



Investigating and Scaling-up Effective Nature-Based Solutions for Climate Resilience in Dessie City Administration, Ethiopia

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Executive Summary

Problem, Rationale, and Objective of the Study

Urban areas, particularly in developing countries, are at the forefront of climate change impacts, facing various hazards such as heat stress, landslides, flooding, and deteriorating air quality, among others, due to their high sensitivity and limited adaptive capacity. Dessie city administration, located in Ethiopia's Amhara Regional State, has faced these challenges primarily due to rapid population growth, insufficient urban infrastructure, inadequate waste management, and unplanned settlements. These factors have escalated the city's vulnerability to climate change-induced disasters, most notably flash floods, landslides, and urban heat island effects, which would have a cumulative effect on the health, livelihoods, and safety of residents. To mitigate such impacts, Nature-based Solutions (NbS) have emerged as promising cost-effective and feasible strategies for fostering ecosystem restoration, climate resilience, and enhancing urban livability. Despite their growing recognition, there is limited empirical evidence on how to effectively implement and scale NbS within rapidly urbanizing contexts, particularly in Africa. Thus, this study was conducted with the overarching objective of investigating and scaling community-driven NbS to bolster urban climate resilience in Dessie City. Specifically, this research opted to evaluate the effectiveness of existing community-based NbS interventions; to explore local perceptions and socio-economic challenges encountered during implementation; to identify best practices and scalable models for wider adoption, and to couple with mapping hazard-prone and suitable areas for future NbS expansion.

Research Methodology

We employed a mixed-methods approach, which involved conducting household surveys with 305 respondents across four sub-cities, alongside focus group discussions, key informant interviews, direct field observation, and participatory vulnerability mapping, to explore the multifaceted nature of NbS. Quantitative methods, including the Problem Confrontation Index (PCI) and weighted mean analysis, were used to examine perceptions and challenges. Thematic analysis was employed to analyze the FGD and interview results. Maps of vulnerability to floods, landslides, and heat, as well as suitability maps for NbS interventions, were produced using GIS-based spatial analysis with Multi-Criteria Evaluation and the Analytical Hierarchy Process.

Major Findings

The findings of the study revealed a complex picture. Different forms of NbS are identified in the Dessie City administration, which includes the forest resources in and around the City, mainly in the surrounding Tossa mountain range. Besides, both biological and physical forms of NbS have been introduced over the last ten years. The dominant tree types include the eucalyptus tree and *Juniperus procera* forest, coupled with some indigenous trees are also found in scattered places. Although many residents only occasionally visit NbS sites, a substantial majority participate in NbS-related activities, mainly tree planting, waste management, maintenance, and attending community meetings. However, participation in planning, financial backing, and long-term stewardship was comparatively limited. The primary motives behind their engagement mainly stem from environmental concern, interaction, and financial incentives. Participants primarily recognized the ecological and health benefits of NbS-ranging from reduced soil erosion, stabilizing run-off, restoring degraded lands, minimizing air pollution, and reducing heat stress to improved mental and

physical well-being. Residents admire NbS as a vital solution to these environmental challenges, particularly their importance in controlling floods, landslides, and preventing soil erosion. Economic benefits, however, were less apparent, with limited awareness of potential gains from tourism, recreation, or increased property value. Socially, NbS have promoted community cohesion and created shared spaces, though inclusivity and volunteering opportunities remain underdeveloped. As a result, it is possible to conclude that the existing NbS are effective in benefiting varied ecological and social benefits, while their economic benefits are not yet fully capitalized. Besides, disparities were observed in their perception regarding the potential benefits of NbS and their actual benefits. The integration of case study analysis provided qualitative depth to the quantitative survey findings. These case studies illustrated how varying environmental conditions, governance structures, and community engagement levels influenced the performance and sustainability of NbS interventions. The triangulation of case study evidence with survey data strengthened the reliability of the results and clarified the contextual factors driving success or failure across different urban settings.

Respondents acknowledged the social benefits of NbS but were constrained by concerns associated with inclusivity and participatory opportunities. On the other hand, the economic benefits of NbS were viewed as relatively weak, with most residents not perceiving direct household-level gains (like being resources for tourism, in enhancing property values) except for their opportunities in temporary employment. These findings underscore the need for a more integrated approach to NbS implementation. For local authorities and stakeholders in Dessie City, future efforts should build upon the strong ecological and health dimensions while addressing the weaker economic and social aspects. Enhancing inclusivity, strengthening community engagement, and creating livelihood-oriented opportunities can help ensure that NbS interventions are not only environmentally sustainable but also socially equitable and economically visible. Such an approach would maximize community acceptance and ensure the long-term sustainability of NbS as a core strategy for building urban climate resilience. Critical barriers impeding the full engagement include weak institutional support, poor accessibility, high maintenance costs, safety issues (particularly at night), limited community ownership, limited financial incentives, lack of institutional coordination, low awareness, encroachment into buffer zones, and insufficient municipal integration of NbS into urban planning. GIS analysis output revealed that more than 60% of the city faces moderate to very high vulnerability to floods and landslides, while nearly 58% of its area is moderately to highly suitable for NbS, which highlights the urgency of interventions. Positively, a great proportion of the city was mapped as highly suitable for NbS interventions, presenting an opportunity to systematically and strategically extend ecological infrastructure.

Conclusion and Recommendations

The study concludes that while NbS have been considered as low-cost, effective, and multi-benefit strategies for urban climate resilience, their sustainability and long-term benefits are determined by the extent of sustained community engagement, integrated planning, and enabling institutional frameworks. To that end, strategic communication and awareness programs should be capitalized through partnerships with relevant community-based organizations, effectively conveying the multifaceted benefits of NbS and countering misconceptions. Policymakers must mainstream NbS within urban planning and development agendas, backed by clear, inclusive, and actionable policy frameworks that articulate community roles and support mechanisms for NbS initiatives. To this end, the study recommends: (i) embedding NbS into formal urban development and municipal policies, (ii) incentivizing community participation through livelihood linkages and financial support, (iii) strengthening coordination among government, NGOs, and community-based organizations

and other relevant stakeholders, (iv) raising public awareness through education and outreach, (v) using community-based organizations as a good entry point for mobilizing the community that could enhance their participation and foster a sense of ownership, (vi) improving accessibility and safety by investing in infrastructure improvements such as walkways, lighting, and signage to ensure safe, equitable access for all, including vulnerable groups, and (vii) prioritizing hazard-prone zones for targeted NbS expansion. Above all, NbS should be advanced not just as ecological fixes, but as integrated urban strategies that connect environmental, social, and economic resilience. By linking ecological, social, and spatial perspectives, this study contributes actionable knowledge for policymakers, practitioners, and communities in Ethiopia and beyond. It highlights that NbS are not merely environmental interventions but critical pathways to inclusive, sustainable, and resilient urban futures. Besides, the inclusion of GIS-based vulnerability and suitability mapping represents a pioneering application of GIS-based multi-criteria evaluation for urban resilience planning in Dessie City and provides a novel contribution to local NbS planning. This analytical approach offers city planners a scientific basis to prioritize interventions in high-risk zones and integrate NbS within land-use plans.