

From Households to Communities: Collective Action Pathways for Equitable Heat Adaptation

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Abstract

Climate change disproportionately affects socio-economically vulnerable households, raising urgent concerns about climate justice in adaptation actions. Although public protection mechanisms exist, they frequently fall short of effectively reaching and safeguarding individual households, thereby shifting the burden of responsibility onto those least equipped to bear it. Community-Based Adaptation (CBA) offers a promising bottom-up approach that strengthens adaptive capacity, redistributes responsibility, and fosters greater justice in climate responses. This study explores the development of CBA for adaptation to heatwaves. A mixed-methods design is employed, combining agent-based model simulations (ABMS) with empirical survey data to capture household and community behaviours in response to extreme heat episodes. The ABM conceptualizes households as heterogeneous agents with varying adaptive capacities, social ties, and access to resources, allowing exploration of emergent patterns of collective adaptation. The survey aims to gather data on risk perception, coping strategies, and informal support networks, which will inform model parameters and validate behavioural assumptions. Ultimately, this research seeks to identify pathways for more equitable and locally grounded heat adaptation strategies that enhance climate justice for vulnerable communities.

Keywords: CBA; ABMS; heat adaptation; climate justice

Introduction

Globally, climate change has doubled the number of extreme heat days in 195 countries, with approximately four billion people, nearly half the world's population, experiencing at least 30 days of extreme heat between May 2024 and May 2025 (Giguere et al., 2025). Although the health consequences of extreme heat, including elevated mortality and morbidity, are well documented (Hossain et al., 2024; Vargo et al., 2016), the implementation of adaptation measures remains inadequate (Lao et al., 2025). Climate adaptation strategies either rely on top-down approaches that emphasize centralized planning and technical solutions while neglecting local contexts and community needs (Woodruff & Stults, 2016), or focus on private adaptation action by individual households (Berrang-Ford et al., 2021). However, top-down adaptation strategies have shown limited effectiveness (Dupuits et al., 2024), failing to provide adequate protection at the neighborhood and household levels (Laranjeira et al., 2021). At the same time, individual household adaptation is often hindered by financial constraints, and further limited by social isolation and the absence of coordination mechanisms, which makes it difficult for households to access shared resources or learn from others, reinforcing the need for community-level strategies that promote mutual support and collective learning. Scholars

have emphasized that these local scales are among the most vulnerable and exposed, as environmental and demographic factors can amplify heat exposure (Borsky et al., 2024; Gabbe et al., 2023; Lo et al., 2022; Sharmin et al., 2023; Vargo et al., 2016). These factors are closely tied to disparities in adaptive capacity among households, which influences their ability to respond to heat stress and raises concerns about climate justice. Many studies have shown that marginalized households and neighborhoods are more susceptible to heat episodes due to limited financial resources, inadequate housing conditions, and densely built environments that lack open and green spaces (Büchs et al., 2024; Cutter et al., 2003; Johnson et al., 2010; Osberghaus & Abeling, 2022).

One promising approach to address climate injustice in adaptation efforts is community-based adaptation (CBA). The Intergovernmental Panel on Climate Change (IPCC) describes CBA as a local, community-driven approach that focuses on empowering and promoting the adaptive capacity of communities, treating context, culture, knowledge, agency, and preferences as strengths (IPCC, 2023). CBA has emerged in response to the limitations of top-down adaptation strategies, which often overlook the lived experiences and knowledge of vulnerable communities. By centering local participation and knowledge, CBA aims to equitably distribute the burdens and responsibilities of climate adaptation (Schreuder & Horlings, 2022).

Despite its growing relevance, CBA remains relatively unfamiliar to many of the citizens who are expected to carry it forward. Although widely discussed in academic domains, its practical application in everyday community settings is limited (Shammin, Wang, et al., 2022). Literature often separates CBA into bottom-up participatory efforts (Parsons et al., 2025) or top-down policy frameworks, with little attention to how household-level actions and government strategies can be effectively integrated (Shammin, Haque, et al., 2022). Furthermore, the potential of CBA to promote distributive justice at a regional scale is still unclear. While CBA has shown effectiveness at the neighborhood level, its transferability across different urban contexts, even within the same city, remains underexplored (Shammin, Wang, et al., 2022). Building on these gaps, the study explores how CBA can be integrated with existing individual and top-down government strategies to address heat stress in daily life practices, alongside household-level actions that are often constrained by financial and structural limitations.

Research design

This study adopts a mixed-methods approach, integrating a qualitative empirical survey with quantitative agent-based simulation modeling. The empirical component is designed to investigate how individual households perceive and respond to CBA initiatives. To capture the evolving nature of household engagement, the survey incorporates a temporal dimension, examining past experiences, current realities, and future expectations. These insights will inform the structure and parameters of the agent-based model, enabling a dynamic simulation of individual household behavior and institutional framework within CBA contexts. This dual-layered design enables the model to reflect both individual agency and systemic governance, offering a holistic view of adaptation processes. The conceptual framework guiding this approach is illustrated in Figure 1. This conceptual model is applied to selected neighborhoods

in Antwerp city. Further, the study evaluates the transferability and out-scaling potential of CBA across these neighborhoods to understand their potential for broader application within the same urban context.

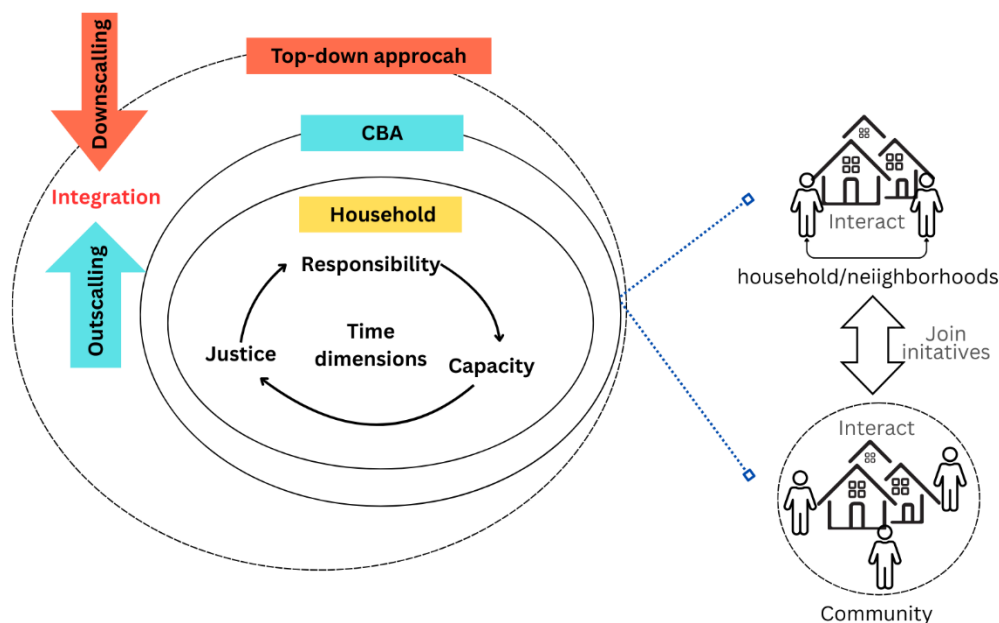


Figure 1 Conceptual framework illustrating the integration of top-down and bottom-up approaches in community-based adaptation, using responsibility, capacity, and justice as analytical lenses, with time as a dimension reflecting both long-term and historical aspects.

Conclusions

This abstract has laid the groundwork for investigating the role of CBA in addressing heat stress and promoting climate justice at the urban scale. By combining empirical insights with agent-based modeling, the study aims to capture the dynamics of household behavior and institutional support in response to extreme heat. The conceptual model and research design presented here mark the starting point of a broader inquiry into how adaptation can be made more inclusive and responsive to local realities. At the ICRS26 conference, we will present the first simulation results, offering initial reflections on how CBA mechanisms shape adaptation pathways and contribute to more equitable climate responses.

Acknowledgements

This research is funded by the UrbanAIR project, Funded by the European Union under Grant Agreement number 101188131.

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