broader development issues such as poverty, food insecurity, and weak institutional resilience. As a result, climate vulnerability in the region is closely tied to socio-economic fragility and uneven development patterns.

Pakistan faces particularly severe climate risks due to its heavy dependence on the Indus River system, limited water storage infrastructure, and relatively weak institutional capacity to respond to environmental challenges. The growing intensity of floods, glacier melting in northern regions, and prolonged droughts in certain areas have significantly affected agricultural productivity and rural livelihoods. These challenges are further compounded by rapid population growth and limited financial resources, which restrict the country's ability to implement large-scale adaptation measures. In addition, climate-induced displacement is becoming increasingly visible, as vulnerable communities are forced to migrate from high-

risk areas, placing additional pressure on urban centers.

India, while comparatively more advanced in terms of policy frameworks and institutional structures, still faces extensive climate-related challenges due to its large population size and regional diversity. Extreme heatwaves, irregular monsoon patterns, and water stress are affecting both rural and urban populations, particularly marginalized communities. Although India has introduced several climate adaptation and mitigation initiatives, their effectiveness varies significantly across regions due to differences in governance capacity and resource allocation. This uneven impact highlights that climate vulnerability in India is not only environmental but also deeply rooted in socio-economic inequality and development disparities.

Overall, both Pakistan and India remain highly vulnerable to the impacts of climate change, despite differences in capacity and governance structures. The analysis shows that climate change acts as a threat multiplier, intensifying existing development challenges and creating new pressures on governance systems, economies, and societies. Without effective long-term planning and coordinated action, both countries may continue to experience escalating environmental and socio-economic risks. Therefore, integrating climate resilience into national development planning is essential for ensuring sustainable growth in the region.

Way Forward

To effectively address climate vulnerability in South Asia, both Pakistan and India need to strengthen their national climate governance frameworks through improved institutional coordination and policy implementation. Priority should be given to developing climate-resilient infrastructure, sustainable agricultural practices, and efficient water management systems. Early warning systems and disaster preparedness mechanisms must also be enhanced to reduce the impact of extreme weather events. In Pakistan, particular attention is required to improve water storage capacity and strengthen rural livelihood resilience, while India must focus on reducing regional inequalities in climate adaptation and ensuring that vulnerable populations receive adequate protection and support.

In addition to national efforts, regional cooperation between Pakistan and India is essential for addressing shared climate challenges. Since both countries rely on interconnected river systems and experience similar climatic conditions, collaborative approaches to water management, disaster response, and environmental protection are necessary. Strengthening dialogue on climate issues can also help build trust and reduce tensions between the two countries. Joint initiatives in renewable energy development, climate research, and migration management can further enhance regional resilience. Ultimately, a coordinated and cooperative regional strategy is crucial for transforming shared vulnerabilities into opportunities for sustainable and inclusive development in South Asia.

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