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# Editorial: Climate change vulnerability, adaptation, and human settlements

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## KEYWORDS

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## Editorial on the Research Topic

Climate change vulnerability, adaptation, and human settlements

## Introduction

Climate issues have become a global concern and are impacting the sustainable development of human settlements worldwide (Boulanger, 2023). Adapting to climate change in these settlements is vital to ensure that growth is not compromised and that the increasing global population can thrive in their own habitats (Dodman et al., 2019). Even before climate change became a pressing Research Topic, human settlements faced significant challenges like urban flooding in rapidly growing cities, water scarcity in arid and semi-arid regions, coastal erosion and sea-level rise (Matta et al.). The compounding effects of climate change will further exacerbate these challenges, making human settlements vital in local, national, and global adaptation plans. However, developing effective adaptation strategies requires a comprehensive understanding of the challenges and alternatives specific to human settlements, based on the National Climate Change Response insights (Adger et al., 2005; Kalantari et al.). In recent decades, urban, rural, and coastal human settlements have encountered various environmental challenges (Liu et al.; Zhu et al.). Urban settlements, in particular, face complex and diverse implications from both direct and indirect climate change.

The susceptibility of human settlements to natural and artificial risks worldwide, especially in developing nations like India, China, Bangladesh, Pakistan, delta and coastal regions, and Small Island Developing States, is increasing due to climate change. Assessments of human settlements should consider location-specific vulnerabilities, encompassing economic, social, environmental, political, and cultural aspects (Dong et al.; Thakur et al.). It is crucial to utilize gender-disaggregated vulnerability data generated at the local level to identify and address the root causes of gender-differentiated vulnerability (Liu et al.). National and local governments can employ a variety of risk assessment and adaptation planning toolkits that cover a range of communities, from cities to villages and informal

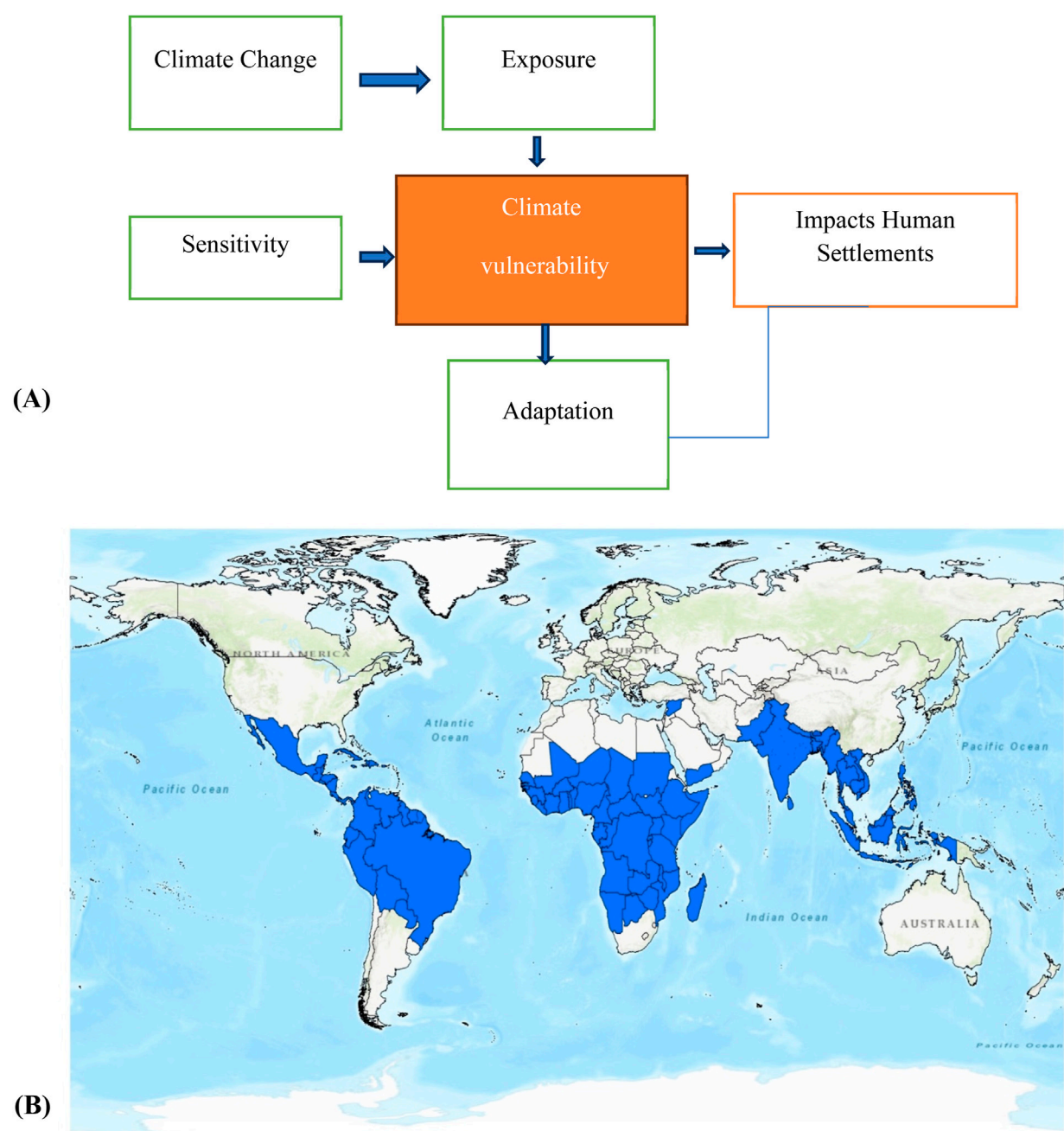


FIGURE 1  
(A) Conceptual framework of climate vulnerability and adaptation in human settlements, (B) global climate vulnerability hotspots.

settlements. Some of these toolkits are specifically designed for areas lacking resources or experience with adaptation planning. Several national adaptation measures are applicable across climate scenarios and offer additional social benefits, such as job creation and social equity. Despite growing attention to climate resilience, several critical research gaps persist. First, there is a lack of disaggregated and longitudinal data, limiting our understanding of how vulnerability evolves over time and varies within settlements, particularly across gender, age, and socio-economic groups. Second, urban–rural comparative studies remain underexplored, hindering insights into differentiated adaptation needs and

strategies. Third, the role of informality whether in slum settlements or rural governance is often overlooked, despite its significant influence on access to resources and adaptive behavior. Fourth, local and indigenous knowledge systems are insufficiently integrated into formal adaptation planning. Moreover, adaptation finance remains skewed toward infrastructure and mitigation, with inadequate attention to social and community-based interventions (McNamara and Buggy, 2017). Finally, fragmented multi-scalar governance continues to constrain coordinated and inclusive adaptation efforts across local, regional, and national levels. Addressing these gaps, these editorial aims to

assess spatial and socio-economic variability in climate vulnerability across different settlement types, evaluate the effectiveness of nature-based and infrastructural adaptation strategies, and explore the role of informal systems and community-based approaches in enhancing resilience. It also seeks to investigate the integration of traditional knowledge in planning, analyze equity in adaptation finance, and propose coherent, multi-level governance models that support inclusive and context-specific adaptation pathways. These measures can and should be prioritized, often complementing existing government policies and initiatives. Therefore, the Research Topic “Climate Change Vulnerability, Adaptation, and Human Settlements” was organized. The interests of this Research Topic mainly included i) Climatic change in human settlements, ii) Ecosystem-based adaptation, iii) Community-based adaptation, iv) Disaster risk management, v) Water quality issues and challenges, vi) Urban densification, and vii) Rural housing subsidies. Eleven articles were published in this Research Topic, highlighting key progress in the field, which are cited and published online in this Research Topic section.

As illustrated in Figure 1, climate vulnerability is highly uneven across the globe, with the most affected regions primarily located in the Global South. Sub-Saharan Africa faces acute risks due to persistent poverty, fragile institutions, and high exposure to droughts and extreme temperatures. South Asia, particularly India, Bangladesh, and Pakistan, experiences high vulnerability from dense populations, climate-sensitive livelihoods, and frequent flooding. In Southeast Asia, countries like Vietnam, the Philippines, and Indonesia are threatened by sea-level rise, cyclones, and urbanization in coastal zones. Similarly, Central and South America face increasing risks from droughts and deforestation, particularly in the Amazon basin and Andean regions. Small Island Developing States (SIDS) remain especially vulnerable to sea-level rise and extreme weather due to their geographic isolation and limited adaptive capacity. In contrast, developed regions like North America, Europe, and East Asia generally maintain higher resilience through stronger infrastructure, governance, and access to technology and finance while exposed to climate risks. This global pattern underscores the urgent need for targeted adaptation and equitable climate action.

Climate change poses multifaceted risks to human settlements, ranging from coastal cities to remote rural communities and often disproportionately affecting the most socio-economically vulnerable populations (Shang et al.; Hong et al.). Vulnerability is broadly defined by three key dimensions: exposure to climate hazards, sensitivity of the system to those hazards, and the capacity to adapt (IPCC, 2022). Settlements with dense infrastructure, high population concentrations, and limited institutional capacity are particularly susceptible to cascading climate impacts, especially in low- and middle-income countries. Adaptation in human settlements encompasses both reactive and proactive strategies that span physical, social, and institutional dimensions. These include climate-resilient infrastructure, early warning systems, nature-based solutions, climate-sensitive urban planning, and community-based adaptation approaches. Innovations such as green roofs, flood-retaining parks, and climate-smart building codes offer substantial potential to buffer climate impacts in urban areas. In contrast, rural settlements often require tailored strategies that integrate indigenous knowledge systems, diversified livelihoods, and improved water governance (UN-Habitat, 2023). The success of adaptation is

highly contingent on local governance, financial resources, and social capital. Importantly, climate adaptation must be equitable, ensuring that marginalized groups (e.g., indigenous communities, urban poor, and women) are actively involved in planning and decision-making. Climate-resilient settlements cannot be achieved without bridging the gap between top-down planning and bottom-up resilience, supported by multi-scalar coordination among local, national, and global actors (Boulanger, 2023). Moreover, integrating adaptation into long-term spatial planning and disaster risk reduction policies is essential for minimizing residual risks. Recent advancements in geospatial technologies, artificial intelligence, and participatory risk assessment frameworks offer new tools to assess vulnerability and monitor adaptive progress. Yet, climate change's urgency demands scaling up funding and implementation. A comprehensive settlement-level adaptation strategy must embrace systemic approaches that combine infrastructure, ecosystem resilience, and inclusive governance for transformative outcomes.

## Author contributions

AK: Conceptualization, Writing – review and editing, Investigation, Project administration, Writing – original draft, Formal Analysis, Methodology. RK: Writing – review and editing, Investigation, Visualization, Validation. PS: Visualization, Data curation, Investigation, Writing – review and editing. YH: Conceptualization, Investigation, Writing – review and editing, Validation.

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## References

- Adger, W. N., Arnell, N. W., and Tompkins, E. L. (2005). Successful adaptation to climate change across scales. *Glob. Environ. Change* 15 (2), 77–86. doi:10.1016/j.gloenvcha.2004.12.005
- Boulanger, S. O. M. (2023). Urban adaptation to climate change state of the art: evaluating the role of adaptation assessment frameworks through a systematic and bibliometric analysis. *Sustainability*, 15 (13), 10134. doi:10.3390/su151310134
- Dodman, D., Archer, D., and Satterthwaite, D. (2019). Editorial: responding to climate change in cities and in urban informal settlements with local governments and community organizations. *Environ. Urbanization* 31 (1), 3–12.
- IPCC. (2022). Climate change 2022: impacts, adaptation and vulnerability. Contribution of working group II to the sixth assessment report of the intergovernmental panel on climate change.
- McNamara, K. E., and Buggy, L. (2017). Community-based climate change adaptation: a review of academic literature. *Local Environ.* 22 (4), 443–460. doi:10.1080/13549839.2016.1216954
- UN-Habitat (2023). *Resilient settlements: building urban climate resilience*. Nairobi, Kenya: United Nations Human Settlements Programme.