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Urban Stress and Sustainable Green Infrastructure: A Spatial Perspective on Well-Being in Greater Chennai

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Abstract

Rapid Urbanization in Greater Chennai has contributed to rising stress levels among the people. The primary reasons for stress are pollution, limited green open spaces, inadequate urban planning etc. This study investigates the spatial relationship between urban stress and green infrastructure with a comparative focus on working and non-working professionals across zones in the Chennai City. A primary survey was done with 90 individuals both working and non-working to understand their stress level and how it is related to green open spaces around them. The data was collected using structured questionnaires through Google Forms. The present study used Geographic Information System (GIS) to map areas with high stress and compared them to the presence of green spaces like parks, tree-lined roads, water bodies and other eco-friendly public areas while also examining stressors such as pollution, traffic congestion and lack of open spaces. The results show that areas with more green spaces usually have people with lower stress levels and a better sense of well-being. This research highlights the importance of green infrastructure in lowering urban stress. It suggests adding green engineering ideas into Chennai's city planning will improvise both the environment and the people's stress level. This spatial study gives useful insights to urban planners, government officials and people working on sustainability, showing the need for fair and equal access to green spaces in fast growing cities like Chennai.

Keywords: Urban stress, Green infrastructure, Spatial analysis, Sustainable cities, Chennai.

1. Introduction

Urban areas help with growth and new ideas, but they also bring stress from the environment and daily life. In big Indian cities, people face noise pollution, dirty air, crowded places, few parks, and less greenery. These problems raise stress levels. Greater Chennai clearly shows these issues and how they affect the lives of people living there.

Amid the pressures of modernization, green infrastructure emerges as a sustainable solution. It not only helps with stress, but also controls heat and improves air quality. Trees give shade and cool the surroundings, which is very important in cities like Chennai. It includes parks, green corridors, tree lined avenues, rooftop gardens, and eco-friendly community spaces. These features not only reduce the environmental footprint of urban growth but also serve as natural stress relief buffers, improving residents' overall well-being. This paper looks at how uneven green spaces in Chennai affect stress levels in both

working and non-working people. Using maps and surveys, the study shows how green planning in cities can help reduce stress and improve life for everyone.

2. Literature background

Urban stress has been studied by experts in many fields like Psychology, Urban planning and Geography. Researcher named Gifford (2007) says how things like overcrowding and city noise can affect people's minds. And Evans (2003) highlights how problems in the city, like pollution and not enough green areas, can harm people's health and well-being.

In India, studies by researchers, Tiwari and Jain (2020) and Singh and Sharma (2018) show that worsening city environments can lead to more emotional stress. Because with a fewer open spaces, people find it hard to get nature-based stress relief.

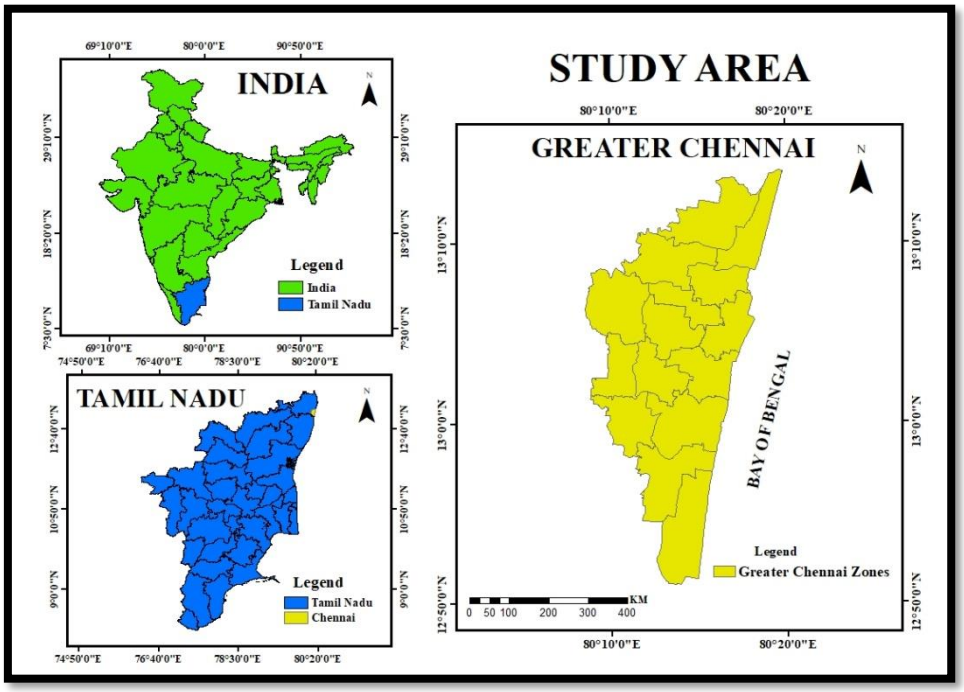
Green infrastructure has gained attention as an ecologically sustainable and socially inclusive urban strategy. Tzoulas *et al.* (2007) define green infrastructure as interconnected green spaces that improve both ecological and human health. Similarly, Kabisch *et al.* (2016) demonstrated the positive impact of urban green spaces on health equity, especially in densely populated cities.

Despite growing recognition, there is limited research connecting green infrastructure and urban stress from a spatial angle in Indian cities particularly in southern metros like Chennai. This study fills that gap by blending spatial tools with human experience.

3. Study Area

Chennai is located on the northeast of Tamil Nadu on the coast of the Bay of Bengal. Chennai was renamed "Greater Chennai" on October 1, 2011, when its area expanded from 174 sq. km to 426 sq. km by merging nearby municipalities and panchayats to improve urban governance.

Figure 1: Study Area of Greater Chennai



Greater Chennai is located at latitude of 13° 4' 2.7804" N and 80° 14' 15.4212" E. Greater Chennai consisting of 10.97 million population with 426 sq. km of urban area is located on the south-eastern coast

of India in the north-eastern part of Tamil Nadu on a flat coastal plain known as the Eastern Coastal Plains. Its average elevation is around 6.7 metres (22 ft), and its highest point is 60 m (200 ft). Chennai boasts of a rich historical legacy, which lends an inexplicable charm to the city. It is popularly known as the 'Gateway to South India' and it is well connected internationally as well as to the other parts of India.

4. Aim

The main aim of the study is to analyse the impact of urban stress and the role of sustainable green infrastructure on the well-being of residents in Greater Chennai.

5. Objectives

1. To analyse the spatial distribution of urban stress levels in Greater Chennai.
2. To study the differences in stress levels between working and non-working professionals.
3. To show the availability and access to eco-friendly green infrastructure in the city.
4. To find the link between access to green spaces and how well people feel mentally.
5. To give helpful ideas for better and greener city planning and infrastructure design.

6. Sampling Design

The study used a Purposive Sampling Technique to collect responses from residents across the 15 administrative zones of Greater Chennai. A total of 90 respondents including both working and non-working individuals participated through an online structured questionnaire.

7. Methodology

The study used a cross sectional survey with numbers and maps to study the topic. Main data was collected through a structured Google Form which included questions such as age, stress factors, availability of green space etc. The responses were analyzed using SPSS software and ArcGIS software used to prepare Maps of Greater Chennai.

8. Results and Discussions

8.1 Demographic Patterns and Urban Lifestyles

Table 1: Demographic Profile of the Respondents

Variable	Category	Frequency (n)	Percentage (%)
Gender	Female	55	38.9%
Gender	Male	35	61.1%
	Total	90	**100%**
Occupation	Working	40	44.4%
Occupation	Non working	50	55.6%
	Total	90	**100%**

The respondent demographics reveal a strong representation from younger and middle-aged groups, with women making up a significant portion. The authority of non-working individuals homemakers, students, alongside working professionals provides a broad insight into how diverse urban routines impact stress levels. Educational background and income variations further reflect the intersection of social and economic vulnerabilities in urban environments.

8.2 Prevalence of Urban Stress

More than half of the participants experience stress daily or often, confirming that urban stress is a widespread and chronic issue in Chennai. This reflects with existing urban psychology research, which showed that dense, fast-paced cities contribute to constant low-grade psychological distress.

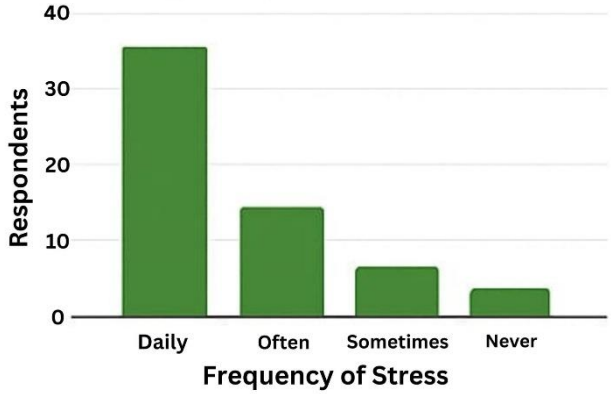


Figure 2: Frequency of Urban Stress

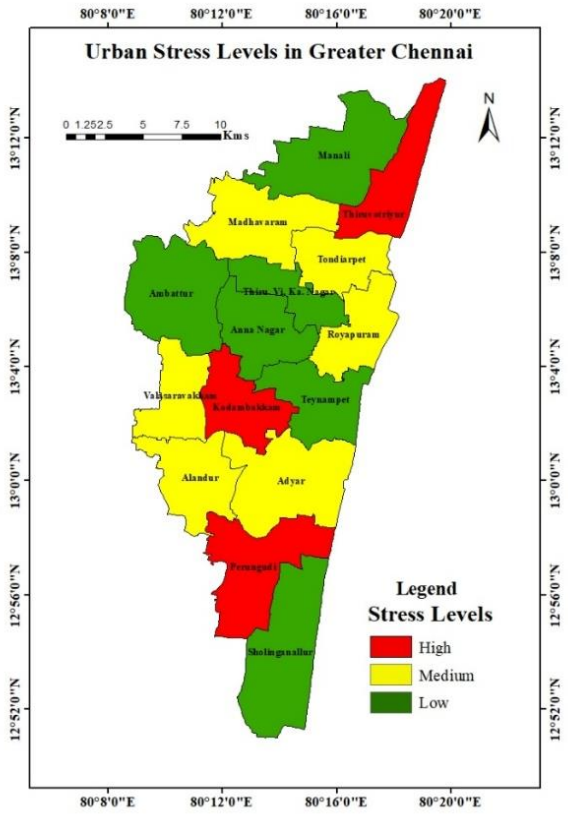


Figure 3: Urban stress levels of Greater Chennai

This map displays the geographical distribution of average urban stress levels across the 15 zones of Greater Chennai. Each zone's stress score was obtained from survey responses using a 3-point scale: Low, Medium, and High. A choropleth colour gradient was applied to visually distinguish between zones with differing stress intensities. Zones such as Thiruvottiyur and Valasaravakkam recorded higher stress levels, while areas like Adyar, Ambattur, and Anna Nagar showed lower stress. This spatial analysis highlights the urban pressure points requiring targeted policy attention. Key Contributors Identified are:

- Heavy Traffic
- Air and noise pollution
- Overcrowding
- Work-related pressure

These Outcomes suggest that urban planning scarcity are not only causing physical discomfort but are directly connected to mental well-being.

8.3 Spatial Disparities in Stress and Infrastructure

The spatial analysis claims to zones like Kodambakkam, T. Nagar, and Anna Nagar showing higher stress levels, corresponding with dense population, commercial activity, and limited open spaces. In contrast, less crowded zones reflected lower stress perception, suggesting that well-being is not equally distributed throughout urban space. This supports the need to explain mental health geographically, especially in spacious metropolitan areas like Chennai.

8.4 Accessibility vs Actual Use of Green Spaces

Whereas 70% claim access to green spaces, their usage remains low with many visiting them only barely. This contradiction essential gap:

- Green infrastructure exists but is underutilized.
- Barriers such as distance, safety concerns, maintenance, or lack of awareness prevent full engagement.
- This indicates as external presence of greenery, which fails to convert into functional, restorative space for urban citizens.

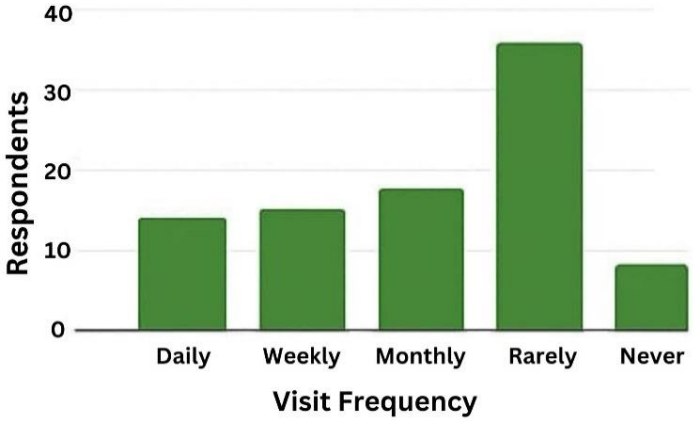


Figure 4: Visiting of Green Spaces Figure

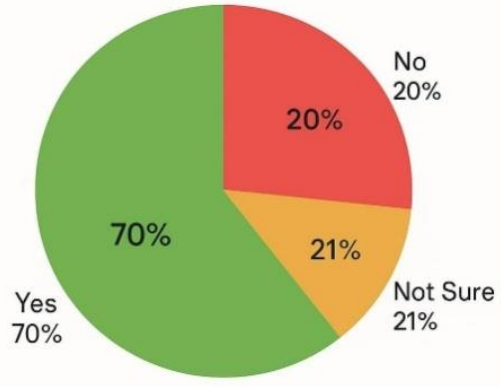


Figure 5: Access to Green Spaces Green Infrastructure access in Greater Chennai

This map presents the zone-wise accessibility of green infrastructure in Greater Chennai. Each zones percentage of respondents who mentioned having access to nearby parks, tree-lined roads, lakes,and other environmentally friendly areas wad determined. Zones such as Adyar, Anna Nagar, and Ambattur demonstrated high accessibility, while Thiruvottiyur and Valasaravakkam showed limited and poor access to green amenities. The choropleth map categorizes these values to visualize spatial inequalities in ecological resources within the city.

8.5 Urban Stress and Green Infrastructure access in Greater Chennai

This overlay map combines urban stress levels with green infrastructure accessibility to analyze the interrelationship between environmental exposure and psychological well-being. Zones with high stress and low green access notably Thiruvottiyur and Valasaravakkam are marked as critical concern areas. On the other hand, Adyar and Ambattur fall into the low stress–high green access category. The dual-layer spatial representation reveals a clear inverse relationship between stress intensity and availability of green infrastructure, reinforcing the role of sustainable urban design in improving quality of life.

Figure 6: Green Infrastructure Access

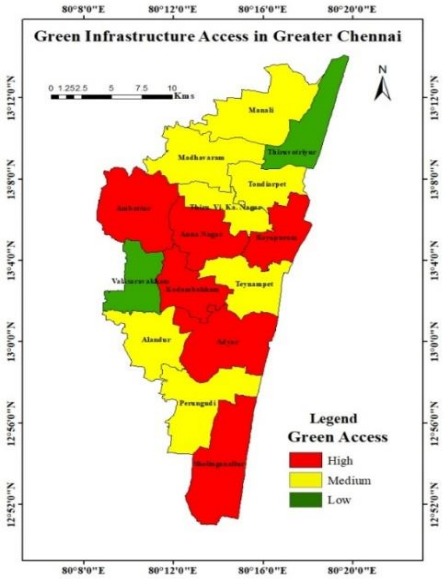
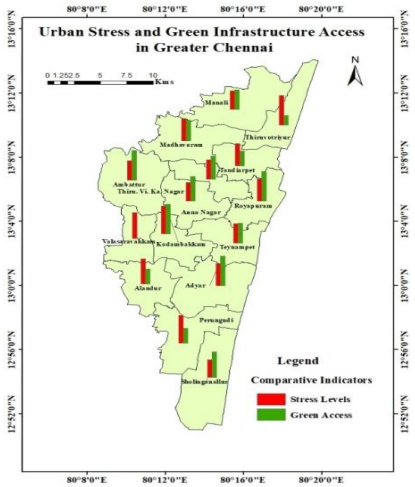


Figure 7: Urban Stress & Green Infrastructure Access



8.6 Psychological Impact of Green Spaces

A significant portion of respondents (over 50%) agree or strongly agree that spending time in green spaces reduces stress and improves mood, reinforcing global studies in environmental psychology. However, the 30% neutral response suggests variability in perception or lived experience, emphasizing the need for more community education and inclusive design.

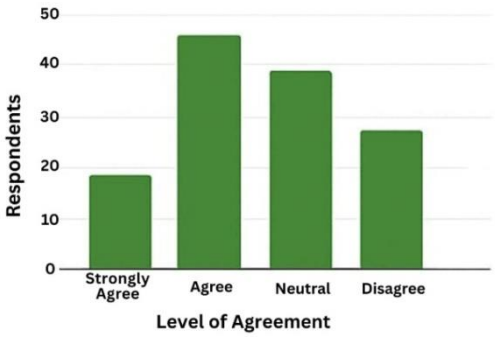


Figure 8: Visiting of Green Spaces

8.7 Deficiencies in Urban Green Infrastructure

The responses identified irregular access to:

- Uneven access to Public parks
- Lakes and water bodies
- Tree-lined roads

Some respondents said they have one of these, it is evident that urban greening is not evenly distributed, particularly in the cities industrial and northern areas, such as Tondiarpet, Royapuram. This strengthen the case that spatial inequality in well-being is a result of infrastructure bias

8.8 Community Insights and Policy Implications

The flexible responses provide rich subjective findings. Citizens are calling for:

- Greener transportation lanes
- Park expansions and maintenance
- Noise and pollution reduction measures
- Tree planting drives and rooftop gardens

This presents a bottom-up desire for environmental friendly urbanism, which can inform data-driven and democratic planning in Chennai.

This analysis illustrates that urban stress in Greater Chennai is deeply tied to spatial inequalities, poor infrastructure planning, and inadequate ecological buffers. While the mental health benefits of green spaces are illustrated affirmed, accessibility, functionality, and inclusivity remain key challenges. Urban planning should adopt a spatial justice framework, ensuring that green infrastructure is distributed equitably, maintained sustainably, and designed for real use—especially in high stress zones. Only then can cities like Chennai move toward a model of resilient and inclusive urban well-being.

8.9 Policies and Recommendations

1. Strengthen Urban Green Infrastructure Policies

Local urban development authorities such as CMDA and GCC should revise land-use policies to order minimum green cover per capita. Involving green infrastructure standards into urban planning frameworks will ensure systematic integration of green spaces in both residential and commercial areas.

2. Ensure Fair Access to Green Spaces

The data shows a important portion of respondents either lack access and rarely visit green spaces. The Policies must prioritize equitable distribution of parks and green corridors particularly in neglected and high density neighbourhoods. Government schemes like the Smart Cities Mission can integrate spatial equity criteria for green infrastructure.

3. Green Prescriptions for Mental Health

Green spaces have a positive effect mode, medical professionals and city wellness initiatives should look into "green prescription" that promote frequent park visits as a mental health intervention, especially for working and urban youth.

4. Improve Public Awareness and Engagement

Raising Awareness of advantages of spending time in nature can improve community involvement. Schools and university ought to incorporate environmental literacy and encouraged park based recreation, eco-walks, urban gardening.

5. Institutional Collaboration

Urban planning bodies, environmental NGOs, public health departments, and educational institutions should work in synergy to create, maintain and monitor green spaces. Involving locals in a participatory governance model will improve accountability and guarantee that spaces are user centred.

6. Revive and Maintain Existing Green Assets

Many existing parks and open lands suffer from neglect and invasion Periodic audits and GIS based mapping of green spaces can help identify gaps in maintenance. Allotting dedicated budgets and green space task forces will facilitate restoration and upkeep.

7. Completing the Green Infrastructure with the Climate Resilience Integration

The Green spaces safeguard against air pollution, flooding and heat in the urban areas. A planner must include dynamic Green Infrastructure bios wale, rain garden tree canopy which are environmental and psychological resilience resources.

8. Data-Driven Decision Making

The Prioritization of green interventions should be based on behavioural and spatial data collected from surveys and GIS platforms should inform the prioritization of green interventions. Public feedback loops and regular evaluations can help adjust strategies in real time.

9. Conclusion

The growing problem of urban stress in Greater Chennai is highlighted in this study, along with the vital role that green infrastructure plays in fostering psychological health. The spatial and survey based analysis conclusions shows that a sizable fraction of city dwellers. Either don't have access to green spaces or use them infrequently. Higher stress level and less benefits from mood enhancement are correlated with this limited interaction. Despite widespread awareness of the benefits of green spaces regular interaction with nature is hampered by socio-behavioural, accessibility and infrastructure issues.

The study emphasize how urgent it Is to rethink urban planning from an inclusive and sustainable perspective, on that values the therapeutic benefits of green spaces and there fair distribution. Cities like Chennai can improve their daily urban lives by incorporating green infrastructure.

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