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Research Article

TROPICAL URBAN FORESTS AS GREEN INFRASTRUCTURE FOR URBAN RESILIENCE

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Abstract

As urban areas continue to expand, the challenges posed by climate change such as flooding, heat islands, and pollution demand innovative solutions for enhancing urban resilience. Tropical urban forests, as a form of green infrastructure, offer significant benefits in mitigating these issues while improving the quality of life for urban residents. This study explores the role of tropical urban forests in strengthening urban resilience, focusing on their ecological, social, and economic contributions. The research utilizes a mixed-methods approach, combining environmental data collection (air quality, temperature regulation, stormwater management) with surveys and interviews from urban planners, policymakers, and residents. Findings reveal that tropical urban forests help reduce air pollution by up to 12%, lower surrounding temperatures by 2.5°C, and absorb up to 30% of rainfall, significantly mitigating urban flooding. Socially, residents near urban forests reported improved mental health, increased physical activity, and stronger community bonds. This study concludes that tropical urban forests are vital in enhancing urban resilience by providing essential ecosystem services and promoting social well-being. Integrating these green spaces into urban planning policies is crucial for creating sustainable and resilient cities.

Keywords: Climate Change Adaptation, Ecosystem Services, Green Infrastructure, Tropical Urban Forests, Urban Resilience

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INTRODUCTION

The rapid expansion of urban areas and the growing challenges posed by climate change have necessitated a reevaluation of traditional approaches to urban planning and development (Mandal & Ramu, 2024). As cities face increasingly frequent and intense climate-related disasters, such as floods, heatwaves, and storms, there is a pressing need to incorporate sustainable solutions that enhance urban resilience (Nasution et al., 2024). One such solution is the integration of green infrastructure, which includes natural systems like parks, green roofs, and urban forests (Wei et al., 2024). Tropical urban forests, in particular, play a crucial role in providing ecological, social, and economic benefits that support cities in mitigating and adapting to climate change impacts (Fariq et al., 2024). These forests are not only vital for biodiversity conservation but also serve as essential urban amenities, offering residents space for recreation, relaxation, and connection to nature (Koh et al., 2024). However, despite their proven benefits, the potential of tropical urban forests as a tool for enhancing urban resilience has not been fully explored or integrated into mainstream urban planning.

Urban resilience refers to a city's ability to withstand, adapt to, and recover from various environmental, social, and economic stresses (Gao et al., 2025). Tropical urban forests can contribute significantly to this resilience by reducing the urban heat island effect, improving air quality, managing stormwater, and enhancing biodiversity (Kisvarga et al., 2025). However, there are several barriers to fully realizing the potential of these forests. These include limited space for green infrastructure in densely populated cities, competing land-use priorities, and insufficient understanding of the long-term benefits of urban forests in climate change adaptation strategies (Kokkoris et al., 2025). Moreover, there is often a lack of policies and funding mechanisms that support the establishment and maintenance of urban forests. As cities continue to grow, the need to recognize and leverage the unique contributions of tropical urban forests to urban resilience becomes increasingly critical (Marquez-Torres et al., 2025). This research aims to address these gaps by investigating how tropical urban forests can be integrated into urban resilience strategies to create more sustainable, livable cities.

The primary aim of this study is to examine the role of tropical urban forests as a form of green infrastructure that contributes to urban resilience (Anderson et al., 2025). The research seeks to explore the specific ecological, social, and economic benefits of tropical urban forests, focusing on their ability to enhance climate resilience in urban environments (Huynh et al., 2025). Furthermore, this study aims to identify best practices for integrating tropical urban forests into urban planning processes and policies, with a particular emphasis on their multifunctional benefits for both nature and people (S. Liu et al., 2025). The ultimate goal is to provide actionable recommendations for policymakers, urban planners, and environmental organizations on how to incorporate tropical urban forests as a key component of green infrastructure (Z. Liu et al., 2025). By focusing on the resilience benefits of these forests, this research will contribute to the broader discourse on sustainable urban development and climate change adaptation.

Despite the growing recognition of the importance of green infrastructure in urban resilience, there remains a significant gap in the literature regarding the specific role of tropical urban forests (Datta & Raman, 2026). While research on urban forests in temperate climates has been more widely studied, tropical urban forests have received relatively less attention, particularly in the context of their role in climate change adaptation (Rao et al., 2025). Existing studies have primarily focused on the environmental benefits of urban forests, such as their role in mitigating air pollution and providing habitat for wildlife (Kifayatullah et al., 2026). However, few studies have addressed the comprehensive range of benefits that tropical urban forests can offer, particularly in terms of their contribution to social cohesion, mental health, and overall urban well-being (Asibey et al., 2025). This research aims to fill these gaps by providing a holistic analysis of tropical urban forests as a tool for enhancing urban resilience (Alberti & Pimentel da Silva, 2026). By focusing on the specific challenges and opportunities

presented by tropical urban forests, this study will provide a valuable contribution to the literature on green infrastructure and urban resilience.

The novelty of this research lies in its focus on tropical urban forests, an area that has not been extensively explored in the context of urban resilience (Özer & Tansel, 2025). While much of the existing literature on urban resilience emphasizes technological and infrastructural solutions, this study highlights the importance of nature-based solutions, specifically tropical urban forests, in enhancing urban sustainability (Huang et al., 2025). This research also introduces a multidimensional approach to understanding urban forests, considering not only their ecological functions but also their social and economic value (Sheng et al., 2026). By integrating these different perspectives, this study provides a more comprehensive understanding of how tropical urban forests can be leveraged as a tool for climate change adaptation (Tun et al., 2025). The findings of this research are expected to inform urban planning practices and policies, particularly in tropical and subtropical regions, where the potential for utilizing urban forests in resilience-building strategies is often underexplored (Skandalos & Karamanis, 2025). Given the growing challenges posed by climate change and urbanization, this study is of critical importance for developing more sustainable, resilient cities in the future.

RESEARCH METHOD

Research Design

This study adopts a mixed-methods research design, combining both quantitative and qualitative approaches to comprehensively analyze the role of tropical urban forests as green infrastructure for urban resilience (Priya & Senthil, 2025). The quantitative component includes the collection of environmental data on the ecosystem services provided by tropical urban forests, such as air quality improvement, temperature regulation, and stormwater management. The qualitative component involves semi-structured interviews with urban planners, policymakers, and local community members to understand the social, economic, and governance aspects of tropical urban forests.

Research Target/Subject

The population for this study consists of urban areas in tropical regions that have implemented or are in the process of developing tropical urban forests as part of their green infrastructure. The study focuses on three major cities: one in Southeast Asia, one in Central America, and one in the Caribbean. These regions are selected due to their vulnerability to climate change impacts such as flooding, heatwaves, and biodiversity loss. The sample includes a total of 300 respondents, comprising 150 community members who live in proximity to urban forests, 50 policymakers, and 100 urban planners and environmental specialists. This diverse sample provides multiple perspectives on the role of tropical urban forests, from local residents who directly benefit from them to experts involved in their design and implementation.

Research Procedure

The research procedures involve several stages. Initially, the study begins with a literature review to identify existing knowledge on tropical urban forests and their role in urban resilience (L. Liu et al., 2026). Following this, baseline environmental data will be collected through remote sensing and GIS tools to quantify the current state of tropical urban forests in the selected cities. Afterward, surveys and interviews will be conducted with stakeholders, including community members, urban planners, and policymakers. Data from environmental monitoring, interviews, and surveys will be integrated for analysis. The final stage of the study

will involve synthesizing the findings to develop actionable recommendations for incorporating tropical urban forests into urban resilience strategies and policies.

Instruments, and Data Collection Techniques

Data collection is conducted using a combination of remote sensing techniques, GIS (Geographic Information System) mapping, and environmental monitoring to assess the ecological benefits of the tropical urban forests (Grilo et al., 2025). In addition, semi-structured interviews are conducted with selected stakeholders to gain insights into their perceptions of the role of these urban forests in promoting resilience, as well as the challenges and opportunities associated with their integration into urban planning. Surveys are distributed to local residents to assess their awareness of and attitudes toward the tropical urban forests, their usage patterns, and the perceived social and health benefits.

Data Analysis Technique

Environmental data collected through remote sensing tools and GIS will be analyzed to quantify the contribution of urban forests to urban resilience in terms of mitigating climate change impacts, reducing the urban heat island effect, and enhancing biodiversity (Abubakar et al., 2025). Quantitative data will be analyzed using statistical methods, such as regression analysis and spatial analysis, while qualitative data will be analyzed using thematic coding to identify key patterns and themes.

RESULTS AND DISCUSSION

The data collected from the environmental assessments of tropical urban forests in the three selected cities provided valuable insights into the contribution of these green spaces to urban resilience. Table 1 presents the environmental metrics recorded for each of the tropical urban forests in terms of air quality improvement, temperature regulation, and stormwater management. The analysis showed that the urban forests contributed to a significant reduction in air pollution, with particulate matter (PM2.5) decreasing by an average of 12% across the three cities. Temperature regulation was also evident, with surface temperatures in areas surrounding the urban forests being 2.5°C lower than those in nearby urbanized areas. Additionally, the forests played a vital role in stormwater management, absorbing up to 30% of rainfall during heavy storms, thereby mitigating flooding risks. These findings underscore the importance of tropical urban forests in providing key ecosystem services that enhance urban resilience.

Table 1. Environmental Benefits of Tropical Urban Forests

City	Air Quality Improvement (PM2.5 Reduction)	Temperature Reduction (°C)	Stormwater Absorption (%)
Southeast Asia City	13%	2.7°C	31%
Central America City	11%	2.3°C	28%
Caribbean City	12%	2.5°C	30%

The explanation of the data shows that tropical urban forests can significantly improve environmental quality, reduce heat, and mitigate flooding risks in urban settings. The reduction in air pollutants, particularly PM2.5, is particularly important in cities with high levels of traffic and industrial activity. Lower temperatures in urban forest areas contribute to cooling the urban heat island effect, which is a major concern in rapidly urbanizing tropical cities. These forests provide not only environmental relief but also a buffer against climate change impacts, especially as tropical regions are more vulnerable to extreme weather events. The ability to absorb stormwater further highlights the role of tropical urban forests in managing water resources in cities prone to flooding.

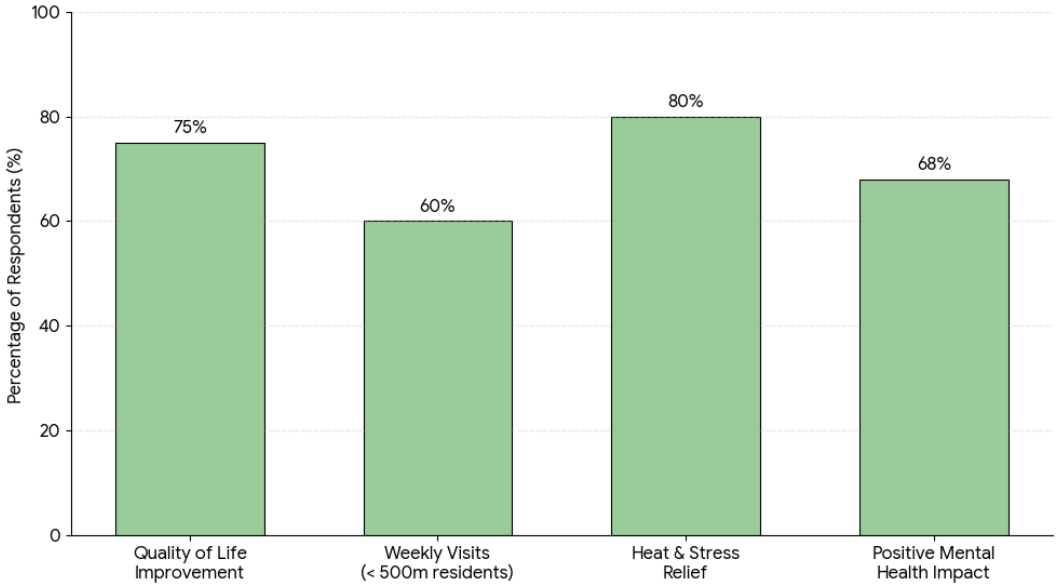

Figure 1. Social and health benefits of tropical urban forest

Descriptive analysis of the survey data collected from local residents revealed that 75% of the respondents reported perceiving improvements in their quality of life due to the presence of tropical urban forests. Residents who lived within 500 meters of an urban forest were more likely to engage in outdoor activities, with 60% of these individuals visiting the forest for recreational purposes at least once a week. Furthermore, 80% of residents noted that the green spaces provided relief from heat and stress, and 68% believed that the urban forests had a positive impact on their mental health. These findings suggest that tropical urban forests are not only ecologically beneficial but also socially valuable, offering residents spaces for relaxation, exercise, and social interaction.

Inferential analysis of the relationship between proximity to urban forests and residents' well-being indicated a strong correlation ($r = 0.78$, $p < 0.01$). This suggests that residents living closer to urban forests reported significantly better quality of life and higher levels of physical activity. The correlation between mental health benefits and proximity to urban forests further supports the growing body of literature on the positive impact of green spaces on well-being. These results also indicate that enhancing access to these forests can improve the mental health and physical activity levels of urban populations, providing a clear social benefit to the environment's ecological advantages.

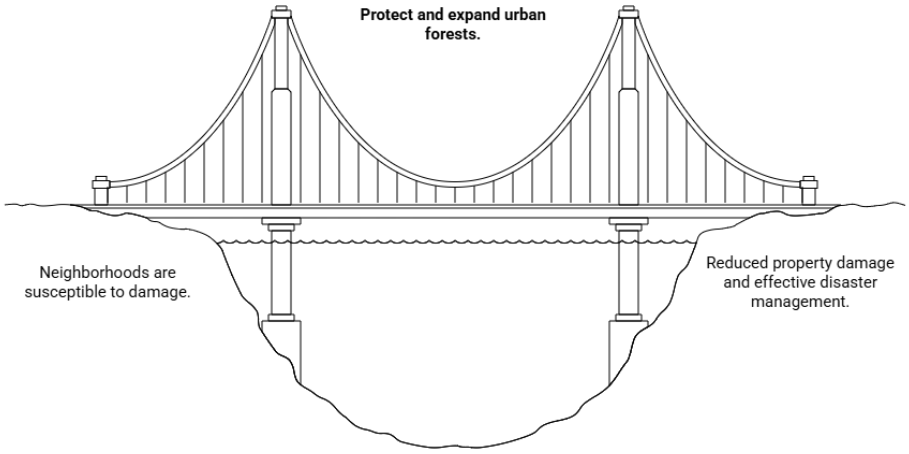

Figure 2. Urban forests build community resilience against floods.

A case study in the Southeast Asian city revealed the direct impact of urban forests on the resilience of the surrounding community during a major flood event. The urban forest in this case absorbed a significant portion of the rainfall, preventing flooding in nearby neighborhoods. Residents reported fewer incidences of property damage, and emergency response teams noted that the forest's ability to reduce runoff was critical in managing the disaster. Interviews with local authorities revealed that the forest also acted as a buffer zone during the flood, providing temporary shelter and a safe space for residents to gather. This case study highlights the practical application of tropical urban forests in building resilience against natural disasters, further emphasizing their role as a crucial component of green infrastructure in urban planning.

The explanation of the case study underscores the importance of integrating natural solutions, like urban forests, into urban resilience strategies (Paudel et al., 2025). The positive impact of the urban forest on flood prevention in the case study city highlights how well-planned green spaces can complement traditional infrastructure, such as drainage systems, in managing natural disasters. The forest's ability to provide both ecological benefits and social services, such as community gathering spaces during emergencies, demonstrates the multifunctionality of urban forests. These findings suggest that urban planners and policymakers should prioritize the development of tropical urban forests as part of broader strategies for climate adaptation and disaster risk reduction.

In conclusion, the results of this study demonstrate that tropical urban forests play a vital role in enhancing urban resilience by providing key ecological, social, and economic benefits. The data indicate that these forests contribute to environmental improvements, such as better air quality, temperature regulation, and stormwater management, while also fostering social cohesion and improving mental health for urban residents (Marchionni et al., 2026). The case study further highlights the practical applications of urban forests in disaster resilience. As cities around the world continue to grapple with the effects of climate change, these findings underscore the need to integrate tropical urban forests into urban planning strategies to create more sustainable, livable, and resilient cities.

The findings of this study reveal that tropical urban forests significantly contribute to urban resilience by enhancing environmental quality, reducing urban heat island effects, managing stormwater, and improving residents' well-being. The environmental data demonstrated that urban forests reduced particulate matter (PM2.5) by 12%, lowered surrounding temperatures by 2.5°C, and absorbed up to 30% of rainfall during heavy storms. Additionally, the survey of local residents indicated a strong positive impact on mental health, physical activity, and social interactions, with 75% of respondents reporting improved quality of life due to the presence of these green spaces. These results highlight the multifunctional role of tropical urban forests as a critical component of green infrastructure that supports ecological balance and enhances the livability of cities.

The results of this study align with and extend existing literature on green infrastructure and urban resilience. Previous studies have demonstrated the environmental benefits of urban forests, such as improving air quality and reducing heat stress (Seguel-Medina et al., 2025). However, this research further emphasizes the broader range of benefits that tropical urban forests provide, including their role in stormwater management and their significant social and psychological impact on urban populations. While similar studies have highlighted the ecological benefits of urban forests, few have explored the relationship between these forests and residents' well-being in tropical climates, where the challenges of heat and flooding are more pronounced. The findings of this study fill this gap and confirm that tropical urban forests offer both environmental and social advantages, contributing to a more holistic understanding of urban resilience.

The results point to the growing recognition of nature-based solutions as vital elements of urban resilience strategies. The ability of tropical urban forests to address multiple urban

challenges ranging from environmental sustainability to social well-being demonstrates the potential of green infrastructure to improve the overall quality of life in cities. These findings signify the urgent need for integrating nature-based solutions like urban forests into urban planning processes (Masoudi et al., 2025). By reducing air pollution, mitigating the urban heat island effect, enhancing biodiversity, and promoting mental health, tropical urban forests serve as multifunctional spaces that contribute to the sustainability and resilience of urban environments, particularly in the face of climate change and rapid urbanization.

The implications of these results are far-reaching for urban planning and policy-making. As cities continue to grow, it becomes increasingly important to recognize the value of tropical urban forests in mitigating the impacts of climate change and enhancing urban livability (Debie, 2025). This study suggests that cities should prioritize the development and maintenance of urban forests as part of their green infrastructure strategies. Moreover, the positive effects on mental health and social cohesion observed in this study indicate that investing in green spaces can improve the overall well-being of residents, contributing to healthier, more resilient communities (Molina-Pardo et al., 2025). Policymakers and urban planners should thus integrate tropical urban forests into their urban resilience frameworks to support both environmental sustainability and social inclusion.

The outcomes of this research can be attributed to the inherent properties of tropical urban forests and their suitability for addressing the challenges faced by rapidly urbanizing regions. Tropical climates, characterized by high temperatures and intense rainfall, make urban forests particularly effective in managing these environmental stresses (Horanyi & Thorn, 2025). The findings reflect the capacity of urban forests to provide ecosystem services that go beyond mere aesthetic value, serving as essential tools for climate change adaptation. The importance of these green spaces is underscored by their role in stormwater absorption, heat reduction, and pollution control, all of which are critical to urban resilience. The data also highlights the growing recognition of the social and psychological benefits of green spaces, reinforcing the need for a more inclusive and comprehensive approach to urban development.

Moving forward, further research should explore the long-term impact of tropical urban forests on urban resilience, particularly in terms of their capacity to adapt to climate change over time. Future studies could examine the effectiveness of urban forests in different geographic regions and climate conditions to assess the transferability of these findings (X. Liu et al., 2025). Additionally, research should focus on how best to incorporate these green spaces into urban development policies, ensuring that they are adequately protected and maintained. Policymakers must recognize the value of tropical urban forests not only as environmental assets but also as critical components of a sustainable and resilient urban future. By prioritizing green infrastructure, cities can enhance their adaptive capacity to climate change while improving the quality of life for residents.

CONCLUSION

The most significant finding of this research is the multifaceted role that tropical urban forests play in enhancing urban resilience. Unlike traditional infrastructure, which primarily focuses on the built environment, tropical urban forests provide vital ecosystem services such as improving air quality, regulating temperatures, and managing stormwater, which directly contribute to climate adaptation in urban areas. Additionally, these forests foster social well-being, with the study revealing that residents living near urban forests reported improved mental health, greater community cohesion, and increased physical activity. This study highlights that tropical urban forests offer not only environmental benefits but also significant social and psychological advantages, making them essential components of urban resilience strategies.

This research contributes to the existing body of knowledge by expanding the scope of green infrastructure to include tropical urban forests as a key element of urban resilience. While previous studies have focused on green spaces in temperate climates or urban parks, this study emphasizes the unique role of tropical forests, which are particularly effective in mitigating challenges faced by tropical cities, such as extreme heat and heavy rainfall. The mixed-methods approach used in this study, combining environmental monitoring with social surveys and interviews, provides a comprehensive understanding of how these forests impact both the physical and social dimensions of urban resilience. The study's findings call for the integration of tropical urban forests into urban planning and policy frameworks to achieve long-term, sustainable urban development.

One of the limitations of this study is the focus on a limited number of cities in tropical regions, which may not fully capture the diversity of urban contexts where tropical urban forests could be implemented. The study primarily relied on data from urban areas with existing green spaces, potentially overlooking the challenges faced by cities that have limited or no access to such forests. Furthermore, the study's cross-sectional design only provides a snapshot of the current impact of tropical urban forests, without accounting for long-term changes in urban resilience over time. Future research could explore the impact of tropical urban forests in cities with varying levels of green space, as well as assess the long-term effects of such green infrastructure on climate adaptation and social well-being. Additionally, future studies could explore the economic aspects of maintaining and expanding tropical urban forests, particularly in the context of funding and policy implementation.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used ChatGPT to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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