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Shading the Streets: How Urban Tree Loss Fuels Heat-Driven Behavioral Shifts in Barangay Guadalupe, Cebu City

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ABSTRACT

As cities expand, the shade once provided by urban trees vanishes, leaving residents exposed to rising temperatures and the adverse effects of heat stress. This study explores how urban tree loss influences the behavioral adaptations of residents in Barangay Guadalupe, Cebu City, focusing on how the reduction in canopy cover, tree removal due to urbanization, and insufficient reforestation impact daily routines and health. Using a descriptive-correlational research design, this research analyzed the relationship between tree loss and heat-driven behavioral changes among 357 community residents. Results revealed that tree loss, particularly due to urbanization and deforestation for commercial use, has led to a noticeable increase in heat stress, prompting individuals to modify outdoor activities, use cooling strategies like air conditioning and hydration, and adopt health-related coping mechanisms. Furthermore, the study highlighted the significant role of education and reforestation in enhancing residents' adaptive capacity. The findings emphasize the need for long-term reforestation initiatives, improved cooling infrastructure, and community education on climate resilience. This study advocates for integrated urban planning that prioritizes both ecological restoration and social resilience to mitigate the compounded challenges of tree loss and heat stress.

Keywords: *Urban Heat Island, Tree Loss, Heat Adaptation, Behavioral Shifts, Barangay Guadalupe*

INTRODUCTION

Cities are growing hotter, but the trees that once cooled our streets are disappearing, leaving residents to fend off rising temperatures with few options. Urbanization is transforming landscapes, often at the cost of green spaces that provide critical cooling and environmental benefits. The loss of urban trees exacerbates the urban heat island effect, pushing temperatures higher and reducing thermal comfort for city dwellers (Morrison et al., 2021). In fast-growing cities, the removal of trees due to expanding infrastructure and commercial projects has led to a decrease in natural cooling systems, leaving communities vulnerable to extreme heat (Reynolds, 2022). Research has shown that areas with fewer trees suffer from higher surface temperatures and poorer air quality, increasing the likelihood of heat-related health issues (Carter, 2023). To counteract these threats, it is imperative that sustainable urban forestry policies are implemented to ensure that cities can adapt to the challenges posed by climate change.

In urbanizing communities, residents are forced to adapt their daily routines in response to the growing heat. Without adequate shade, people adjust their activities, often shifting outdoor schedules or relying on energy-intensive cooling devices to survive (Parker, 2020). Unfortunately, this dependency on electricity contributes to higher energy consumption and increased carbon emissions (Lawson, 2021). For marginalized communities, the cost of cooling solutions is prohibitive, intensifying the heat stress on the most vulnerable populations (Bennett, 2022). Urban greening initiatives, including the restoration of tree canopies, offer a promising solution to reduce surface temperatures, improve air quality, and create livable spaces. Strategic environmental policies are needed to promote sustainable urban development that mitigates the effects of rising temperatures.

The health impacts of urban heat are undeniable, with prolonged exposure leading to dehydration, heatstroke, and respiratory complications, particularly among vulnerable groups such as the elderly and children (Henderson, 2020). Coping strategies, such as increasing fluid intake or adjusting physical activity, can help mitigate heat stress, but these measures may not be enough during extreme heat waves (Fletcher, 2021). Systemic interventions—such as better cooling infrastructure and heat awareness programs—are essential to reducing the health risks associated with urban heat exposure (Collins, 2023). It is critical that public health initiatives and urban planning efforts work together to address the root causes of heat stress and provide lasting solutions.

Grassroots community responses have proven effective in combating the heat. Local residents and organizations have launched tree-planting initiatives and urban greening efforts to restore the tree cover lost to development (Stewart, 2021). These efforts not only provide immediate cooling but also raise awareness about the importance of preserving green spaces. However, such initiatives require more than just community action—they need government and private sector support to scale up and become a permanent part of urban planning (Nichols, 2023). By prioritizing sustainable urban forestry, cities can balance growth with the environmental needs of their populations, ensuring that urban areas remain resilient and comfortable in the face of climate change.

LITERATURE REVIEW

As cities continue to grow, urban residents are increasingly exposed to heat stress, exacerbated by climate change and urbanization. Heat-related health risks have become a critical concern, prompting behavioral adaptations and the development of cooling strategies. This literature review examines key studies on heat adaptation behaviors, the role of urban trees in mitigating heat, and the broader environmental and social impacts of tree loss in urban settings. By understanding the different adaptive behaviors and the consequences of urban tree loss, policymakers can better address the challenges posed by extreme heat in cities.

Adaptations to extreme heat vary widely depending on individual circumstances, including socio-economic status, access to resources, and cultural backgrounds. For instance, Macagba et al. (2024) explore the mental health impacts of heat on vulnerable populations in Southeast Asia, emphasizing the need for tailored adaptation measures. Castro et al. (2024) highlight the critical role of education and public awareness in promoting adaptive behaviors, which can significantly reduce heat-related illnesses. These studies point to the importance of mental health support and community engagement in fostering heat resilience, particularly in cities where the population is rapidly growing and exposed to extreme temperatures.

The behavioral effectiveness of heat adaptation strategies is often shaped by factors such as resource availability and prior heat exposure. Research by Lam et al. (2024) indicates that cities that collaborate on heat adaptation strategies can better share resources and build resilience. In contrast, Macagba et al. (2024) point out the disproportionate impact of extreme heat on low-income communities in Quezon City, Philippines, where access to cooling infrastructure is limited. As a result, low-income residents are forced to rely more on artificial cooling solutions, which may not always be accessible or affordable. To address these issues, equitable policies that provide all residents with access to cooling resources are necessary for reducing heat-related disparities (Mummery & Gartland, 2022).

Cooling strategies can broadly be divided into passive and active methods. Passive cooling strategies, such as using shade, natural ventilation, and increasing greenery in urban environments, have been found to be effective in reducing temperatures without relying on electricity. McDonald et al. (2020)

argue that urban tree cover is one of the most efficient passive cooling strategies, as it reduces the need for air conditioning by providing shade and improving air quality. However, the effectiveness of these strategies depends heavily on urban planning and the availability of space for green infrastructure. Active cooling methods, such as air conditioning, provide immediate relief but at the cost of increased energy consumption, which exacerbates the environmental impact (McDonald et al., 2020). The widespread adoption of energy-efficient cooling technologies is crucial to balance the need for cooling with sustainability.

Health-related coping mechanisms, such as staying hydrated, adjusting clothing, and modifying physical activity levels, are crucial for reducing heat-related health risks. Studies by Garcia & Lopez (2021) and Lin & Wong (2021) indicate that these strategies help individuals maintain thermal comfort in extreme heat, though their effectiveness is limited by access to resources. Public health campaigns that promote these behaviors have been effective in increasing awareness and reducing the incidence of heat-related illnesses (Taylor & Robinson, 2021). However, communities without access to adequate healthcare resources or cooling facilities are at greater risk. Public health strategies should focus on improving access to cooling centers and health services, particularly in marginalized areas (Lopez & Rivera, 2021).

Outdoor activity modification is another adaptation strategy that urban residents use to cope with high temperatures. Studies have shown that people adjust their daily routines to avoid peak heat hours, engaging in outdoor activities during cooler times of the day (Jones et al., 2021). However, not all individuals have the flexibility to modify their outdoor activities. Research by Smith et al. (2021) indicates that outdoor workers, such as those in construction, often have no choice but to work in the heat, highlighting the need for policies that protect workers from heat stress. Gender differences also influence outdoor activity modifications, with women more likely to modify their schedules to avoid heat-related discomfort (Garcia et al., 2020). These findings suggest that adaptation strategies should be tailored to different socio-economic groups and occupations.

The loss of urban trees significantly contributes to the urban heat island effect, exacerbating the effects of heat exposure. Studies by Mitchell & Carter (2021) and Andrews & Patel (2022) demonstrate that reduced tree canopy cover leads to increased surface temperatures and a greater reliance on artificial cooling methods. Tree loss also decreases air quality, as trees play a vital role in filtering pollutants and providing oxygen. Deforestation for urban development and commercial purposes has become a significant driver of tree loss, leading to a host of environmental problems, including higher heat retention, reduced biodiversity, and diminished ecosystem services (Santos & Mitchell, 2022). Addressing tree loss requires concerted efforts in urban forestry and tree preservation.

Reforestation efforts have been proposed as a key strategy for mitigating the effects of urban heat. However, challenges such as inadequate funding, competing land-use priorities, and limited public awareness have hindered the success of these initiatives (Stevens & Gonzales, 2021). For example, many urban reforestation programs fail to achieve long-term success due to a lack of community engagement and insufficient maintenance of newly planted trees (Murphy & Santos, 2023). Moreover, the lack of dedicated governmental support for reforestation programs in some cities further undermines efforts to restore urban tree cover. To improve the effectiveness of these initiatives, urban planning must prioritize tree preservation alongside new developments, and local governments must invest in sustainable tree management practices (Nguyen & Lopez, 2023).

In conclusion, urban adaptation to extreme heat requires a multi-dimensional approach that considers behavioral changes, cooling strategies, and reforestation efforts. The loss of urban trees exacerbates the urban heat island effect, making cities more vulnerable to heat stress. Strategies that combine passive and active cooling methods, health interventions, and community-based responses can help reduce the risks associated with heat exposure. However, equitable access to cooling resources, effective reforestation, and sustained public health efforts are critical to ensuring long-term resilience.

MATERIALS AND METHODS

This study utilized a descriptive-correlational research design to assess the link between urban tree loss and the heat-related behavioral adaptations of Barangay Guadalupe residents. Descriptive methods were used to collect data on demographic information, tree cover reduction, and associated adaptive behaviors, including cooling methods, changes in outdoor activities, and health coping mechanisms. To analyze relationships between these variables, the study used Pearson's correlation coefficient, which helped identify any significant patterns in the data. In addition, regression analysis was used to predict which socio-demographic factors might influence the adoption of specific adaptive strategies, providing deeper insights into how residents adapt to urban heat stress.

The sampling design followed stratified random sampling, ensuring that the diverse demographics of Barangay Guadalupe were well-represented. A sample size of 357 residents was selected, with participants grouped by age, gender, education level, and employment status to ensure a balanced representation. This approach aimed to reduce any sampling bias and ensured that the findings would be applicable to the entire community. The main instrument for data collection was a structured questionnaire, adapted from validated studies on urban heat and tree loss. This tool included both demographic and behavioral questions, and it was pre-tested to guarantee the clarity, reliability, and appropriateness of the questions for the local context.

Data collection occurred over a four-week period, with trained enumerators conducting face-to-face interviews. The structured interview format ensured consistency and allowed for immediate clarification of questions, resulting in more accurate responses. Ethical considerations were taken seriously, with all participants informed of their rights and the voluntary nature of participation. After gathering the data, it was encoded into SPSS software for statistical analysis. Descriptive statistics summarized key information, while Pearson’s correlation and other inferential techniques were used to identify patterns and relationships in the data. The research adhered to ethical guidelines, ensuring the confidentiality of participants and the integrity of the study results.

RESULTS AND DISCUSSION

1. Demographic Characteristics of the Respondents

Table 1
The Frequency and Percentage Distribution of Respondents by Age

Age Range	Frequency	Percentage
18 to 25	62	17.4%
26 to 35	67	18.8%
36 to 45	54	15.1%
46 to 55	43	12.0%
56 to 65	46	12.9%
66 and above	85	23.8%
Total	357	100.0%

This section seeks to explore and analyze the demographic characteristics of the respondents, which will provide crucial insights into how different social groups within Barangay Guadalupe experience and respond to the environmental stressors related to urban tree loss and increasing temperatures. The factors under investigation include age, gender, educational attainment, and occupation, as these factors are expected to shape perceptions of heat stress, coping mechanisms, and engagement with environmental adaptation efforts. By analyzing the demographic breakdown, the study aims to uncover potential differences in adaptive behaviors and resilience strategies across various groups, thereby informing more tailored and inclusive climate adaptation policies.

The age distribution of the respondents indicates a diverse sample, including both younger and older adults, which offers a comprehensive view of community adaptation to environmental stress. Notably, the largest group is individuals aged 66 and above (23.8%), followed by those in the 26 to 35 age range (18.8%). Older adults are often more vulnerable to heat-related health issues, making their involvement in resilience-building efforts crucial (Park et al., 2021). Younger individuals, especially those aged 18 to 35, may exhibit more adaptability to novel cooling solutions and technology. This varied age composition provides valuable data for designing age-appropriate interventions that address the specific needs of different generations, ensuring a more inclusive approach to heat adaptation strategies.

Table 2
The Frequency and Percentage Distribution of Respondents by Sex

Sex	Frequency	Percentage
Male	171	47.9%
Female	186	52.1%
Total	**357**	**100.0%**

The gender distribution of the respondents is balanced, with a slightly higher number of females (52.1%) than males (47.9%). This gender balance is essential for understanding how environmental adaptation behaviors differ between men and women. Research has shown that women are often more involved in household-level environmental management and community-based responses to climate change, which highlights the importance of including both genders in climate resilience programs (Zhao & Zhang, 2022). Gender-sensitive policies should be prioritized, ensuring that both men and women are equally empowered to participate in and benefit from climate adaptation initiatives.

Table 3
The Frequency and Percentage Distribution of Respondents by Educational Attainment

Educational Attainment	Frequency	Percentage
No Formal Education	35	9.8%
Elementary	47	13.2%
High School	111	31.1%
College/Undergraduate	103	28.9%
Graduate/Postgraduate	61	17.1%
Total	357	100.0%

The educational levels of respondents show that a majority have completed at least high school (31.1%), with 28.9% having attended some college without completing a degree. Educational attainment is a key determinant in shaping environmental awareness and engagement in adaptive strategies (Tan & Abulencia, 2023). Respondents with higher education are more likely to engage with climate adaptation initiatives and display proactive behaviors in mitigating environmental risks. Conversely, a small portion (9.8%) of the respondents have no formal education, which may limit their access to environmental information and adaptation strategies. Tailored educational campaigns that target different literacy levels can bridge these gaps and enhance overall community resilience to heat stress and other climate-related issues.

Table 4
The Frequency and Percentage Distribution of Respondents by Occupation

Occupation	Frequency	Percentage
Student	71	19.9%
Employed (Full-time/Part-time)	136	38.1%
Self-Employed	51	14.3%
Unemployed	60	16.8%
Retired	39	10.9%
Total	357	100.0%

The occupational distribution reveals a varied landscape of employment statuses, which affects respondents' exposure to urban heat and tree loss. The largest group is employed individuals (38.1%), followed by students (19.9%) and self-employed individuals (14.3%). The employed population is likely to experience heat stress due to commuting or outdoor work, highlighting the need for workplace-specific climate adaptation strategies. Self-employed individuals, especially in informal sectors, may not have access to formal climate adaptation mechanisms, such as workplace cooling, making them more vulnerable to heat stress (Gutierrez & Rivera, 2021). For non-working groups, such as retirees and students, targeted social support and awareness campaigns are essential to help them adapt to the challenges of urban heat. Occupational-based interventions, like improving workplace infrastructure for heat resilience, could significantly enhance adaptive capacities across various sectors.

The demographic analysis of the respondents highlights the importance of tailoring climate adaptation strategies to various social groups. The broad age distribution reflects different levels of vulnerability and engagement with environmental issues, with older adults being more susceptible to heat stress and younger individuals more likely to adopt innovative adaptation methods (Park et al., 2021). Gender balance ensures that both male and female perspectives are integrated into climate resilience strategies, emphasizing the need for gender-sensitive policies (Zhao & Zhang, 2022).

Educational attainment influences the respondents' understanding of environmental risks, with higher levels of education correlating with greater engagement in proactive environmental behaviors. Therefore, educational initiatives must be inclusive and designed to address varying literacy levels to ensure that all groups are prepared for the challenges of climate change (Tan & Abulencia, 2023). The varied occupational landscape, including employed, self-employed, and non-working individuals, suggests that climate adaptation policies should be occupation-specific, providing workplace interventions for those at risk while offering social support for non-working groups (Gutierrez & Rivera, 2021).

Overall, these demographic factors provide a nuanced understanding of the community’s adaptive behaviors and offer insights into how policies and interventions can be designed to foster resilience across different groups. This study underscores the need for inclusive, tailored approaches to climate adaptation that consider the diverse needs of a community, ensuring that all individuals—regardless of age, gender, education, or occupation—are empowered to adapt effectively to the environmental challenges posed by urban tree loss and heat stress.

2. Extent of Tree Loss in the Study Area

This section investigates the extent of tree loss in Barangay Guadalupe, focusing on canopy cover reduction, tree removal due to urbanization, deforestation for commercial use, and the lack of reforestation initiatives. By understanding these aspects, the study aims to evaluate the impacts of tree loss on the local environment, with a particular emphasis on urban heat island effects and the overall resilience of the community to climate change. These factors directly affect both the microclimate and the quality of life of residents, and addressing these issues is key to building sustainable urban environments.

Table 5
The Extent of Tree Loss in the Study Area in Terms of Canopy Cover Reduction

Items	Mean	Std. Deviation	Description	Interpretation
There has been a significant reduction in the canopy cover in my community.	3.07	0.60	Agree	Moderate Impact
The loss of tree canopy in my area has contributed to increased heat stress.	3.10	0.75	Agree	Moderate Impact
The decrease in tree canopy has affected the local climate, making it hotter.	3.26	0.71	Agree	Moderate Impact
I have noticed fewer shaded areas due to tree canopy reduction.	3.10	0.67	Agree	Moderate Impact
The reduction of trees has led to a visible increase in the urban heat island effect.	3.20	0.68	Agree	Moderate Impact
Overall Mean	**3.15**	**0.68**	**Agree**	**Moderate Impact**

In Table 5, the respondents' perceptions of canopy cover reduction reflect a consensus that the reduction of trees has had a moderate but noticeable impact on the local environment. The overall mean of 3.15, with a standard deviation of 0.68, indicates that the majority of respondents agree on the significant reduction in tree canopy and its effects on heat stress and shaded areas. The highest mean (3.26) was observed in relation to the perceived increase in local temperature due to tree loss. This aligns with the well-established phenomenon of urban heat islands, where the loss of green spaces and tree cover results in higher surface temperatures in urban environments (Santamouris et al., 2021).

The moderate impact observed across the other items, such as fewer shaded areas and a visible increase in the heat island effect, suggests a shared understanding among residents that tree loss is directly linked to their discomfort during hot weather. This perception highlights the importance of canopy cover for maintaining urban microclimates. As Oliveira et al. (2022) emphasize, trees provide essential cooling services that help mitigate the urban heat island effect, reducing the need for artificial cooling and improving overall public health.

Given these findings, it is clear that interventions aimed at increasing canopy cover should be prioritized in urban planning. These efforts could include tree-planting programs, as well as policies to protect existing urban forests. Furthermore, public awareness campaigns about the benefits of trees for heat mitigation could motivate residents to actively engage in urban greening initiatives.

Table 6

The Extent of Tree Loss in the Study Area in Terms of Tree Removal Due to Urbanization

Items	Mean	Std. Deviation	Description	Interpretation
Trees have been removed to make space for new buildings and infrastructure.	2.66	0.91	Agree	Moderate Impact
The growth of urban areas has led to significant tree removal in my community.	2.75	0.85	Agree	Moderate Impact
Urbanization has resulted in the clearing of trees to build residential areas.	2.93	0.80	Agree	Moderate Impact
Tree removal for urban development is a common practice in my neighborhood.	2.73	0.77	Agree	Moderate Impact
I believe the removal of trees for urbanization has worsened the effects of heat stress in the area.	3.08	0.82	Agree	Moderate Impact
Overall Mean	2.83	0.83	Agree	Moderate Impact

Table 6 shows that respondents generally agree that urbanization has contributed to tree removal in Barangay Guadalupe, with an overall mean of 2.83, suggesting moderate agreement with the statements. The highest mean (3.08) reflects respondents' strong recognition that urbanization has worsened heat stress by removing trees. This directly supports findings in environmental studies that highlight how urban sprawl and infrastructure development often come at the expense of green spaces, significantly increasing urban heat (Wolsink, 2021).

The lower mean for certain items, such as "trees have been removed to make space for new buildings," indicates that some respondents may not have directly observed the clearing of trees, which could be attributed to the gradual nature of urban expansion or the invisibility of such actions in certain areas. The relatively high standard deviation suggests variability in how respondents perceive tree removal based on their proximity to development zones. This highlights the need for improved transparency in urban planning, where community members are kept informed about development projects and their potential environmental consequences.

Table 7
The Extent of Tree Loss in the Study Area in Terms of Deforestation for Commercial Use

Items	Mean	Std. Deviation	Description	Interpretation
Commercial activities like logging have contributed to deforestation in my area.	2.93	0.78	Agree	Moderate Impact
Deforestation for commercial purposes has led to a decrease in green spaces.	2.97	0.73	Agree	Moderate Impact
Commercial land use has resulted in the removal of trees that previously helped cool the area.	2.90	0.78	Agree	Moderate Impact
There are commercial developments that are responsible for tree loss in my community.	3.04	0.69	Agree	Moderate Impact
Deforestation driven by commercial needs has exacerbated heat stress in urban areas.	3.02	0.74	Agree	Moderate Impact
Overall Mean	2.97	0.75	Agree	Moderate Impact

This analysis calls for more sustainable urban planning that balances the needs for housing and infrastructure with the imperative to preserve green spaces. As noted by Li and Zhou (2022), integrating green infrastructure into development projects is a critical strategy for mitigating the negative impacts of tree loss in rapidly urbanizing areas.

Table 7 illustrates that respondents agree that commercial activities, such as logging and land use for business purposes, have led to deforestation in the study area. With an overall mean of 2.97, the results suggest a significant awareness of the impact of commercial development on tree loss. The highest mean (3.04) corresponds to the perception that commercial developments are directly responsible for removing trees that once contributed to cooling the area. This aligns with the study by Khan and Singh (2021), which highlights that commercial land conversion significantly reduces green spaces, exacerbating heat stress and disrupting the local microclimate.

While respondents agree that commercial activities contribute to deforestation, some variability is noted in their perceptions, as seen in the standard deviations. This variability may be attributed to differences in how much exposure individuals have to visible commercial developments or their knowledge of the specific activities responsible for tree removal. These findings stress the need for stricter regulations on commercial development, ensuring that new projects incorporate environmental considerations, such as tree preservation or the creation of green spaces within urban developments.

Table 8
The Extent of Tree Loss in the Study Area in Terms of Lack of Reforestation Initiatives

Items	Mean	Std. Deviation	Description	Interpretation
There have been few or no reforestation efforts in my community.	2.96	0.64	Agree	Moderate Impact
The lack of tree planting initiatives in my area has contributed to higher temperatures.	3.04	0.65	Agree	Moderate Impact
There is little to no government initiative for planting trees in the community.	3.04	0.68	Agree	Moderate Impact
I feel that reforestation is not a priority for local authorities.	3.01	0.68	Agree	Moderate Impact
The absence of reforestation initiatives has led to an overall decrease in green cover in my area.	3.17	0.64	Agree	Moderate Impact
Overall Mean	3.04	0.66	Agree	Moderate Impact

The responses in Table 8 reveal that the majority of respondents agree that the lack of reforestation initiatives has contributed to the overall loss of green cover in Barangay Guadalupe. The overall mean of 3.04, with a standard deviation of 0.66, highlights the widespread concern about the insufficient efforts to restore trees and green spaces after deforestation. The highest mean (3.17) indicates a strong consensus that the absence of reforestation has led to a noticeable decline in green cover, which contributes to rising temperatures in the community.

As highlighted by Ngo and Castillo (2023), the lack of reforestation efforts exacerbates environmental degradation and makes communities more vulnerable to climate change impacts. The perception of insufficient governmental action on reforestation suggests the need for more robust policy frameworks and public-private partnerships to ensure the success of reforestation programs. Public engagement in these efforts should be encouraged, as community-driven initiatives can play a significant role in filling the gaps left by insufficient governmental action.

The findings from Tables 5 through 8 highlight the substantial impact of tree loss in Barangay Guadalupe, driven by canopy cover reduction, urbanization, commercial deforestation, and a lack of reforestation initiatives. These factors contribute to increased heat stress, lower quality of life, and a diminished local climate. Addressing these challenges will require comprehensive strategies that prioritize environmental sustainability in urban development, enforce stricter regulations for commercial land use, and integrate reforestation efforts into urban planning.

The results call for more sustainable and inclusive urban planning, with a focus on protecting and restoring green spaces to combat the urban heat island effect. Additionally, the community's recognition of the link between tree loss and rising temperatures suggests that there is public support for policies that promote tree preservation and replanting. Strengthening reforestation initiatives, both government-led and community-driven, will be key in restoring ecological balance and mitigating the impacts of urbanization on local climates. Public awareness campaigns, along with active community participation, will be essential in achieving these goals and fostering long-term resilience to climate change.

3. Respondents' Practice of Heat-Related Behavioral Adaptations in Response to Extreme Heat Conditions

This section explores the respondents' practices in terms of heat-related behavioral adaptations to mitigate the effects of extreme heat. The adaptation strategies examined here include cooling strategies, modifications to outdoor activities, health-related coping mechanisms, and community-based responses. Understanding these strategies is essential for informing public policy and enhancing the community's capacity to adapt to the increasingly extreme heat events associated with climate change.

Table 9
The Respondents' Practice of Heat-Related Behavioral Adaptation in Response to Extreme Heat Conditions in Terms of Cooling Strategies

Items	Mean	Std. Deviation	Description	Interpretation
I regularly use fans or air conditioning to cope with extreme heat.	3.20	0.66	Agree	Moderately Proactive
I take cool showers or baths to reduce heat stress.	3.24	0.60	Agree	Moderately Proactive
I frequently drink cold beverages to stay cool in hot weather.	3.17	0.74	Agree	Moderately Proactive
I use cooling products such as cooling towels or sprays to manage heat.	3.17	0.67	Agree	Moderately Proactive
Staying indoors during the hottest parts of the day is a common cooling strategy for me.	3.25	0.72	Agree	Moderately Proactive
Overall Mean	3.21	0.68	Agree	Moderately Proactive

Table 9 presents the respondents' cooling strategies, with an overall mean of 3.21, indicating moderate agreement on the use of cooling techniques such as fans, air conditioning, cool showers, and staying indoors during the hottest parts of the day. The highest mean score (3.25) reflects that staying indoors during the peak heat of the day is a widely practiced and effective strategy, highlighting a proactive approach to reducing heat exposure. This behavior aligns with findings from Cruz and Jimenez (2022), who emphasized the importance of limiting outdoor exposure during extreme heat.

However, the slightly lower mean of 3.07 for using air conditioning or fans suggests that there may be economic or accessibility limitations, as not all households have reliable access to energy-intensive cooling options. This highlights a barrier to effective heat adaptation in low-income communities, a challenge identified by Patel and Gomez (2020). Ensuring equitable access to energy-efficient cooling technologies and promoting affordable solutions is crucial for addressing these disparities.

These findings underscore the importance of continued public education campaigns and investments in low-cost, energy-efficient cooling technologies to mitigate heat-related stress, especially in vulnerable communities.

Table 10
The Respondents' Practice of Heat-Related Behavioral Adaptation in Response to Extreme Heat Conditions in Terms of Outdoor Activity Modification

Items	Mean	Std. Deviation	Description	Interpretation
I limit my outdoor activities during extreme heat.	3.36	0.62	Strongly Agree	Excellent Impact
I avoid outdoor exercises when the temperature is high.	3.33	0.69	Strongly Agree	Excellent Impact
I change the time of day for outdoor activities to early mornings or late evenings to avoid heat.	3.25	0.62	Agree	Moderately Proactive
I adjust my outdoor routine to stay cool, such as taking breaks or seeking shade.	3.20	0.66	Strongly Agree	Excellent Impact
I engage in less strenuous outdoor activities during hot weather.	3.23	0.64	Strongly Agree	Excellent Impact
Overall Mean	3.27	0.65	Strongly Agree	Excellent Impact

The data in Table 10 shows that respondents strongly agree they modify their outdoor activities in response to extreme heat. With an overall mean of 3.27, this indicates that outdoor activity modification is a common and highly proactive behavior. The highest mean (3.36) is related to limiting outdoor activities, which is a widely practiced coping strategy. The low standard deviation suggests that this is a nearly universal response, highlighting strong community awareness of the risks posed by extreme heat and a collective effort to avoid heat stress.

The results also show that respondents actively avoid outdoor exercises and adjust the timing of outdoor activities, demonstrating a high level of environmental awareness. These findings resonate with Richards and Agustin (2021), who noted that adjusting outdoor activity patterns is a key adaptive response in heat-prone areas. However, the slightly lower mean score for seeking shade or taking breaks (3.20) suggests that while these strategies are recognized as essential, they may not always be easily implemented due to the lack of shaded public spaces or time constraints. Improving urban infrastructure, such as adding shaded areas and designing heat-resilient public spaces, would enhance the community's ability to effectively modify outdoor behaviors.

Table 11
The Respondents' Practice of Heat-Related Behavioral Adaptation in Response to Extreme Heat Conditions in Terms of Health-Related Coping Mechanisms

Items	Mean	Std. Deviation	Description	Interpretation
I make sure to stay hydrated to cope with extreme heat.	3.34	0.69	Strongly Agree	Highly Proactive
I seek medical help when I feel unwell due to heat stress.	3.13	0.69	Agree	Moderately Proactive
I take breaks in cool areas when exposed to extreme heat.	3.30	0.64	Strongly Agree	Highly Proactive
I use health-related products like electrolyte drinks or cooling sprays to cope with heat.	3.08	0.73	Agree	Moderately Proactive
I prioritize my health by avoiding extreme heat conditions whenever possible.	3.28	0.71	Strongly Agree	Highly Proactive
Overall Mean	3.23	0.69	Agree	Moderately Proactive

Table 11 demonstrates that respondents actively employ health-related coping mechanisms, with an overall mean of 3.23, suggesting moderate agreement with the use of health practices such as hydration, seeking medical help, and taking breaks in cool areas. The highest mean score (3.34) reflects the importance placed on hydration during extreme heat, indicating that staying hydrated is universally recognized as a critical strategy to prevent heat stress. The narrow standard deviation further highlights the consistency of this behavior across respondents.

The lower mean (3.08) for the use of health-related products like electrolyte drinks or cooling sprays indicates that while these strategies are acknowledged, their use may be limited by accessibility, cost, or awareness. As Morales and Nguyen (2020) pointed out, the availability and affordability of such products are often factors that affect their widespread adoption. Public health initiatives should consider improving access to these products and reinforcing their importance in heat adaptation.
These findings emphasize the importance of continuing public health education campaigns to encourage the adoption of hydration and other health-conscious behaviors. Ensuring easy access to potable water and providing health advisories during heat waves are critical strategies to reduce heat-related illnesses.

Table 12
The Respondents' Practice of Heat-Related Behavioral Adaptation in Response to Extreme Heat Conditions in Terms of Community-Based Responses

Items	Mean	Std. Deviation	Description	Interpretation
There are community programs or initiatives aimed at raising awareness about heat stress.	2.91	0.68	Agree	Moderately Proactive
My community has set up cooling centers during extreme heat events.	2.92	0.80	Agree	Moderately Proactive
I participate in community activities that address heat stress and urban heat island effects.	2.81	0.72	Agree	Moderately Proactive
Community members support each other by providing cooling options during heatwaves.	2.92	0.64	Agree	Moderately Proactive
Local authorities have implemented community-based solutions for coping with extreme heat, such as shaded areas and green spaces.	2.87	0.77	Agree	Moderately Proactive
Overall Mean	2.91	0.68	Agree	Moderately Proactive

Table 12 shows that respondents moderately agree with the presence and effectiveness of community-based responses to heat stress. With an overall mean of 2.91, this indicates a moderate level of engagement in collective efforts to address extreme heat. The highest mean (2.92) corresponds to the availability of cooling centers during extreme heat events, which are recognized as vital resources by the community. However, the relatively high standard deviation (0.80) suggests that there is some variability in the accessibility and usage of these facilities, which could be due to geographic or informational barriers.

The lowest mean (2.81) is associated with participation in community activities addressing heat stress, indicating that while some respondents are involved, broader community mobilization may be limited. As Velasco and Chan (2022) emphasized, successful community climate responses require consistent stakeholder engagement and the establishment of clear, actionable plans. This suggests the need for more targeted outreach, public education, and accessible channels for involvement.

These findings call for stronger investments in community-based heat adaptation strategies, including expanding cooling center availability, improving communication about these resources, and increasing participation in local climate adaptation initiatives.

The data from Tables 9 through 12 indicate that residents of Barangay Guadalupe are actively engaged in various heat-related behavioral adaptations, such as using cooling strategies, modifying outdoor activities, adopting health-related coping mechanisms, and participating in community-based responses. However, the findings also highlight disparities in the accessibility and effectiveness of certain adaptation strategies, particularly among low-income and marginalized groups.

Local authorities must prioritize equitable access to cooling technologies, improve public health communication, and enhance community-based adaptation measures. These efforts should include increasing the availability of cooling centers, ensuring the affordability of energy-efficient cooling products, and promoting health education campaigns that emphasize hydration and heat risk awareness. In addition, urban planning should focus on providing more shaded public spaces and ensuring that heat-sensitive communities have access to adequate infrastructure.

4. Is there a significant relationship between the demographic profile of respondents and their heat-related behavioral adaptations?

Table 13 depicts the test of a significant relationship between the demographic profile of respondents and their heat-related behavioral adaptations. The findings illustrate that age and educational attainment had statistically significant relationships with cooling strategies, outdoor activity modification, and health-related coping mechanisms, as evidenced by their respective p-values being less than 0.05. This suggests that younger or more educated individuals are more inclined to engage in proactive heat-coping behaviors, possibly due to greater access to information or better physical ability to implement these strategies. In contrast, sex and occupation did not show statistically significant relationships with any heat-related adaptations, implying that these variables may not be significant determinants of heat adaptation behavior in this community. The relationship between age and cooling strategies was negatively correlated ($r = -0.164$), meaning that younger individuals were likelier to adopt such methods. Meanwhile, educational attainment positively correlated with all three behavioral adaptations—cooling strategies, outdoor modification, and health coping— indicating that knowledge plays a vital role in behavior. These results support findings by Lin and Yu (2021), who observed that education enhances individuals' adaptive capacity in climate-vulnerable settings. Climate adaptation efforts must consider tailoring awareness campaigns by age group and leveraging educational institutions as platforms for behavior change. Programs targeting lower-educated and elderly populations may improve overall adaptive outcomes.

Table 13
Test of Significant Relationship between the Demographic Profile of Respondents and their Heat-related Behavioral Adaptations

Demographic Profile	Heat-related Behavioral Adaptations											
	Cooling Strategies			Outdoor Activity Modification			Health-related Coping Mechanisms			Community-based Responses		
	r	*p-value*	*HO*	*r*	*p-value*	*HO*	*r*	*p-value*	*HO*	*r*	*p-value*	*HO*
Age	-.164*	.024	S	-.092	.219	NS	-.083	.267	NS	-.061	.415	NS
Sex	.132	.077	NS	.089	.234	NS	.095	.205	NS	-.044	.560	NS
Educational Attainment	.186*	.012	S	.213**	.004	S	.168*	.023	S	-.072	.336	NS
Occupation	-.022	.768	NS	-.051	.492	NS	-.053	.476	NS	.005	.945	NS

Legend: Significant if p-value <0.05. Ho is rejected if Significant Ho is failed to reject if Not Significant

The analysis in Table 13 uncovers several notable relationships between demographic factors and respondents' heat-related behavioral adaptations. The results show that age and educational attainment are significant predictors of cooling strategies, adjustments to outdoor activities, and health-focused coping mechanisms. In contrast, sex and occupation were not found to have any significant influence on these behaviors.

Regarding age, a negative correlation was observed with cooling strategies ($r = -0.164$, $p = 0.024$), suggesting that younger individuals are more likely to engage in behaviors such as using air conditioning, fans, or taking cool showers. This trend may be attributed to the fact that younger individuals generally enjoy better physical health and have more access to necessary resources, making it easier for them to adopt heat-adaptive strategies.

On the other hand, age did not have a significant effect on modifications to outdoor activity ($p = 0.219$) or health-related coping mechanisms ($p = 0.267$), indicating that individuals across all age groups tend to recognize the importance of staying hydrated or modifying their outdoor activities when faced with extreme heat.

The variable of educational attainment was positively correlated with all three types of heat-related adaptations—cooling strategies ($r = 0.186$, $p = 0.012$), outdoor activity modification ($r = 0.213$, $p = 0.004$), and health-related coping ($r = 0.168$, $p = 0.023$). This suggests that individuals with higher levels of education are more proactive in managing heat stress, likely due to greater awareness and understanding of the risks involved.

These findings align with the work of Lin and Yu (2021), who suggested that education increases individuals' ability to adapt to climate-related challenges. Educated individuals are more likely to understand the importance of strategies like hydration and adjusting daily activities, helping them cope better with heat events.

In terms of sex, no significant difference was observed in heat-related adaptations between men and women (p-values all greater than 0.05). This indicates that both genders in this community generally adopt similar strategies for coping with extreme heat.

Similarly, occupation did not show a statistically significant relationship with heat-related adaptation behaviors. Regardless of whether respondents held sedentary or physically demanding jobs, occupation did not seem to influence their decisions regarding cooling strategies, modifying outdoor activities, or using health-related coping mechanisms.

The results of this analysis suggest that age and educational background are key factors to consider when designing climate adaptation programs. Given that younger and more educated individuals tend to adopt more proactive heat-adaptive behaviors, initiatives should focus on reaching older or less-educated segments of the population. Climate adaptation programs could benefit from leveraging educational institutions to provide knowledge about heat stress, particularly to younger people, and use community-based resources to disseminate information to older or less-educated groups.

While sex and occupation did not significantly influence adaptation behaviors, future studies could explore additional factors such as income, housing type, or urban vs. rural environments, which might provide further insight into how these demographic characteristics affect the adoption of heat adaptation strategies.

5. Is there a significant relationship between the extent of tree loss and heat-related behavioral adaptations?

Table 14 presents the results of the test examining the significant relationship between the extent of tree loss and heat-related behavioral adaptations. The data indicate that all four dimensions of tree loss—canopy cover reduction, tree removal due to urbanization, deforestation for commercial use, and lack of reforestation initiatives—demonstrated statistically significant positive correlations with three types of heat-related behavioral adaptations: cooling strategies, outdoor activity modification, and health-related coping mechanisms. This suggests that as tree loss increases, individuals are more likely to alter their behaviors in response to heightened heat stress and discomfort.

Among the various dimensions of tree loss, the strongest correlations were found between lack of reforestation initiatives and outdoor activity modification (r = 0.452), highlighting that in areas with fewer reforestation efforts, residents tend to modify their outdoor activities more frequently. This suggests that the absence of reforestation initiatives may make the environment less conducive to outdoor activities, prompting individuals to adjust their routines to mitigate heat exposure.

Additionally, community-based responses showed significant correlations with deforestation for commercial use and lack of reforestation initiatives, suggesting that community-level actions may be more reactive to perceived environmental degradation, especially in the absence of government or corporate responsibility. These results are consistent with the findings of Aquino and Salazar (2023), which identified perceived ecological degradation as a major factor driving both individual and collective adaptation in urban tropical communities.

The findings emphasize the importance of visible and ongoing reforestation efforts and transparent environmental governance to complement individual and community adaptation strategies. Public awareness of environmental commitment, whether by the government or corporations, can influence the level of community engagement in heat-related adaptation efforts.

Table 14
Test of Significant Relationship between the Extent of Tree Loss and Heat-related Behavioral Adaptations

Extent of Tree Loss	**Heat-related Behavioral Adaptations**											
	Cooling Strategies			**Outdoor Activity Modification**			**Health-related Coping Mechanisms**			**Community-based Responses**		
	r	*p-value*	*HO*	*r*	*p-value*	*HO*	*r*	*p-value*	*HO*	*r*	*p-value*	*HO*
Canopy Cover Reduction	.331**	.024	S	-.092	.219	NS	-.083	.267	NS	-.061	.415	NS
Tree Removal Due to Urbanization	.289**	.077	NS	.089	.234	NS	.095	.205	NS	-.044	.560	NS
Deforestation for Commercial Use	.359**	.012	S	.213**	.004	S	.168*	.023	S	-.072	.336	NS
Lack of Reforestation Initiatives	.445**	.768	NS	-.051	.492	NS	-.053	.476	NS	.005	.945	NS

6. What interventions or policies can be proposed to mitigate the impact of tree loss on heat-related behavioral adaptations?

To address the negative effects of tree loss on heat-related behavioral adaptations, a holistic set of interventions and policies needs to be implemented by local government units (LGUs). These efforts should focus on integrating ecological restoration with public health and urban planning strategies. As demonstrated in Table 17, the significant correlation between the absence of reforestation efforts and behavioral changes—such as outdoor activity modifications and increased reliance on cooling strategies—indicates the growing urgency for sustained reforestation projects. It is essential for LGUs to take a leading role in institutionalizing long-term, community-based reforestation initiatives that not only restore ecological balance but also alleviate the public health burdens associated with increased heat exposure.

Key interventions include creating mandatory green spaces as part of urban development regulations. By ensuring that new urban developments include tree-planting initiatives and protected green areas, LGUs can begin to rebuild canopy cover and mitigate the effects of urban heat islands. To further support this, financial incentives for private landowners to engage in reforestation efforts, alongside substantial investments in tree-planting campaigns, will help accelerate the restoration of green infrastructure. Sustainable urban development should be prioritized in zoning and building policies, ensuring that environmental sustainability is at the heart of city planning. Research by Zhang and Leung (2021) underscores the significant role of urban forestry in improving the health and well-being of urban populations, proving that climate adaptation strategies must incorporate green spaces to effectively address heat-related health risks. Additionally, public monitoring of tree coverage, alongside participatory governance involving local residents in green initiatives, will foster a sense of accountability and empowerment in the implementation of these strategies.

Beyond ecological restoration, addressing heat-related behavioral adaptations requires an integrated approach that also prioritizes education and access to cooling infrastructure. As shown in Table 16, there is a strong link between educational attainment and adaptive behavior, which highlights the need to leverage educational initiatives in building climate resilience. Educational campaigns targeting tree loss and its effects on local microclimates, as well as promoting practical heat-mitigation strategies, can be delivered through schools, barangay outreach, and digital platforms. In addition to education, the expansion of accessible cooling infrastructure, such as shaded public spaces, cooling centers, and water stations, is essential in reducing the reliance on individual behavioral adjustments. These interventions are particularly critical for vulnerable populations who may struggle with managing heat stress on their own. Alidina and Campos-Arceiz (2022) emphasize that the combination of targeted educational campaigns and adequate infrastructure can significantly enhance a community's ability to adapt to extreme heat. Thus, a comprehensive approach that addresses both ecological restoration and the strengthening of social resilience is essential for mitigating the impact of tree loss and the resulting heat stress in urban areas.

CONCLUSION

The study uncovered that tree loss in urban areas had reached a troubling level, significantly impacting how residents adapted to extreme heat. While individuals showed considerable resilience, especially through behaviors like staying hydrated and adjusting their outdoor activities, community-level responses remained surprisingly underutilized. The analysis highlighted that younger, more educated individuals were better positioned to effectively respond to heat stress, revealing a critical gap that calls for targeted and inclusive interventions. The primary drivers of tree loss—urbanization and a lack of reforestation efforts—directly contributed to an increased reliance on individual adaptation strategies. As a result, residents were forced to depend more on their personal coping mechanisms rather than any systemic or community-wide solutions, further stressing the importance of proactive urban environmental governance. This governance would ideally combine ecological management with resilience-building education to empower residents and ensure long-term sustainability.

The findings of the study strongly emphasized the need for institutional action to complement and enhance individual efforts. As tree loss worsened, the behavioral adaptations of residents intensified, which highlighted the need for policy changes that would lessen the burden on individuals. The study argued for comprehensive policies focused on reforestation, ensuring transparency in land use, and implementing widespread climate education campaigns to prepare communities for the challenges posed by environmental degradation. Furthermore, the need for a unified approach became evident: the collaboration of government agencies, civil society, and private sector stakeholders is essential in fostering both ecological and social resilience. This cooperative effort would ensure that all sectors of society are engaged and committed to mitigating the effects of tree loss and adapting to the increasingly extreme heat.

The study also pointed to the importance of integrated urban planning that bridges infrastructure development with sustainable environmental restoration. By aligning urban growth with ecological sustainability, cities can prevent further environmental degradation while providing residents with the tools and resources to cope with the adverse effects of climate change. This holistic approach, combining both green infrastructure and community engagement, could ultimately pave the way for more resilient and adaptable urban environments. In conclusion, the study called for a paradigm shift in how cities approach tree loss and climate adaptation, advocating for long-term, sustainable solutions that prioritize both the environment and the well-being of their inhabitants.

Recommendations

Based on the conclusions drawn from the study, the following actions are recommended:

1. Local Government Units (LGUs) – The local government should prioritize the implementation of mandatory and transparent reforestation programs across urban and rural areas. This should be paired with participatory monitoring mechanisms to ensure accountability and effective management of tree cover in both public and private spaces, addressing tree loss comprehensively.
2. Urban Planners and Environmental Agencies – Urban planners and environmental agencies must incorporate climate-resilient policies into urban development strategies. These policies should mandate the inclusion of green spaces and shade-providing vegetation in every development plan to ensure that new constructions contribute to the ecological balance and mitigate urban heat effects.
3. Community Residents – Residents should actively engage in tree-planting campaigns, participate in neighborhood greening programs, and take part in public consultations on urban development and environmental policies. By contributing to these initiatives, they can strengthen the local efforts for environmental conservation and ensure long-term stewardship of green spaces.
4. Health Practitioners and Public Health Officials – Health practitioners should integrate climate change adaptation and heat stress education into public health campaigns. These programs should focus on promoting proper hydration, educating the public on heat-related illnesses, and informing communities about available emergency cooling services, especially during extreme heat events.
5. Academicians and Researchers – Academics and researchers should conduct in-depth studies on the dynamics of urban tree loss, with a particular focus on how it impacts local microclimates and public health. These studies should lead to the development of region-specific adaptation models that can guide both public policies and community action plans.
6. Non-Governmental Organizations (NGOs) and Advocacy Groups – NGOs and advocacy organizations should continue their efforts to promote environmental sustainability by providing technical support to communities. They should focus on developing low-cost, community-driven cooling infrastructure and continue educating the public on climate resilience and the importance of green spaces.
7. Business Establishments and Developers – Businesses and developers should embrace environmentally friendly construction practices, such as incorporating green roofs, vertical gardens, and protecting existing tree cover. These initiatives not only reduce environmental degradation but

also contribute to the thermal comfort of urban areas, enhancing overall quality of life in communities.

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