

planning green infrastructure strategies for urban heat island mitigation in sholinganallur,
Chennai

PLANNING GREEN INFRASTRUCTURE STRATEGIES FOR URBAN HEAT ISLAND
MITIGATION IN SHOLINGANALLUR, CHENNAI

A REPORT

With the guidance of

Dr. Arshi Parashar

Submitted

*in the partial fulfilment of the requirements for
the subject*

PLANNING THESIS

By

P.T. ROHITHA

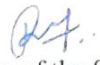
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DECLARATION

I **P. T. ROHITHA**, Scholar No **2211002118** hereby declare that the thesis titled Planning green infrastructure strategies for urban heat island mitigation in sholinganallur, Chennai submitted by me in partial fulfilment for the award of degree of Bachelor of Planning, at Maulana Azad National Institute of Technology, Bhopal, India, is a record of Bonafide work carried out by me. The matter/result embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.


Signature of the Student

Date: 8/5/26

CERTIFICATE

This is to certify that the declaration of **P. T. ROHITHA** is true to the best of my knowledge and that the student has worked under my guidance for one semester in preparing this thesis.

RECOMMENDED


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Signature of the Guide
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ACCEPTED

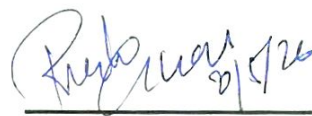

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Abstract

Rapid urbanization and infrastructure expansion along the Old Mahabalipuram Road (OMR) IT Corridor have significantly transformed the urban landscape of Sholinganallur, Chennai. The conversion of vegetation, wetlands, and open spaces into dense built-up areas has intensified the Urban Heat Island (UHI) effect, resulting in increased Land Surface Temperature (LST), environmental degradation, and declining urban thermal comfort. The proximity of the ecologically sensitive Pallikaranai Marsh further highlights the environmental vulnerability of the study area due to continuous encroachment and loss of natural ecological buffers.

The present study aims to assess the spatial distribution and intensity of Urban Heat Island effects in Sholinganallur through Remote Sensing and Geographic Information System (GIS)-based analysis. The study examines the relationship between land-use transformation, vegetation loss, built-up expansion, and thermal variation using geospatial techniques. Satellite imagery was utilized to derive thematic layers such as Land Surface Temperature (LST), Land Use Land Cover (LULC), Normalized Difference Vegetation Index (NDVI), Normalized Difference Built-up Index (NDBI), and Normalized Difference Water Index (NDWI). Hotspot analysis was carried out to identify thermally vulnerable zones within the study area.

The findings indicate that wards dominated by dense built-up development and impervious surfaces exhibit significantly higher surface temperatures, while areas containing vegetation, wetlands, and water bodies demonstrate relatively lower thermal intensity. The analysis establishes a strong relationship between increasing built-up density, declining vegetation cover, and rising surface temperatures. The study further identifies environmentally stressed wards such as Sholinganallur, Thoraipakkam, Pallikaranai, Palavakkam, Neelankarai, and Kottivakkam as priority zones for intervention.

Based on the spatial analysis, the study proposes climate-responsive Green Infrastructure strategies including urban green corridors, roadside plantation buffers, shaded pedestrian pathways, green roofs, vertical greening systems, permeable pavements, blue-green infrastructure integration, and ecological restoration near wetland edges. These interventions aim to reduce heat accumulation, improve urban thermal comfort, strengthen ecological resilience, and promote sustainable urban development. The study contributes toward developing a spatial planning framework for Urban Heat Island mitigation in rapidly urbanizing metropolitan regions.

सारांश

ओल्ड महाबलीपुरम रोड (OMR) आईटी कॉरिडोर के तीव्र शहरीकरण एवं आधारभूत संरचना विकास के कारण चेन्नई के शोलिंगनल्लूर क्षेत्र में भूमि उपयोग एवं पर्यावरणीय स्वरूप में व्यापक परिवर्तन हुआ है। वनस्पति क्षेत्र, आर्द्रभूमि तथा खुले स्थानों का घने निर्मित क्षेत्रों में परिवर्तन होने से शहरी ऊष्मा द्वीप (Urban Heat Island – UHI) प्रभाव में वृद्धि हुई है, जिसके परिणामस्वरूप भूमि सतह तापमान, पर्यावरणीय क्षरण तथा शहरी तापीय असुविधा में वृद्धि देखी गई है। अध्ययन क्षेत्र के समीप स्थित पर्यावरणीय दृष्टि से संवेदनशील पल्लिकारनई मार्श क्षेत्र का निरंतर अतिक्रमण और क्षरण इस क्षेत्र की पारिस्थितिकीय संवेदनशीलता को और अधिक बढ़ाता है।

प्रस्तुत अध्ययन का उद्देश्य शोलिंगनल्लूर क्षेत्र में शहरी ऊष्मा द्वीप प्रभाव की तीव्रता एवं स्थानिक वितरण का विश्लेषण करना है। अध्ययन में रिमोट सेंसिंग एवं भू-स्थानिक सूचना प्रणाली (GIS) तकनीकों का उपयोग करते हुए भूमि उपयोग परिवर्तन, वनस्पति हास, निर्मित क्षेत्र विस्तार एवं तापीय परिवर्तन के मध्य संबंध का विश्लेषण किया गया है। उपग्रह चित्रों के माध्यम से भूमि सतह तापमान (LST), भूमि उपयोग एवं भूमि आवरण (LULC), सामान्यीकृत अंतर वनस्पति सूचकांक (NDVI), सामान्यीकृत अंतर निर्मित क्षेत्र सूचकांक (NDBI) तथा सामान्यीकृत अंतर जल सूचकांक (NDWI) जैसे विषयगत मानचित्र तैयार किए गए। तापीय रूप से संवेदनशील क्षेत्रों की पहचान हेतु हॉटस्पॉट विश्लेषण भी किया गया।

अध्ययन के निष्कर्ष दर्शाते हैं कि घने निर्मित क्षेत्रों एवं अभेद्य सतहों वाले वार्डों में सतही तापमान अधिक पाया गया, जबकि वनस्पति, जल निकाय एवं आर्द्रभूमि वाले क्षेत्रों में अपेक्षाकृत कम तापीय तीव्रता दर्ज की गई। अध्ययन से यह स्पष्ट हुआ कि निर्मित क्षेत्र की वृद्धि एवं वनस्पति आवरण में कमी के कारण सतही तापमान में वृद्धि हुई है। शोलिंगनल्लूर, थोराइपक्कम, पल्लिकारनई, पलावक्कम, नीलांकरई एवं कोट्टीवक्कम जैसे वार्डों को उच्च तापीय संवेदनशीलता वाले प्राथमिक हस्तक्षेप क्षेत्रों के रूप में चिह्नित किया गया।

अध्ययन के आधार पर जलवायु-संवेदनशील हरित अवसंरचना रणनीतियाँ प्रस्तावित की गई हैं, जिनमें शहरी हरित गलियारे, सड़क किनारे वृक्षारोपण, छायादार पैदल पथ, ग्रीन रूफ, वर्टिकल ग्रीनिंग सिस्टम, पारगम्य पथरीकरण, ब्लू-ग्रीन अवसंरचना तथा आर्द्रभूमि पुनर्स्थापन जैसी योजनाएँ शामिल हैं। इन प्रस्तावों का उद्देश्य ताप संचयन को कम करना, शहरी तापीय आराम में सुधार करना, पारिस्थितिकीय संतुलन को मजबूत करना तथा सतत शहरी विकास को प्रोत्साहित करना है। यह अध्ययन तीव्र गति से विकसित हो रहे महानगरीय क्षेत्रों में शहरी ऊष्मा द्वीप शमन हेतु एक स्थानिक नियोजन रूपरेखा प्रदान करता है।

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CHAPTER 1

INTRODUCTION

1.0 Introduction

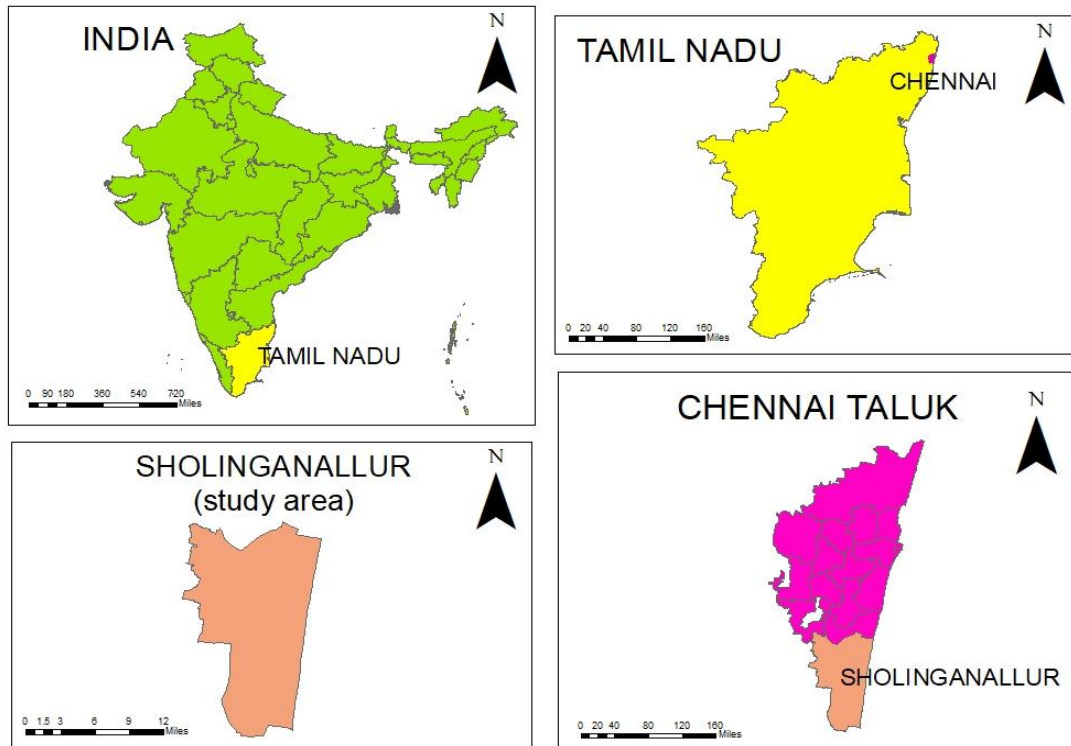
Urban areas across India are undergoing unprecedented spatial and environmental transformation due to rapid urbanization, economic liberalization, infrastructure growth, and technological advancement. Metropolitan regions driven by Information Technology (IT) and service-sector development have emerged as major urban growth centres. This rapid urban expansion has significantly altered land-use patterns, ecological balance, and urban climatic conditions. One of the most critical environmental consequences associated with this transformation is the Urban Heat Island (UHI) effect.

Sholinganallur, located along the Old Mahabalipuram Road (OMR) IT Corridor in Chennai, has transformed from a peri-urban settlement into a dense urban node characterized by IT parks, residential townships, institutional campuses, and transportation infrastructure. The large-scale conversion of wetlands, vegetation, and open land into impervious built-up surfaces has intensified thermal stress within the study area.

The dominance of concrete roads, asphalt pavements, glass façades, rooftops, and parking surfaces has increased heat absorption and retention, leading to elevated surface temperatures. Simultaneously, the reduction of vegetation and ecological buffers has weakened evapotranspiration processes and natural cooling mechanisms. These transformations have significantly contributed to the formation of Urban Heat Island conditions within the study area.

The proximity of Sholinganallur to the ecologically sensitive Pallikaranai Marsh further increases environmental vulnerability. The marsh historically functioned as a natural cooling zone, biodiversity habitat, groundwater recharge area, and flood retention basin. However, rapid urban encroachment and infrastructure development have fragmented the wetland ecosystem and reduced its climatic regulation capacity.

Therefore, there is an urgent need to scientifically assess Urban Heat Island intensity and identify environmentally sensitive zones requiring intervention. This study utilizes Remote Sensing and Geographic Information System (GIS) techniques to analyse Land Surface Temperature (LST), vegetation distribution, built-up intensity, and moisture characteristics in order to formulate sustainable Green Infrastructure-based mitigation strategies.



1.1 Background

The IT corridor along Old Mahabalipuram Road (OMR) has emerged as one of the most rapidly urbanizing and economically significant growth corridors in South India. The establishment of major developments such as the ELCOT Special Economic Zone (SEZ), SIPCOT IT Park, multinational corporate offices, commercial complexes, educational institutions, and large-scale residential townships has transformed Sholinganallur from a peri-urban settlement into a dense urban node within the Chennai Metropolitan Area. Improved transportation connectivity, employment opportunities, and real estate investments have further accelerated the pace of urban expansion over the last two decades.

This rapid urban transformation has led to extensive horizontal and vertical built-up growth across the region. Large tracts of vacant land, agricultural areas, and open spaces have been converted into high-rise residential apartments, office buildings, roads, parking areas, and

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commercial infrastructure. The increase in construction activities and urban densification has significantly altered the natural land surface characteristics of the area.

One of the major consequences of this urban expansion is the substantial reduction in vegetation cover and green open spaces. Trees, wetlands, and natural landscapes that once contributed to regulating local temperature and maintaining ecological balance are being continuously replaced by concrete structures and paved surfaces. The loss of urban greenery has reduced evapotranspiration processes, which naturally help in cooling the surrounding environment. As a result, the thermal comfort of the area has deteriorated considerably.

Simultaneously, the increase in impervious surfaces such as asphalt roads, concrete pavements, rooftops, parking lots, and other hardscape elements has intensified surface heat accumulation. These materials possess high heat absorption and heat retention capacities. During daytime, they absorb large amounts of incoming solar radiation and store thermal energy, which is gradually released during the night. This process causes elevated land surface temperatures and leads to the formation and intensification of Urban Heat Island (UHI) effects within Sholinganallur and surrounding areas.

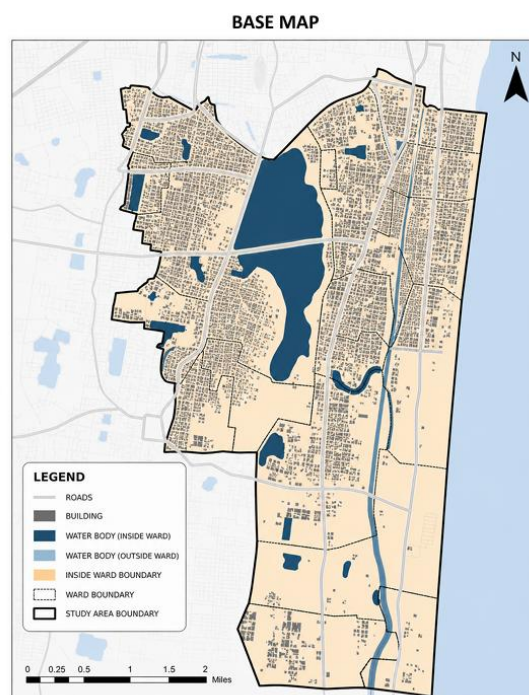
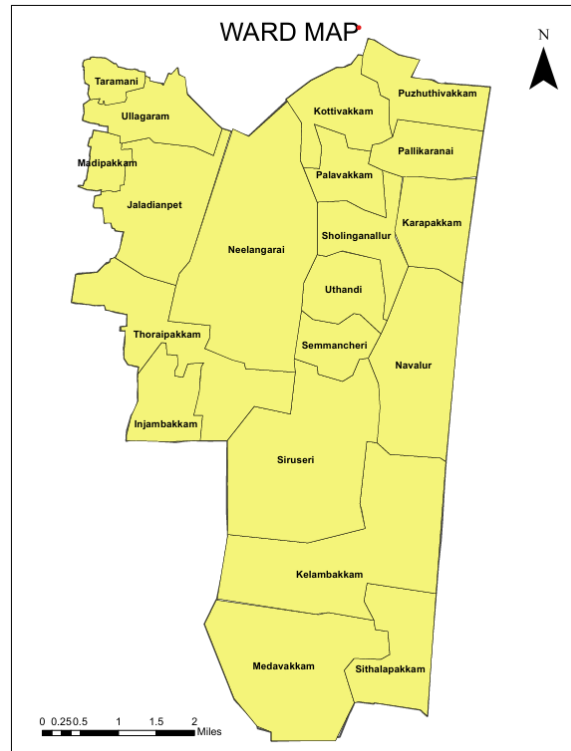
Another critical environmental issue associated with this urban growth is the encroachment and degradation of wetlands and natural drainage systems, particularly the Pallikaranai Marsh. The marshland historically functioned as an important ecological buffer by regulating microclimate, supporting biodiversity, storing floodwater, and maintaining groundwater recharge. However, rapid urbanization, land reclamation, dumping activities, and infrastructure development have significantly reduced the extent and ecological functionality of the marsh. The degradation of this wetland system has weakened its natural cooling and moisture-regulating capabilities, thereby contributing further to rising urban temperatures and climatic imbalance.

In addition to physical land transformation, increasing anthropogenic heat generation from vehicles, air-conditioning systems, industries, commercial establishments, and energy-intensive activities has further amplified heat stress within the urban environment. The growing dependency on motorized transportation and energy consumption within the IT corridor has resulted in continuous heat emissions, especially during peak working hours.

Although existing statutory planning mechanisms and master plans primarily focus on macro-level land use zoning, transportation infrastructure, and urban development regulations, limited attention has been given to micro-scale climate-responsive planning strategies. Critical interventions such as shaded pedestrian corridors, urban green buffers, permeable pavements, cool roofing materials, urban tree networks, and integrated blue-green infrastructure systems remain inadequately addressed in current planning practices. The absence of localized environmental planning measures has reduced the city's resilience against increasing heat stress and climate-related challenges.

Therefore, there is a growing need for sustainable and climate-responsive urban planning approaches within the OMR corridor, particularly in Sholinganallur, to mitigate Urban Heat Island effects, restore ecological balance, improve thermal comfort, and enhance long-term urban resilience.

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1.2 Problem Statement

Sholinganallur, located along the rapidly developing Old Mahabalipuram Road (OMR) corridor in Chennai, has witnessed intense urbanization and infrastructural growth over the past two decades. The transformation of natural landscapes into dense built-up areas, combined with large-scale commercial, residential, and transportation developments, has significantly altered the local microclimate. As a result, the region is increasingly experiencing elevated land surface temperatures, reduced environmental quality, and intensified Urban Heat Island (UHI) effects. The continuous conversion of ecologically sensitive areas into impervious urban surfaces has weakened the natural thermal regulation capacity of the environment, creating severe thermal stress for both the ecosystem and the urban population.

The major issues identified within the study area are discussed below:

1.2.1 Rising Land Surface Temperature

One of the primary concerns in Sholinganallur is the steady rise in land surface temperature (LST), particularly in densely built-up urban zones. The expansion of high-rise buildings, IT parks, commercial establishments, and residential developments has replaced natural land surfaces with heat-retaining materials such as concrete, asphalt, metal, and paved surfaces. These urban materials absorb large quantities of solar radiation during the daytime and gradually release stored heat during the night, resulting in elevated ambient temperatures and prolonged heat retention.

Satellite-based thermal analysis indicates that areas with high built-up density exhibit significantly higher thermal intensity compared to vegetated or water-covered regions. The concentration of infrastructure and anthropogenic activities has accelerated localized warming, thereby intensifying Urban Heat Island effects within the region. Increased land surface temperatures not only affect environmental quality but also contribute to higher energy consumption due to increased cooling demands.

1.2.2 Reduction in Green Cover

Rapid urban development has led to substantial reduction in vegetation cover, open spaces, and natural ecosystems within Sholinganallur. Large areas of trees, grasslands, wetlands, and agricultural lands have been converted into residential layouts, commercial complexes, roads, and infrastructure corridors. This decline in urban greenery has reduced the effectiveness of natural cooling mechanisms such as shading and evapotranspiration.

The encroachment and degradation of the Pallikaranai Marsh, one of Chennai's most important wetland ecosystems, have further aggravated environmental imbalance in the region. Wetlands traditionally function as ecological cooling zones by maintaining moisture levels, regulating microclimate, and supporting biodiversity. However, continuous land reclamation, dumping, and construction activities have reduced the marshland extent and weakened its ecological functions. The loss of vegetation and wetland ecosystems has therefore significantly contributed to rising urban temperatures and reduced thermal comfort.

1.2.3 Heat Stress in Settlements

The increasing intensity of heat within Sholinganallur has created severe thermal discomfort for residents living in both formal and informal settlements. High-density residential areas with limited ventilation, inadequate tree cover, and insufficient public open spaces experience elevated daytime and nighttime temperatures. In many low-income and informal settlements, buildings are often constructed using heat-absorbing materials with poor insulation and minimal climatic considerations, making them highly vulnerable to heat stress.

The absence of shaded pedestrian pathways, community green spaces, and cooling infrastructure further worsens outdoor thermal conditions. Prolonged exposure to excessive heat negatively impacts public health, productivity, and overall quality of life, particularly among vulnerable population groups such as elderly individuals, children, outdoor workers, and economically weaker communities. Increasing heat stress also raises dependency on mechanical cooling systems, leading to higher energy consumption and additional anthropogenic heat generation.

1.2.4 Increasing Impervious Surfaces

Urban expansion within Sholinganallur has resulted in a substantial increase in impervious surfaces such as roads, parking areas, concrete pavements, rooftops, and paved open spaces. These surfaces prevent natural infiltration of rainwater into the soil and significantly increase surface runoff during rainfall events. At the same time, impervious materials absorb and retain large amounts of solar energy, thereby intensifying heat accumulation across the urban landscape.

The widespread presence of dark-colored asphalt roads and exposed concrete surfaces further contributes to increased surface temperatures. The reduction in permeable surfaces has also affected groundwater recharge and natural hydrological balance within the area.

Consequently, the combination of thermal stress and drainage inefficiencies has made the region increasingly vulnerable to both heat-related impacts and urban flooding.

1.2.5 Lack of Climate-Responsive Planning

Despite the rapid pace of urbanization, existing planning frameworks and development regulations within the region primarily focus on land use allocation, transportation infrastructure, and economic growth, with comparatively limited emphasis on climate-responsive urban design. Current urban planning mechanisms inadequately address microclimatic considerations such as thermal comfort, heat mitigation, ecological restoration, and sustainable surface management.

Critical strategies including green roofs, vertical greenery systems, urban tree networks, shaded pedestrian corridors, cool roofing materials, permeable pavements, and integrated blue-green infrastructure are not sufficiently incorporated into mainstream planning and development practices. Furthermore, inadequate coordination between environmental conservation policies and urban development activities has resulted in fragmented implementation of sustainable interventions. The lack of comprehensive climate-responsive planning has therefore reduced the resilience of Sholinganallur against increasing Urban Heat Island effects and future climate-related challenges.

Overall, the combined impact of rising temperatures, ecological degradation, impervious urban growth, and insufficient climate-sensitive planning highlights the urgent need for sustainable urban planning interventions aimed at mitigating Urban Heat Island effects and improving environmental resilience in Sholinganallur.

Sholinganallur is experiencing increasing land surface temperatures due to rapid land-use transformation and reduction of ecological buffers.

1.3 Aim and Objectives

Aim

To develop spatially informed Green Infrastructure strategies for mitigating the Urban Heat Island effect in Sholinganallur through micro-scale planning interventions supported by Remote Sensing and GIS analysis.

Objectives

1. To analyse Land Surface Temperature patterns using Remote Sensing techniques.
2. To assess vegetation cover and built-up transformation using NDVI and LULC analysis.
3. To examine the relationship between land-use transformation and thermal intensity.
4. To identify high-temperature hotspot zones.
5. To develop Green Infrastructure suitability strategies.
6. To propose corridor-level and street-level UHI mitigation interventions.

1.4 Scope of Work

The scope of the study includes:

- Land Surface Temperature mapping
- NDVI, NDBI, and NDWI analysis
- Land Use Land Cover analysis
- Urban Heat Island hotspot identification
- Ward-level thermal comparison
- Green Infrastructure suitability modelling
- Preparation of planning-based mitigation proposals

The study primarily focuses on spatial analysis and planning recommendations rather than engineering-level implementation.

1.5 Methodology

The research adopts a spatial analytical methodology integrating Remote Sensing, GIS, and planning analysis.

1.5.1 Data Collection

- Satellite imagery
- Base maps
- Planning authority data
- Secondary reports and spatial datasets

1.5.2 Thermal Analysis

- Land Surface Temperature extraction
- NDVI computation
- Built-up density mapping

1.5.3 Spatial Correlation Analysis

- Relationship between LST, NDVI, and NDBI
- Urban Heat Island hotspot identification

1.5.4 Comparative Analysis

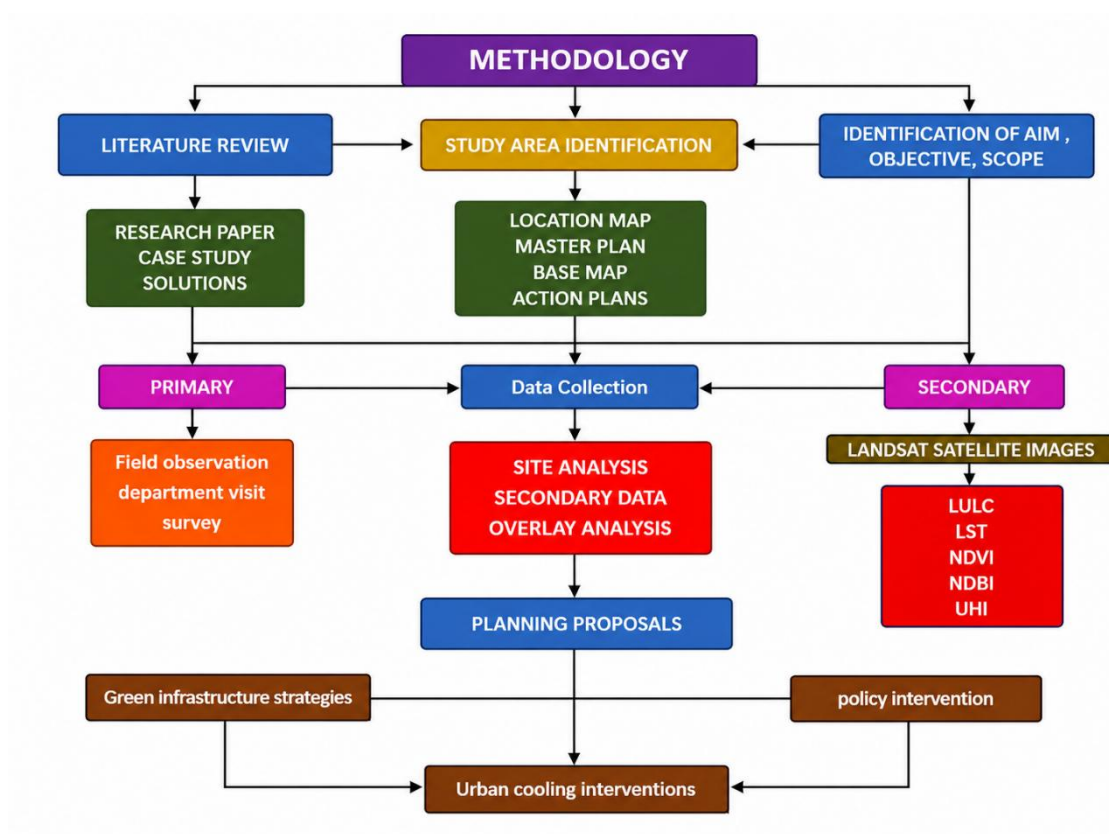
- Formal and informal settlement comparison

1.5.5 Suitability Modelling

- GIS-based multi-criteria analysis for intervention prioritization

1.5.6 Proposal Formulation

- Green corridor planning
- Shaded pedestrian systems
- Green roofs and vertical greening
- Permeable pavement strategies



1.6 Limitations of the Study

While the study aims to comprehensively assess Urban Heat Island effects and propose climate-responsive planning strategies for Sholinganallur, certain limitations exist due to data availability, methodological constraints, and practical considerations. These limitations are discussed below:

1.6.1 Dependence on Satellite-Derived Surface Temperature Data

The study primarily relies on satellite-based remote sensing data for the extraction and analysis of Land Surface Temperature (LST). Although satellite imagery provides efficient spatial coverage and helps in understanding large-scale thermal patterns, it represents surface temperature rather than actual atmospheric air temperature experienced by humans. Therefore, the observed thermal values may differ slightly from real-time ground-level temperature conditions. In addition, thermal satellite data provides information only for the specific time of image acquisition and may not fully capture daily or seasonal temperature fluctuations.

1.6.2 Limited Availability of Cloud-Free Imagery

The availability of suitable cloud-free satellite imagery poses another challenge for the study. Chennai experiences seasonal cloud cover and monsoonal weather conditions, which can obstruct satellite observations and reduce image clarity. Cloud contamination affects thermal and spectral analysis, thereby limiting the availability of high-quality datasets for consistent temporal comparison. As a result, image selection is constrained to specific periods where cloud-free or minimally affected imagery is available.

1.6.3 Micro-Scale Climatic Variations May Not Be Fully Represented

The study focuses on macro and meso-scale spatial analysis using remote sensing and GIS techniques. However, micro-climatic variations occurring at street level, building level, or neighborhood scale may not be fully represented in satellite-based analysis. Factors such as building orientation, shading conditions, wind flow patterns, material reflectivity, and localized human activities can significantly influence thermal comfort but may not be accurately captured due to the spatial resolution limitations of the data used.

1.6.4 Limited Field Temperature Observations

Ground truth verification and field-based temperature observations within the study area are limited due to time, accessibility, and resource constraints. Although satellite-derived thermal analysis provides valuable spatial information, extensive field measurements would improve the accuracy and validation of the results. The absence of continuous on-site monitoring data restricts detailed comparison between observed field temperatures and remotely sensed surface temperature values.

1.6.5 Cost and Implementation Feasibility Beyond the Study Scope

The study primarily focuses on identifying Urban Heat Island hotspots, analyzing environmental conditions, and proposing planning-level mitigation strategies. Detailed financial analysis, economic feasibility studies, policy implementation costs, and long-term maintenance requirements of proposed interventions are beyond the scope of this research. Therefore, while the study suggests sustainable and climate-responsive solutions, their practical implementation may require further technical, administrative, and economic evaluation by relevant authorities and stakeholders.

1.7 Expected Outcomes

The study is expected to generate comprehensive spatial, environmental, and planning-based outcomes that contribute toward understanding and mitigating Urban Heat Island effects in Sholinganallur. The major expected outcomes are as follows:

1.7.1 Generation of LST, NDVI, NDBI, and NDWI Maps

The study is expected to produce detailed thematic maps using Remote Sensing and GIS techniques, including Land Surface Temperature (LST), Normalized Difference Vegetation Index (NDVI), Normalized Difference Built-up Index (NDBI), and Normalized Difference Water Index (NDWI) maps. These spatial datasets will help in understanding the distribution

of thermal intensity, vegetation cover, built-up concentration, and water/moisture presence across the study area.

The generated maps will provide a scientific basis for identifying environmentally sensitive zones and assessing the relationship between urbanization and changing thermal conditions.

1.7.2 Identification of Urban Heat Island Hotspot Zones

Through thermal analysis and spatial overlay techniques, the study aims to identify areas with significantly high land surface temperatures and intense Urban Heat Island effects. These hotspot zones are expected to correspond with dense built-up areas, transportation corridors, commercial clusters, and regions with limited vegetation cover.

The identification of hotspot zones will help planners and decision-makers prioritize areas requiring immediate climate mitigation interventions and sustainable urban design measures.

1.7.3 Establishing Relationship Between Built-Up Intensity and Temperature Rise

The study is expected to establish a clear relationship between urban built-up intensity and rising surface temperatures within Sholinganallur. By comparing thermal data with land-use and land-cover characteristics, the research will demonstrate how dense urbanization, impervious surfaces, and reduction in green spaces contribute to elevated temperatures.

This relationship will provide evidence-based understanding of how rapid urban growth influences microclimatic changes and environmental degradation within the IT corridor region.

1.7.4 Development of Green Infrastructure Suitability Frameworks

Based on environmental analysis and hotspot identification, the study aims to develop suitability frameworks for introducing Green Infrastructure interventions within the study area. These frameworks may include recommendations for urban greening, green roofs, vertical greenery systems, shaded pedestrian corridors, permeable surfaces, urban tree networks, wetland restoration, and blue-green infrastructure integration.

The suitability framework will help identify appropriate locations and strategies for implementing climate-responsive urban planning solutions.

1.7.5 Formulation of Climate-Responsive Planning Recommendations

The final outcome of the study is expected to include planning recommendations aimed at mitigating Urban Heat Island effects and improving environmental resilience in Sholinganallur. The recommendations will focus on integrating sustainable and climate-sensitive approaches into future urban development practices.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

2.0 Introduction

The literature review examines previous research, case studies, and planning approaches related to Urban Heat Island (UHI) mitigation, Green Infrastructure planning, thermal analysis, and climate-responsive urban development. Rapid urbanization across major cities has resulted in increased land surface temperatures, ecological degradation, and declining environmental quality, making Urban Heat Island mitigation an important area of urban research and planning. Various international and national studies have explored the relationship between land-use transformation, built-up intensity, vegetation cover, and thermal behavior using Remote Sensing, GIS techniques, and climate-responsive planning frameworks.

The selected literature for this study focuses on different dimensions of UHI mitigation, including blue–green infrastructure systems, heat action policies, GIS-based thermal modelling, IT corridor urbanization impacts, and coastal urban heat dynamics. These studies collectively provide insights into how vegetation, wetlands, urban morphology, planning regulations, and governance frameworks influence urban thermal conditions. They also highlight the growing importance of integrating environmental planning with sustainable urban development practices.

The reviewed studies are particularly relevant to Sholinganallur due to its rapid transformation into a major IT and residential corridor along Old Mahabalipuram Road (OMR). Similar to other rapidly urbanizing metropolitan regions, Sholinganallur faces increasing land surface temperatures, loss of ecological buffers, wetland encroachment, and extensive built-up expansion. The literature helps establish a theoretical and methodological foundation for analysing these issues within the study area.

The review also identifies commonly used methodologies such as Land Surface Temperature (LST) analysis, NDVI, NDBI, NDWI mapping, buffer analysis, spatial regression modelling, GIS-based hotspot identification, and climate-responsive planning strategies. These methods support the present study in understanding the spatial relationship between urbanization and thermal behavior in Sholinganallur. Furthermore, the reviewed cases demonstrate the importance of integrating green infrastructure, ecological restoration, and policy-level interventions to improve urban resilience against increasing heat stress.

Overall, the literature review provides critical understanding of existing knowledge, identifies research gaps, and supports the development of suitable planning recommendations for mitigating Urban Heat Island effects in Sholinganallur through sustainable and climate-responsive urban planning approaches.

2.1 Assessing the Cooling Effect of Blue–Green Spaces: Implications for Urban Heat Island Mitigation

This international study examines how integrated blue–green infrastructure reduces Urban Heat Island (UHI) intensity in dense urban environments. The research focuses on understanding the spatial relationship between land surface temperature (LST), vegetation cover, water bodies, and urban morphology using quantitative geospatial techniques.

Study Focus

The study evaluates how parks, urban forests, lakes, rivers, and wetlands collectively influence surface temperature reduction. Unlike studies that assess green and blue spaces independently, this research investigates their combined cooling performance and spatial effectiveness.

Methodology

The study utilized:

- Landsat satellite imagery
- NDVI (Normalized Difference Vegetation Index)
- NDBI (Normalized Difference Built-up Index)
- Land Surface Temperature (LST) extraction
- Multi-ring buffer analysis (200m–500m cooling gradient)
- Spatial regression modelling

The buffer-based cooling gradient method measured how far temperature reduction spreads from green–blue patches into surrounding built-up areas.

Key Findings

The results showed that:

- Large, continuous blue–green networks reduce surrounding temperatures by **1–4°C**.
- Cooling effects extend up to **200–500 meters** from ecological patches.
- Fragmented and isolated green spaces produce significantly lower cooling impacts.
- Patch size and connectivity matter more than just percentage of green cover.

The study concludes that ecological configuration plays a critical role in urban thermal regulation.

Relevance to Sholinganallur

This research directly supports integrating the **Pallikaranai Marsh** into a broader green infrastructure network in **Sholinganallur**. The findings justify corridor-based cooling strategies and buffer modelling along OMR.

Limitations

The study focuses primarily on surface temperature rather than human thermal comfort. Socio-economic vulnerability is not deeply analysed.

2.2 Ahmedabad Heat Action Plan (2019)

The **Ahmedabad Heat Action Plan (HAP)** is India's first comprehensive city-level strategy to address extreme heat risks. It was developed after the devastating 2010 heatwave that caused over 1,300 excess deaths.

Study Focus

Unlike spatial UHI studies, this case emphasizes governance, public health preparedness, and institutional coordination to reduce heat-related mortality.

Methodology

The plan was formulated through:

- Mortality and health data analysis
- Temperature trend monitoring
- Policy framework development
- Stakeholder coordination mechanisms
- Seasonal phased implementation
- Color-coded heat alert systems

The approach combined meteorological forecasting with public health and disaster management planning.

Key Findings and Outcomes

- Approximately **2,380 deaths avoided** after implementation.
- Indoor temperature reduction of **2–5°C** through cool roof initiatives.
- Improved public awareness and early warning systems.
- Replication of the Heat Action Plan model in other Indian cities.

The HAP demonstrated that institutional preparedness significantly reduces vulnerability to extreme heat events.

Relevance to Sholinganallur

While your thesis focuses on spatial mitigation, this case highlights the importance of integrating planning with governance frameworks such as the Tamil Nadu State Action Plan on Climate Change. It strengthens the argument that UHI mitigation must combine spatial interventions with policy mechanisms.

Limitations

The plan focuses more on heatwave response than long-term land-use restructuring. It lacks GIS-based spatial modelling of UHI hotspots.

2.3 Urban Heat Island Mitigation: GIS-Based Analysis for a Tropical City – Singapore

This study investigates UHI mitigation strategies in **Singapore**, a high-density tropical coastal city comparable to Chennai.

Study Focus

The research evaluates how green-certified buildings, skyrise greenery, parks, and spatial planning reduce urban temperature rise in compact commercial districts.

Methodology

The study applied:

- ArcGIS spatial analysis
- IDW interpolation for temperature distribution
- 2 km buffer zones around weather stations
- Raster-based thermal modelling
- Python-based data processing

It also integrated green building certification (Green Mark system) with spatial temperature analysis.

Key Findings

- Areas with more than 57% green coverage experienced lower temperature increases (~1.6%).
- Areas with limited green infrastructure showed higher increases (~2.2%).
- Skyrise greenery and green-certified buildings significantly reduced anthropogenic heat.
- Spatial buffer analysis effectively prioritized intervention zones.

Relevance to Sholinganallur

Sholinganallur's IT-SEZ developments resemble Singapore's commercial high-rise districts. This study supports integrating green roofs, reflective surfaces, and vertical greenery into IT corridors along OMR.

Limitations

The study was correlational rather than causal. It focused mainly on surface temperature and had limited long-term monitoring duration.

2.4 Urban Heat Island and Land Use Dynamics in Hyderabad IT Corridor

This Indian case study examines the impact of IT-driven urban expansion on UHI intensity in Hyderabad, Telangana.

Study Focus

The research evaluates how rapid built-up expansion along the IT corridor altered land-use patterns and increased surface temperatures.

Methodology

- Multi-year Landsat satellite imagery
- Built-up density mapping
- Land Surface Temperature extraction
- Land Use/Land Cover (LULC) change detection

Key Findings

- IT corridor zones showed significantly higher thermal intensity.
- Loss of open land and vegetation directly contributed to temperature rise.
- Built-up density had a strong positive correlation with LST.

Relevance to Sholinganallur

This case is highly comparable because Sholinganallur is also an IT-driven growth corridor. The findings validate your hypothesis that rapid commercial development along OMR intensifies UHI.

Limitations

The study did not explore micro-scale design interventions or corridor-level green infrastructure planning.

2.5 Urban Heat Island Dynamics in Coastal City – Mumbai

This study analyses UHI patterns in **Mumbai**, a coastal metropolitan city.

Study Focus

The research examines the influence of coastal proximity, reclaimed land, and high-rise development on temperature variation.

Methodology

- Land Surface Temperature mapping
- Coastal proximity analysis
- Land cover comparison

Key Findings

- Coastal buffering reduces heat intensity in nearby zones.
- Reclaimed land and dense high-rise areas exhibit higher thermal values.
- Urban morphology significantly influences temperature patterns.

Relevance to Sholinganallur

Like Mumbai, Chennai is a coastal city. However, Sholinganallur's inland IT corridor may not fully benefit from coastal cooling. The case strengthens the need for artificial cooling mechanisms such as green corridors.

Limitations

The study primarily assessed macro-scale coastal influence rather than micro-level urban design.

CHAPTER 3

ANALYSIS

3.0 Introduction

This chapter analyses thermal characteristics, vegetation distribution, built-up intensity, and moisture conditions within the study area using Remote Sensing and GIS techniques.

3.1 Land use land cover Analysis

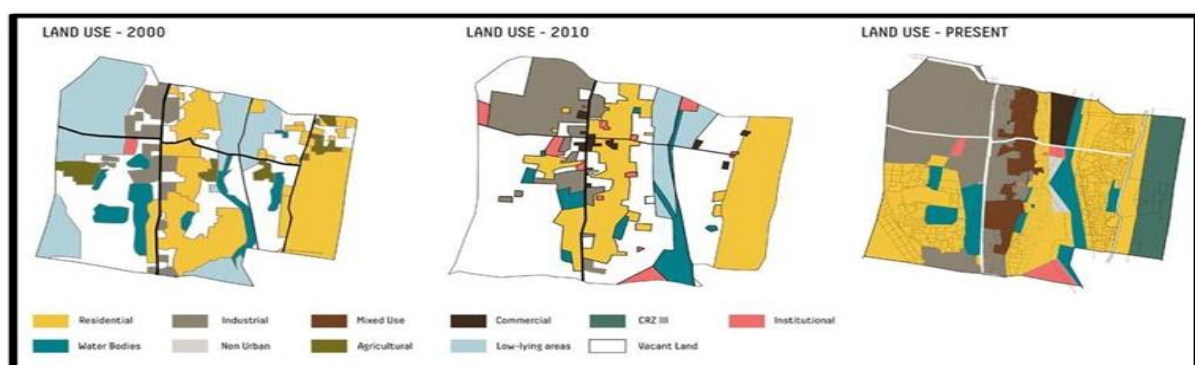
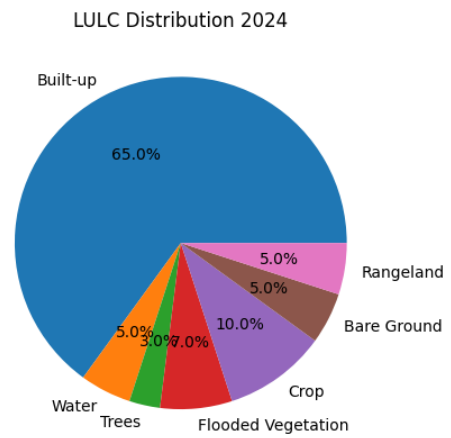
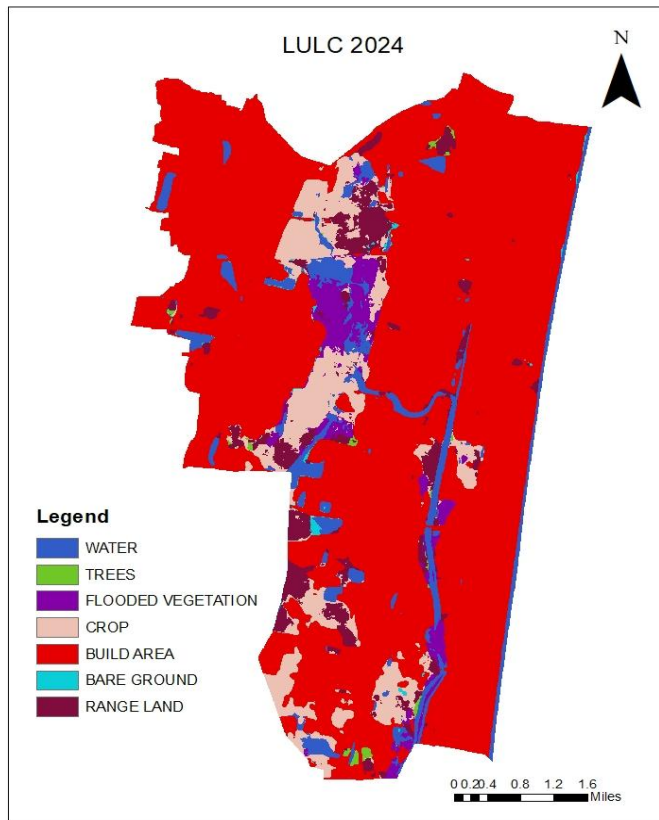
Land Use Land Cover (LULC) analysis of Sholinganallur reveals a significant transformation in the spatial structure of the region over recent years, primarily characterized by the rapid expansion of built-up land. The growth of residential complexes, commercial establishments, IT parks, institutional developments, transportation infrastructure, and associated urban services has considerably increased the extent of impervious surfaces across the study area. This pattern clearly reflects the accelerated pace of urbanization driven by economic growth and infrastructure development along the Old Mahabalipuram Road IT Corridor.

Simultaneously, the analysis indicates a substantial decline in natural land-cover features such as vegetation, open spaces, wetlands, and vacant lands. Areas that previously functioned as ecological buffers and natural cooling zones have gradually been converted into urbanized surfaces. The reduction in green cover has weakened the natural evapotranspiration process, while the loss of permeable surfaces has increased heat absorption and surface runoff. This transformation has significantly altered the environmental and thermal characteristics of the region.

The dominance of built-up land in the LULC pattern is a strong indicator of increasing urban density and land-use intensity. High concentrations of concrete structures, asphalt roads, paved surfaces, and glass façades contribute to greater heat retention, thereby intensifying the Urban Heat Island (UHI) effect within the study area. In contrast, areas with remaining vegetation and open spaces exhibit comparatively lower surface temperatures, highlighting the critical role of green infrastructure in regulating the urban microclimate.

The LULC analysis therefore not only demonstrates the physical expansion of urban development but also establishes a direct relationship between land transformation and environmental degradation. The observed decline in natural surfaces emphasizes the urgent need for sustainable planning interventions focused on ecological conservation, urban greening, and climate-responsive development strategies to mitigate the adverse impacts of rapid urban growth in Sholinganallur.

planning green infrastructure strategies for urban heat island mitigation in sholinganallur, Chennai



3.2 Land Surface Temperature and Hotspot Analysis

The analysis of Land Surface Temperature (LST) forms a critical component of this study as it helps in understanding the spatial distribution of thermal variation within the study area and identifying regions vulnerable to Urban Heat Island (UHI) effects. In rapidly urbanizing regions such as Sholinganallur, increasing built-up density, reduction in vegetation cover, and extensive use of impervious construction materials have significantly altered the urban microclimate. Therefore, LST analysis was carried out to examine the intensity and concentration of surface temperatures across different wards of the study area.

The Land Surface Temperature map was generated using Landsat thermal satellite imagery through Remote Sensing and GIS techniques. Thermal infrared bands obtained from satellite data were processed and converted into temperature values to understand the spatial thermal characteristics of the region. The derived temperature values were classified into different ranges and represented through a gradient color scheme to visually interpret the variation in surface temperature. Lower temperature zones are represented using green shades, while moderate and high-temperature zones are indicated using yellow, orange, and red shades respectively.

The LST map reveals considerable spatial variation in temperature distribution across the study area. Areas characterized by dense built-up development exhibit significantly higher surface temperatures compared to surrounding regions. High-temperature zones are primarily concentrated along the urbanized corridors containing residential apartments, IT parks, commercial establishments, institutional campuses, transportation infrastructure, and paved surfaces. The extensive presence of impervious materials such as asphalt roads, concrete pavements, rooftops, and parking areas contributes to greater heat absorption during the daytime and slow heat release during nighttime. This process results in elevated surface temperatures and intensifies the Urban Heat Island effect within the urban environment.

In contrast, relatively lower temperature zones are observed in areas containing vegetation cover, wetlands, open spaces, and water bodies. These regions function as natural cooling zones due to evapotranspiration, moisture retention, and shading effects. The southern and peripheral portions of the study area, where fragments of green cover and ecological features still exist, exhibit comparatively lower temperature values. The analysis therefore establishes a strong relationship between land-use characteristics and thermal behavior within the urban landscape.

To further understand the concentration and severity of heat-affected regions, hotspot analysis was carried out using statistical classification techniques. The hotspot identification process was based on the mean (μ) and standard deviation (σ) of the Land Surface Temperature values derived from the satellite imagery. Areas recording temperature values greater than the threshold value of Mean + Standard Deviation were classified as hotspot zones. These areas represent regions experiencing significantly higher temperatures compared to the average thermal condition of the study area.

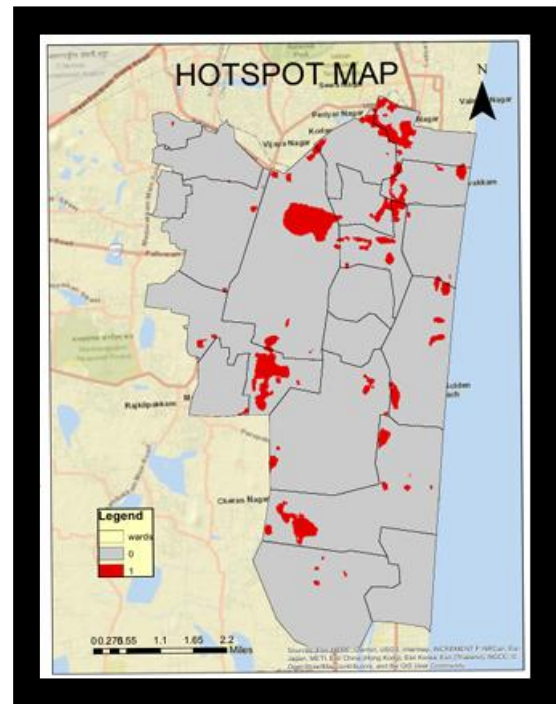
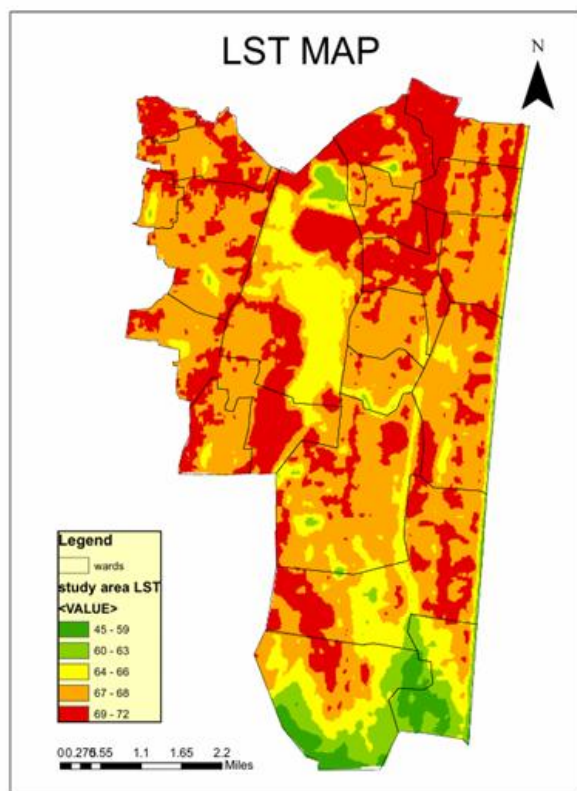
The hotspot map clearly identifies concentrated pockets of extreme surface temperature distributed across densely urbanized wards. Most hotspot zones correspond to areas with high built-up intensity, low vegetation cover, limited open spaces, and continuous infrastructure development. These thermal hotspots indicate environmentally stressed urban pockets where heat accumulation is considerably higher due to anthropogenic activities and altered land-cover patterns. The analysis demonstrates that rapid urbanization and uncontrolled land transformation have significantly contributed to localized thermal stress within the study area.

The identified hotspot regions were further analyzed at the ward level to prioritize areas requiring detailed intervention. Based on hotspot concentration, selected wards were identified for proposal formulation and planning-based mitigation strategies. These wards exhibit characteristics such as high Land Surface Temperature values, dense urban morphology, increasing impervious surface coverage, and declining ecological features. The selected wards are primarily located along the IT corridor and surrounding urban growth zones, where development pressure is highest.

The ward-level selection provides a focused framework for implementing climate-responsive planning interventions. Since the selected wards represent the most heat-vulnerable regions within the study area, targeted mitigation measures can be proposed to improve thermal comfort and environmental sustainability. The analysis supports the introduction of green infrastructure strategies such as roadside plantation, urban green buffers, shaded pedestrian pathways, green roofs, vertical greening systems, permeable pavements, and restoration of ecological corridors. These interventions can help reduce surface temperatures, enhance evapotranspiration, improve urban ventilation, and strengthen climate resilience.

The integration of LST mapping, hotspot analysis, and ward prioritization establishes a comprehensive spatial methodology for Urban Heat Island assessment. This analytical approach not only identifies the thermal behavior of the urban environment but also provides a scientific basis for developing sustainable planning proposals. The findings highlight the direct relationship between urban growth patterns and temperature intensification, emphasizing the need for environmentally sensitive urban planning practices in rapidly urbanizing regions such as Sholinganallur.

Overall, the analysis demonstrates that Urban Heat Island intensity is strongly influenced by land-use transformation and built-up expansion. The reduction of vegetation and natural surfaces has weakened the ecological balance of the area, leading to increased thermal stress. Therefore, integrating green infrastructure and climate-responsive planning measures into future urban development becomes essential for mitigating heat accumulation and ensuring sustainable urban growth within the study area.



Based on the hotspot concentration and Land Surface Temperature (LST) analysis, specific wards within Sholinganallur were selected for detailed study and proposal formulation. The selected wards include Neelankarai, Kottivakkam, Palavakkam, Pallikaranai, Sholinganallur, and Thoraipakkam. These wards were identified because they exhibit high thermal intensity, dense built-up development, rapid urban transformation, and declining ecological characteristics, making them highly vulnerable to Urban Heat Island (UHI) effects.

Among the selected wards, Sholinganallur and Thoraipakkam represent major urban growth centers along the Old Mahabalipuram Road IT Corridor. These areas have experienced extensive residential and commercial expansion due to the concentration of IT parks, office complexes, gated communities, institutional campuses, and transportation infrastructure. The rapid increase in impervious surfaces such as asphalt roads, concrete pavements, and high-rise buildings has significantly increased heat absorption and surface temperature levels. Limited vegetation cover and inadequate shaded public spaces further intensify the thermal discomfort within these wards.

Neelankarai, Kottivakkam, and Palavakkam, located along the coastal stretch, also exhibit increasing urban density and land-use transformation. Earlier characterized by open spaces, vegetation, and low-density settlements, these wards have gradually transformed into compact residential and mixed-use urban zones. Continuous infrastructure development and reduction in natural surfaces have contributed to rising Land Surface Temperature values. Although their coastal proximity provides some climatic moderation, the increasing

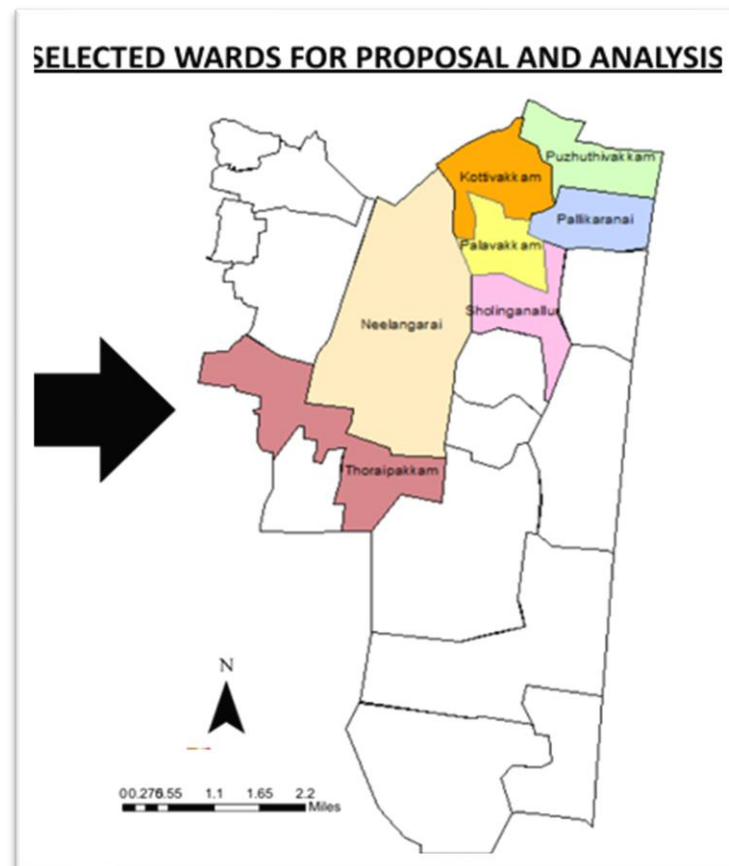
built-up concentration and reduction of tree cover have weakened the natural cooling effect.

The ward of Pallikaranai holds particular environmental significance because of its proximity to the ecologically sensitive Pallikaranai Marsh wetland ecosystem. Historically, the marshland functioned as a natural cooling zone, flood retention basin, and ecological buffer for the surrounding urban areas. However, rapid urban encroachment, road development, and real estate expansion around the marsh edges have fragmented the wetland ecosystem and reduced its climatic regulation capacity. As a result, surrounding areas within the Pallikaranai ward are increasingly experiencing thermal stress and environmental degradation.

The hotspot analysis indicates that these selected wards contain clusters of significantly high surface temperatures compared to other parts of the study area. The concentration of thermal hotspots corresponds strongly with areas of dense built-up land, high Normalized Difference Built-up Index (NDBI) values, and low vegetation presence. Simultaneously, areas with remaining green cover or ecological patches exhibit comparatively lower temperatures, reinforcing the importance of vegetation in regulating the urban microclimate.

These wards were therefore prioritized for detailed analysis because they represent the most heat-vulnerable urban environments within the study area. The selection helps establish a focused framework for introducing targeted Urban Heat Island mitigation measures. Proposed interventions for these wards include urban green corridors, roadside plantation, shaded pedestrian pathways, green roofs, vertical greening systems, permeable paving materials, and restoration of ecological buffers near the marshland areas. Such strategies are intended to reduce surface temperatures, improve urban thermal comfort, enhance environmental quality, and strengthen climate resilience.

The ward-level analysis also supports practical urban planning implementation, as municipal governance and infrastructure interventions are generally administered at the ward scale. By identifying and analyzing these priority wards, the study provides a localized and scientifically informed approach toward sustainable urban development and climate-responsive planning within Sholinganallur and its surrounding urban regions.



3.3 NDVI Analysis

The Normalized Difference Vegetation Index (NDVI) analysis was carried out to assess the spatial distribution and density of vegetation cover within the study area of Sholinganallur. NDVI is an important remote sensing indicator used to evaluate the presence, health, and intensity of vegetation based on the reflectance characteristics of satellite imagery. The analysis plays a crucial role in understanding the relationship between vegetation cover and Urban Heat Island (UHI) intensity, as green surfaces significantly influence urban microclimatic conditions through shading and evapotranspiration processes.

The NDVI map reveals that the study area is predominantly characterized by built-up surfaces with only fragmented and discontinuous vegetation cover. Large portions of the region exhibit low NDVI values, indicating sparse vegetation and extensive urban development. The rapid expansion of residential, commercial, and institutional infrastructure along the Old Mahabalipuram Road corridor has resulted in the replacement of natural land surfaces with impervious materials such as concrete, asphalt, and paved

surfaces. This transformation has significantly reduced the overall green cover within the urban landscape.

The analysis further indicates that high NDVI zones are limited in extent and occur only in isolated patches rather than forming a continuous ecological network. Areas exhibiting relatively higher vegetation values are primarily concentrated along water bodies, marsh edges, open lands, and scattered institutional campuses containing tree cover. Certain patches near the ecologically sensitive Pallikaranai Marsh region still retain moderate vegetation density, which contributes to localized cooling effects and environmental buffering. However, these green areas remain fragmented due to increasing urban encroachment and infrastructure expansion.

Most wards within the study area are dominated by dense built-up development with minimal integration of urban green spaces. The dominance of impervious surfaces has interrupted the continuity of natural ecological systems and weakened the environmental resilience of the area. Vegetation cover is largely restricted to roadside plantations, isolated open spaces, small vacant plots, and fragmented green patches, rather than forming interconnected green corridors capable of effectively regulating the urban microclimate.

The fragmentation of vegetation cover has significant environmental implications. Continuous green networks are essential for maintaining ecological balance, reducing heat accumulation, supporting biodiversity, improving air quality, and enhancing thermal comfort within urban areas. However, the NDVI analysis demonstrates that the existing vegetation pattern within the study area lacks continuity and spatial connectivity. As a result, the cooling effect generated by green spaces remains localized and insufficient to offset the increasing thermal stress caused by dense urbanization.

The limited presence of vegetation directly contributes to the intensification of the Urban Heat Island effect. Areas with low NDVI values generally correspond to zones exhibiting high Land Surface Temperature (LST) values, establishing a strong inverse relationship between vegetation cover and surface temperature. Built-up zones absorb and retain greater amounts of solar radiation, whereas vegetated surfaces help reduce temperature through evapotranspiration and shading. Therefore, the reduction of green cover within the study area has significantly increased urban heat intensity and reduced thermal comfort levels.

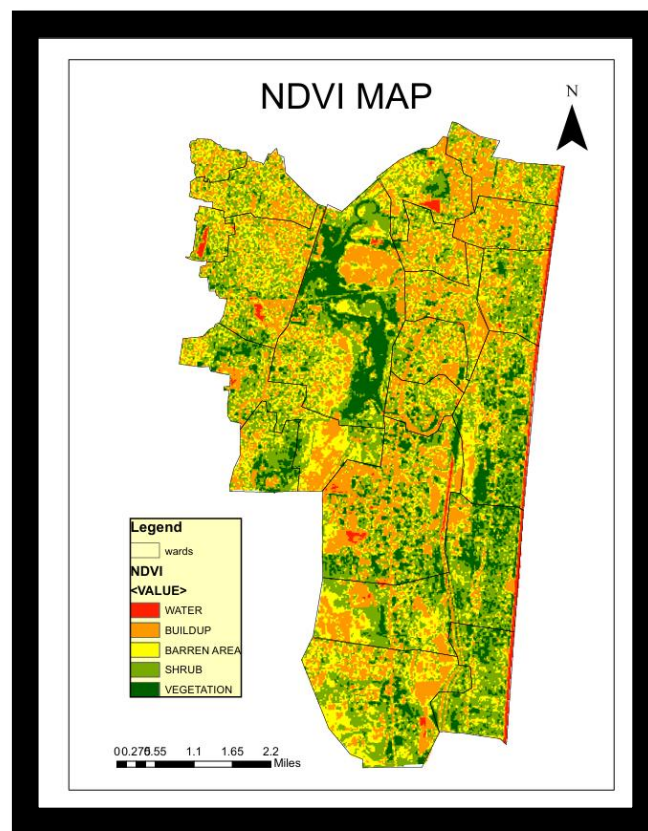
The analysis also highlights the gradual loss of ecological resilience within the urban environment. Ecological resilience refers to the capacity of natural systems to absorb environmental stress and maintain functional stability. The continuous conversion of vegetation and open spaces into built-up land has weakened the ability of the urban ecosystem to naturally regulate temperature, manage stormwater, and support environmental sustainability. This decline in ecological performance increases the vulnerability of the area to heat stress, flooding, and climate-related risks.

The findings of the NDVI analysis emphasize the urgent need for green infrastructure-based planning interventions within the study area. The fragmented nature of vegetation cover indicates the necessity to establish interconnected urban green networks capable of improving thermal regulation and environmental performance. Strategies such as urban

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green corridors, roadside plantation, avenue tree systems, ecological buffer zones, vertical greening, green roofs, pocket parks, and wetland-edge restoration can help restore ecological continuity and reduce Urban Heat Island intensity.

Overall, the NDVI analysis clearly demonstrates that rapid urbanization and uncontrolled built-up expansion have significantly reduced vegetation cover within Sholinganallur. The predominance of fragmented green patches and discontinuous ecological systems has contributed to increasing surface temperatures and declining environmental quality. Therefore, strengthening and reconnecting urban green infrastructure becomes essential for enhancing ecological resilience, improving thermal comfort, and promoting sustainable urban development within the study area.



3.4 NDBI Analysis

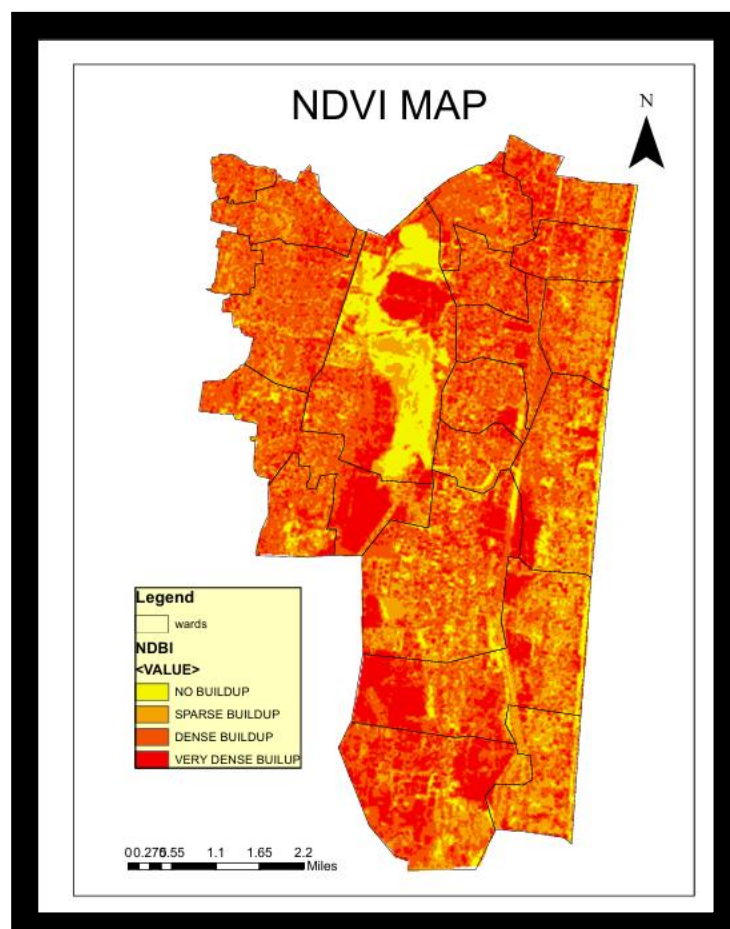
The Normalized Difference Built-up Index (NDBI) analysis was carried out to identify the spatial distribution and intensity of built-up areas within Sholinganallur. The analysis reveals a strong dominance of dense and very dense built-up surfaces across the majority of wards, reflecting the rapid urbanization and infrastructure growth along the Old Mahabalipuram

Road IT Corridor. Large portions of the study area are occupied by residential developments, IT parks, commercial establishments, institutional campuses, transportation networks, and paved surfaces, resulting in extensive impervious surface coverage.

Wards such as Sholinganallur, Thoraipakkam, Pallikaranai, Palavakkam, Neelankarai, and Kottivakkam exhibit particularly high NDBI values due to continuous construction activities and increasing urban density. These areas are characterized by compact built-up structures, concrete roads, asphalt pavements, and limited open spaces, which contribute significantly to heat absorption and retention. As a result, areas with high NDBI values correspond closely with zones of elevated Land Surface Temperature (LST), indicating the strong relationship between built-up intensity and Urban Heat Island (UHI) formation.

The analysis also shows that sparse and no built-up areas are highly limited and fragmented within the study area. Open lands, vegetation patches, and undeveloped spaces occur only in isolated and discontinuous pockets, mainly near water bodies and marsh edges. The lack of continuous open and green spaces has reduced the ecological balance and weakened the natural cooling capacity of the urban environment.

The predominance of dense built-up surfaces and the reduction of permeable land have intensified thermal stress within the study area. Impervious materials absorb large amounts of solar radiation during the day and release heat slowly, leading to increased surface temperatures and reduced thermal comfort. The findings therefore highlight the need for climate-responsive planning interventions such as green infrastructure, urban greening,



permeable pavements, and shaded public spaces to reduce Urban Heat Island intensity and improve environmental sustainability within the selected wards.

3.5 NDWI Analysis

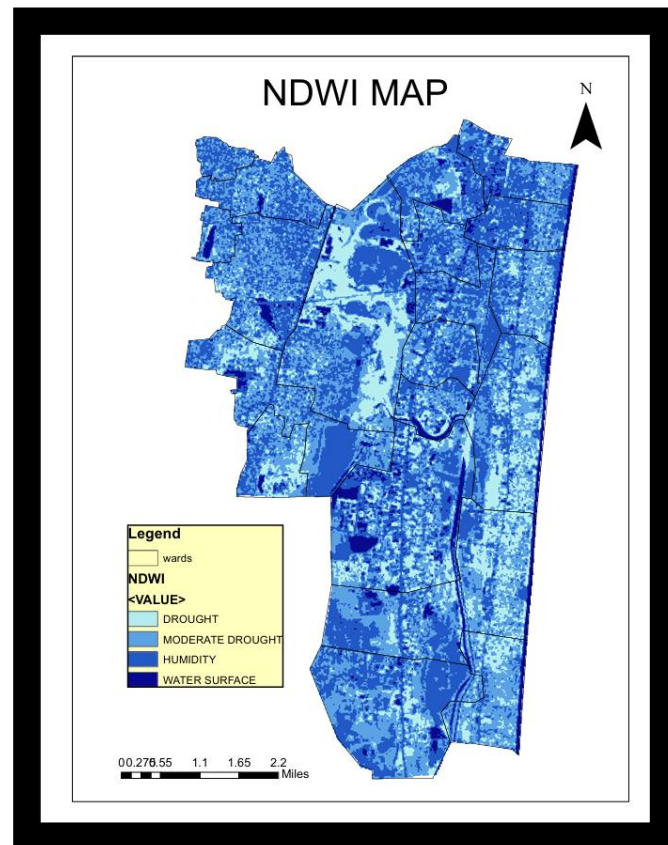
The Normalized Difference Water Index (NDWI) analysis was carried out to assess the spatial distribution of moisture content and surface water presence within Sholinganallur. NDWI is an important remote sensing indicator used to identify water bodies, wet surfaces, and moisture-rich areas, which play a significant role in regulating urban microclimate and environmental balance.

The analysis reveals that the majority of wards within the study area are characterized by low NDWI values, indicating predominantly dry surface conditions and limited moisture retention. Rapid urbanization and extensive built-up development along the Old Mahabalipuram Road corridor have replaced natural and permeable surfaces with impervious materials such as concrete and asphalt. This transformation has reduced groundwater infiltration, surface moisture retention, and natural drainage capacity across the region.

Areas with comparatively high NDWI values are mainly concentrated around the ecologically sensitive Pallikaranai Marsh and nearby water bodies. These zones retain higher moisture content due to the presence of wetlands, marsh vegetation, and low-lying terrain. The marshland continues to function as an important hydrological and ecological buffer by supporting water retention and localized cooling effects within the urban environment.

However, the analysis also indicates that areas surrounding the marsh are highly vulnerable to flooding and waterlogging, particularly during intense rainfall events. Rapid urban encroachment, blockage of natural drainage channels, and increasing impervious surface coverage have disrupted the natural hydrological system of the region. As a result, stormwater runoff accumulates in low-lying areas near the marsh, leading to frequent waterlogging conditions.

The NDWI analysis highlights the critical relationship between urban development, moisture distribution, and environmental vulnerability within the study area. The predominance of dry conditions across most wards contributes to increasing surface temperatures and Urban Heat Island intensity, while moisture-rich zones near the marsh remain environmentally sensitive and flood-prone. The findings emphasize the need for sustainable stormwater management, wetland conservation, permeable surfaces, and blue-green infrastructure strategies to improve hydrological balance and climate resilience within Sholinganallur.

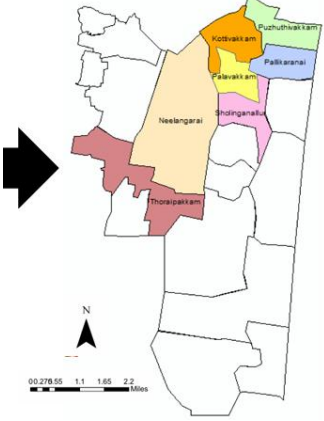
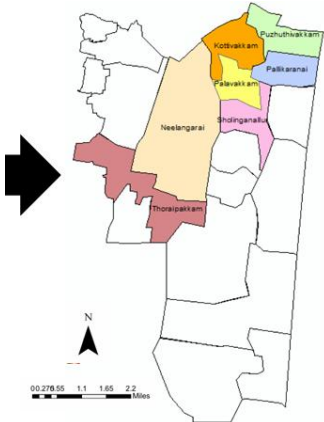


CHAPTER 4

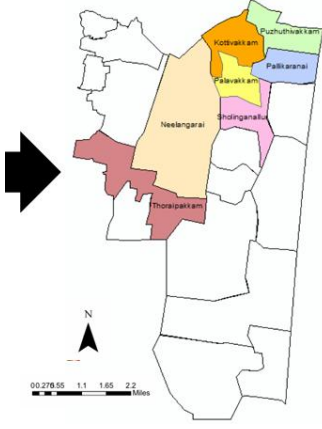
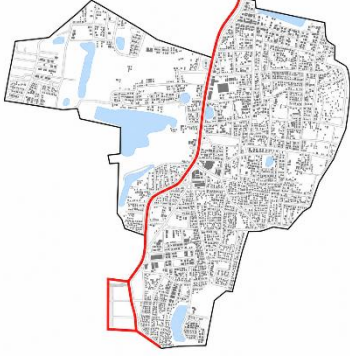
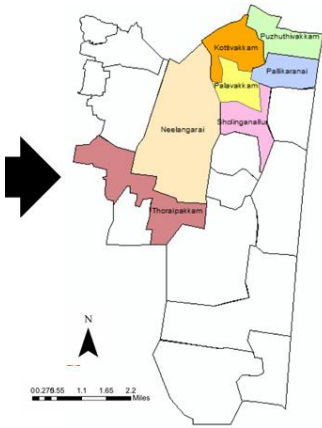
EXISTING CONDITION AND ISSUES

A map of the Sholinganallur area showing various wards. The wards are color-coded: Thoraipakkam (red), Neelgarai (orange), Sholinganallur (pink), Pallikarai (blue), and Puzhuvakkam (green). A north arrow and a scale bar (0.27 to 2.2 miles) are included.	A map of the Pallikarai Marsh area showing water bodies and land use. The map is color-coded to represent different levels of water presence: light blue for DROUGHT, medium blue for MODERATE DROUGHT, dark blue for HUMIDITY, and very dark blue for WATER SURFACE. A north arrow and a scale bar (0.27 to 2.2 miles) are included.	Pallikarai Marsh is a highly degraded yet ecologically critical wetland, facing intense pressure from encroachment, pollution, and urbanization, leading to reduced flood resilience
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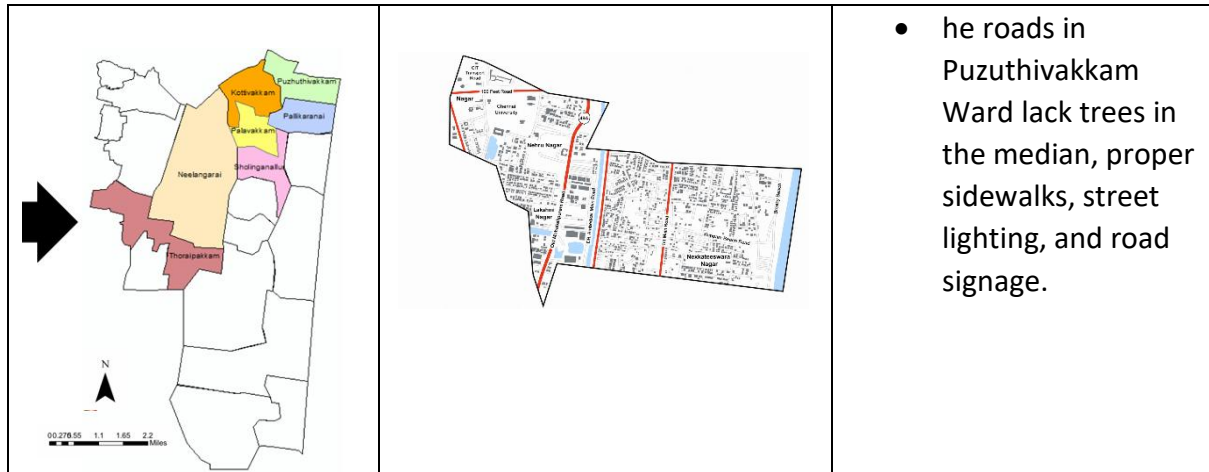
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		and environmental imbalance. The road across Pallikaranai Marsh acts as both a physical and ecological barrier, contributing to hydrological disruption, increased flood risk, and localized heat buildup.
		Perungudi Lake is under severe environmental stress due to waste dumping, pollution, and encroachment, resulting in reduced water quality, diminished flood buffering capacity, and loss of its natural cooling function.
		The clustering of high-rise buildings without adequate green infrastructure and ventilation corridors has intensified localized thermal pockets in Ward 186. This particular road has all highrise building

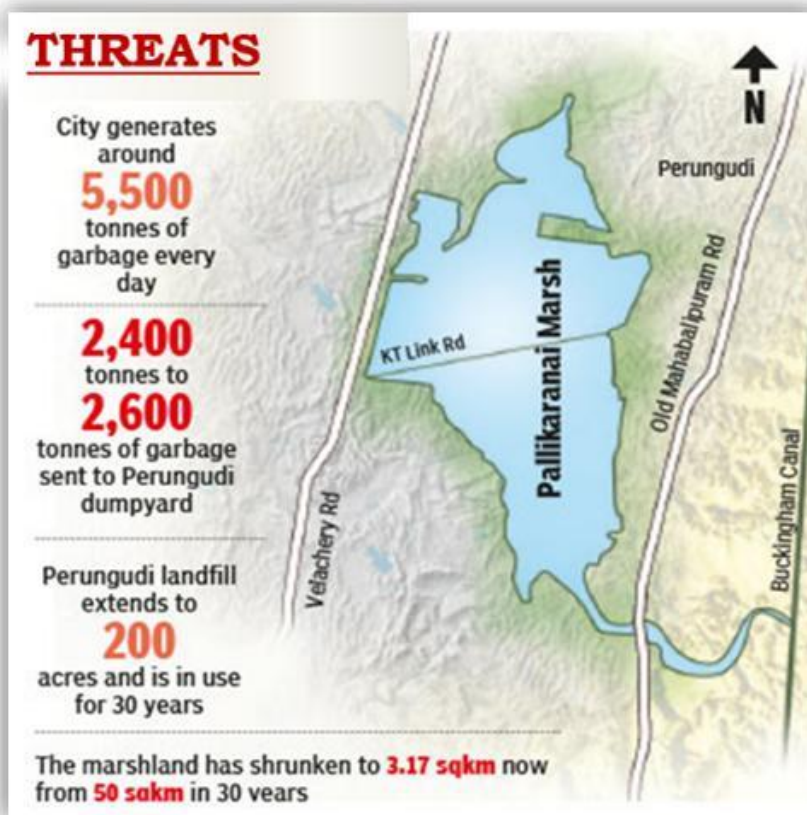
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		along the road stretch\
		- Coastal Humidity Interaction The complex thermodynamics of coastal cities like Chennai pose challenges, where urban structures, building density, and heat-absorbing capacity of surfaces largely dictate the severity of UHI. - The Pallikarai Eri (lake) is severely encroached upon, polluted with untreated sewage and solid waste dumping, and lacks proper maintenance, threatening the local ecosystem and the health of surrounding residents.
		The Cooum Canal in this area is severely polluted due to sewage discharge and illegal garbage dumping, posing serious health and safety risks to residents.

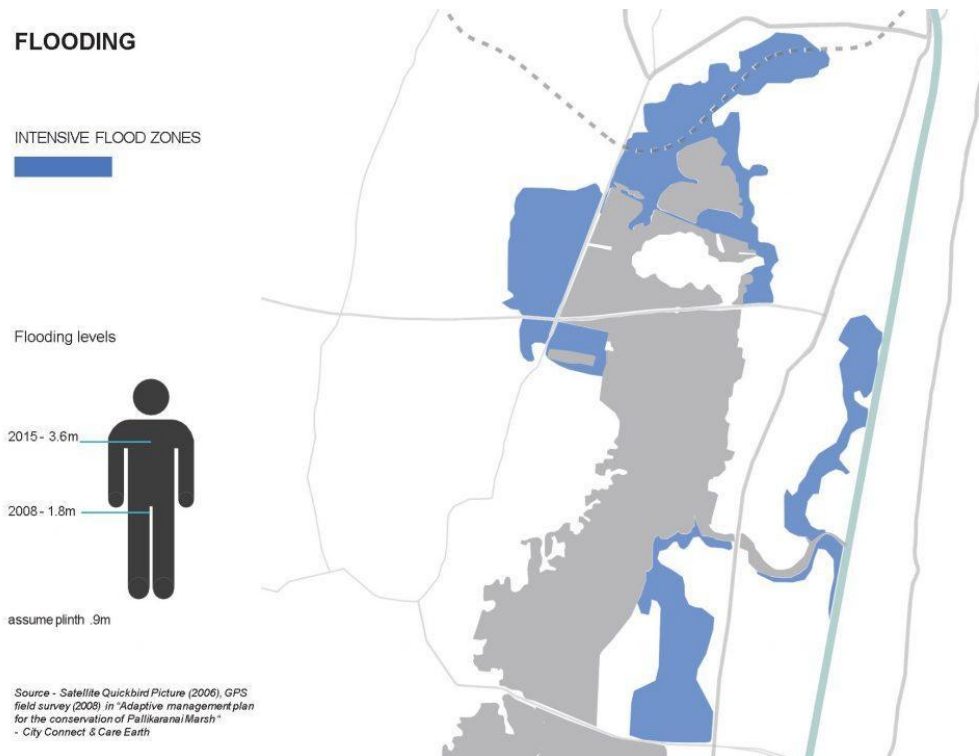
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Pallikaranai Marsh Degradation



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The Pallikaralai Marsh, one of the last remaining natural wetlands in Chennai, is currently experiencing severe ecological degradation due to rapid urbanization, encroachment, and unregulated developmental activities. Historically, the marsh functioned as a major flood absorption basin, biodiversity hotspot, groundwater recharge zone, and climatic regulator for the southern part of Chennai. However, large portions of the wetland have been converted for infrastructure development, roads, institutional uses, dumping yards, and urban expansion associated with the growth of the IT corridor along OMR.

Continuous encroachment and land reclamation have significantly reduced the natural extent and hydrological functioning of the marsh. In addition, pollution from untreated sewage discharge, solid waste dumping, and construction debris has severely affected water quality and ecological health. The degradation of the marsh has weakened its natural flood resilience capacity, increasing the vulnerability of surrounding urban areas to waterlogging and urban flooding during heavy rainfall events.

The loss of wetland vegetation and open water surfaces has also reduced the ecological cooling effect traditionally provided by the marsh ecosystem. As a result, surrounding urban areas are increasingly experiencing higher temperatures, reduced humidity regulation, and environmental imbalance. The deterioration of the Pallikaralai Marsh therefore represents both an ecological and urban climate challenge within the study area.

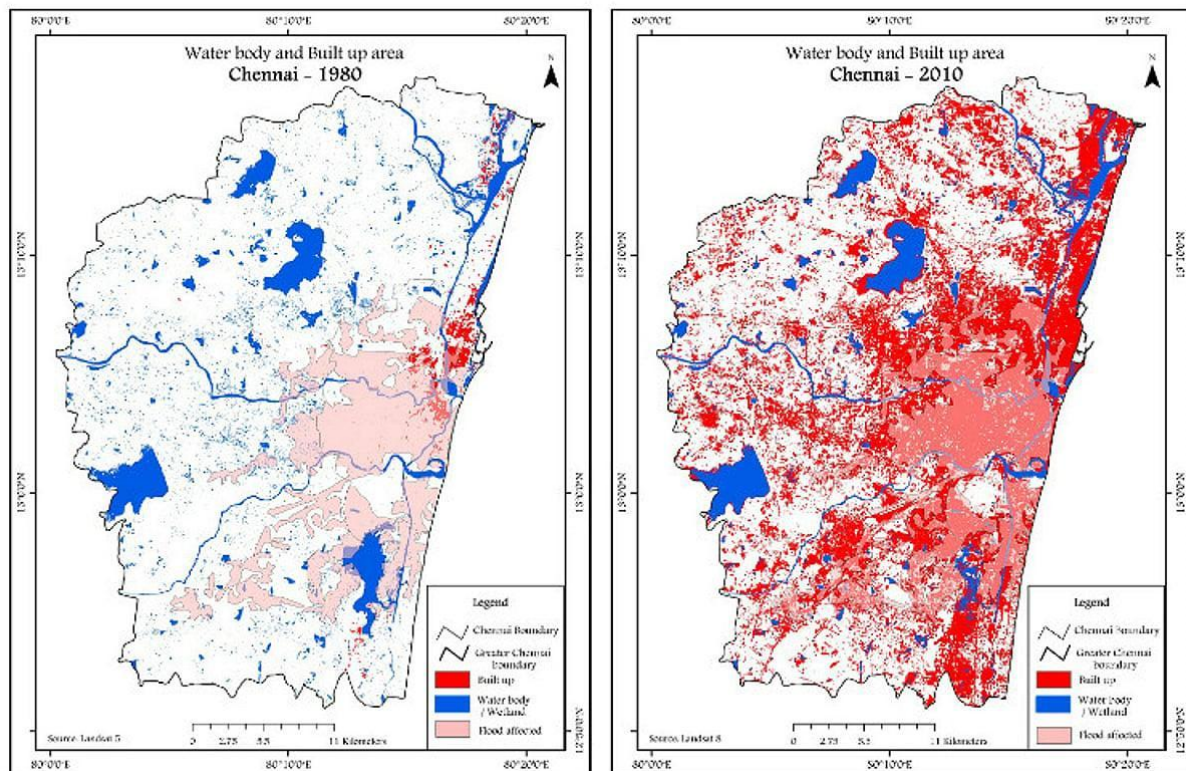
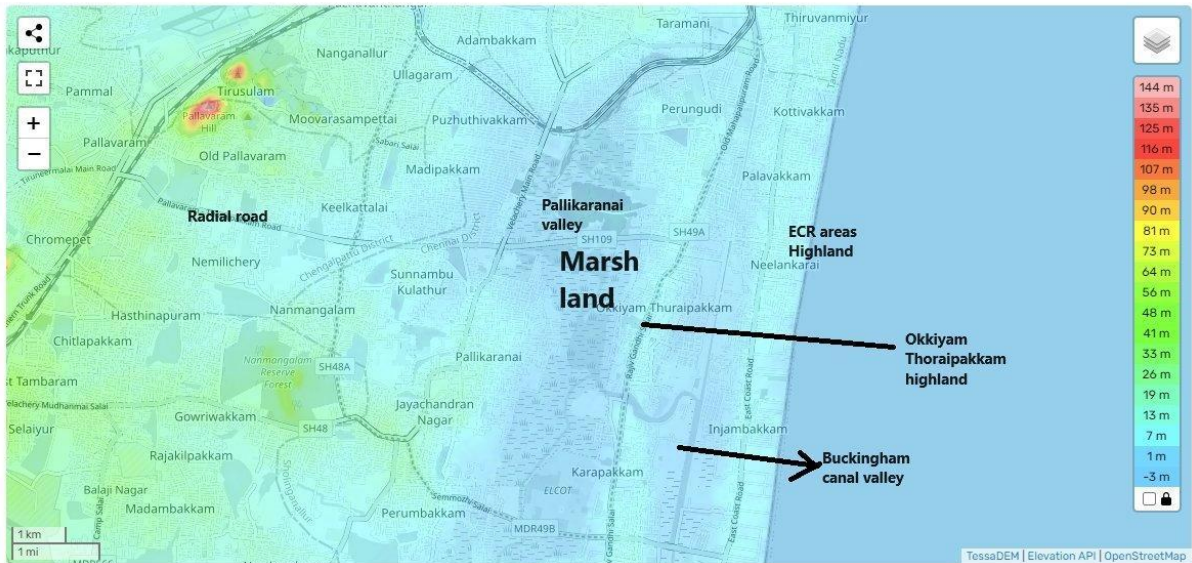
Road Barrier Across Pallikaranai Marsh



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Pallikaranai Marsh topographic map

Click on the map to display elevation.



The major road infrastructure passing through the Pallikaranai Marsh acts as a significant physical and ecological barrier within the wetland system. While the road improves urban connectivity and transportation efficiency, it has fragmented the marsh ecosystem and disrupted the natural flow of water across the wetland landscape.

The elevated road structure and associated embankments obstruct natural drainage channels and hydrological connectivity, leading to uneven water distribution and localized water stagnation during monsoon periods. This disruption contributes to increased flood risk in adjacent urban areas and reduces the efficiency of the marsh as a natural flood mitigation system.

Furthermore, the extensive paved surfaces associated with the roadway absorb and retain heat, creating localized heat buildup within the surrounding environment. Vehicular emissions, traffic congestion, and continuous anthropogenic activity further intensify thermal stress in the area. The road therefore not only affects ecological continuity but also contributes to Urban Heat Island formation and environmental degradation.

Environmental Stress on Perungudi Lake



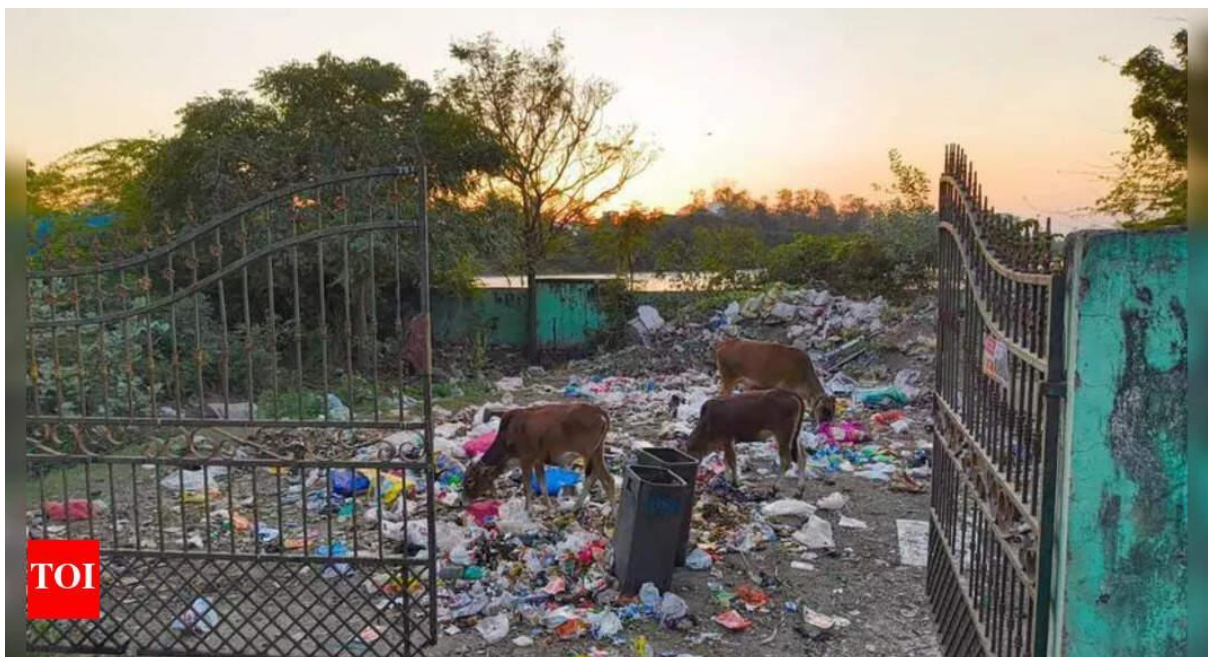
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Figure.No.3 Korattur Lake Encroachments



Figure.No.4 Perungudi Lake Encroachments





Perungudi Lake is currently under severe environmental stress due to rapid urbanization, unregulated waste disposal, and encroachment activities. The lake, which once functioned as an important hydrological and ecological asset within the region, has gradually deteriorated due to continuous dumping of solid waste, sewage inflow, and surrounding developmental pressures.

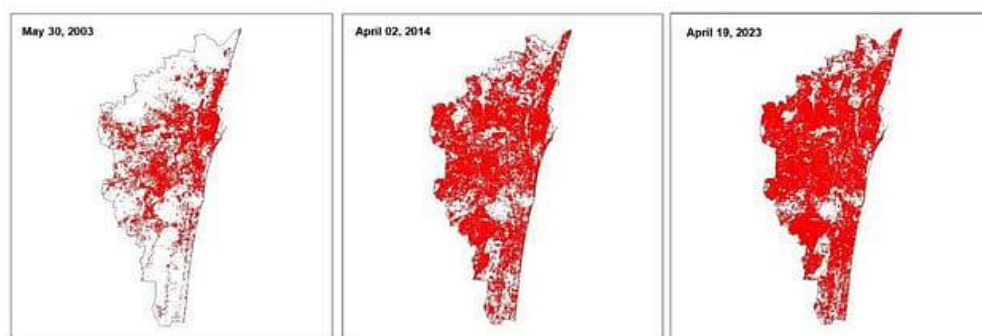
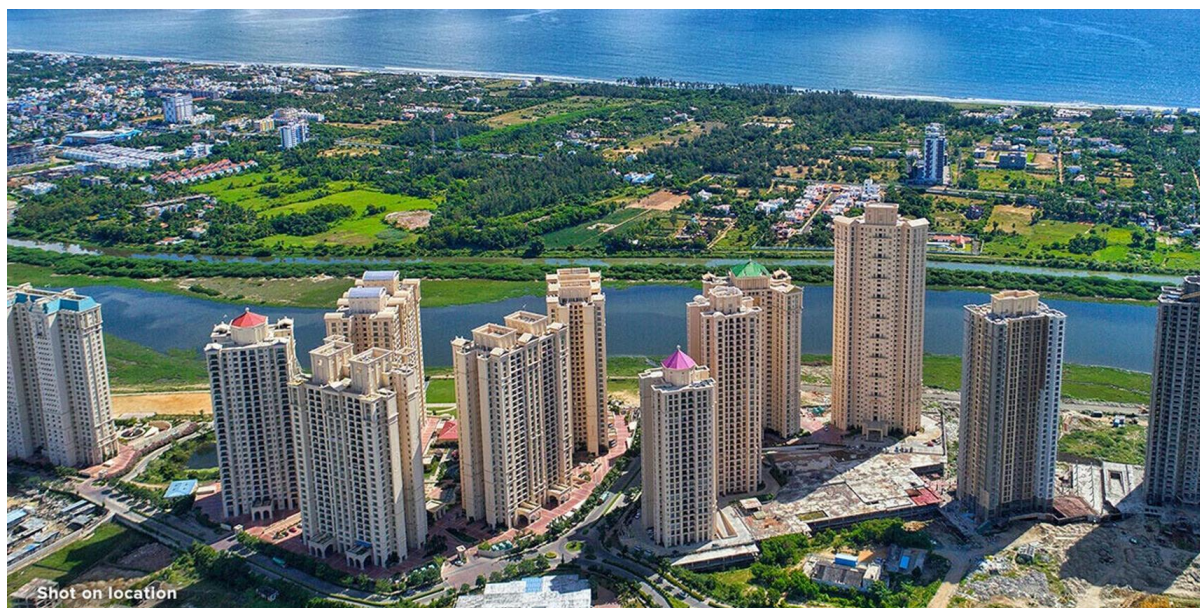
Pollution has significantly reduced the water quality of the lake, affecting aquatic ecosystems and limiting its ecological functionality. Encroachments along the lake edges have reduced the effective water spread area and disrupted natural drainage systems. As a result, the lake's capacity to store excess rainwater and buffer flood conditions has diminished considerably.

The deterioration of Perungudi Lake has also reduced its natural cooling function within the urban environment. Water bodies generally help moderate surrounding temperatures through evaporation and moisture regulation. However, due to pollution, shrinking water extent, and environmental degradation, the lake's ability to contribute to local thermal regulation has weakened, thereby intensifying heat stress in nearby urban areas.

High-Rise Clustering and Thermal Pockets in Ward 186



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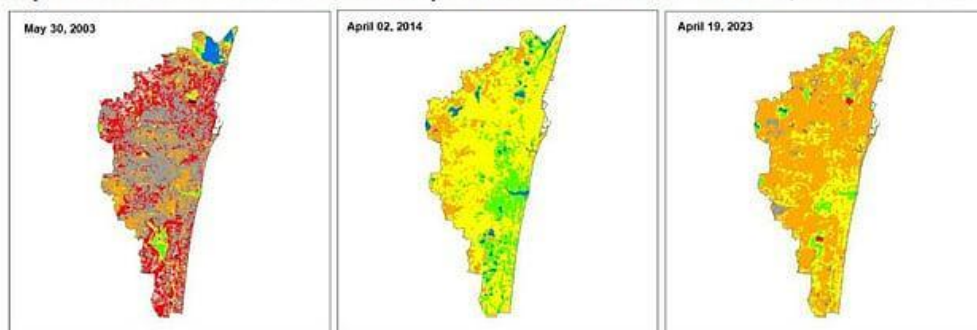


Legend
 City Boundary Built-up

Note: Urban expansion for each year – 2003, 2014, and 2023. The red colour depicts the urban growth in the city.

Source: CSE analysis of Landsat 7 and Landsat 8 satellite images from United States Geological Survey (USGS) Earth Explorer.

Map 2: Variation in Land Surface Temperature over Chennai for 2003, 2014 and 2023



The maximum Land surface temperature reached 48.22 °C on May 30, 2003. The city outskirts in the southern and northern region records temperature above 38 °C. On April 02, 2014, the densely built-up area near Ambattur in the Northwest area records LST above 36 °C. On April 19, 2023, the city maximum land surface temperature observed at 41.6 °C. The highest LST ranges between 38 °C - 40 °C was recorded at the Chennai corporation waste disposal site in the southern part of the city and Chennai corporation dump yard in northeast region of the city.

Land Surface Temperature (°C)
 <27 30.1 - 33 36.1 - 38 40.1 - 42
 27.1 - 30 33.1 - 36 38.1 - 40 >42

Note: Summer heat wave months (April - May) are chosen to analyse the Land Surface Temperature (LST). The respective dates of acquisition of the images are May 30, 2003, April 02, 2014, and April 19, 2023.

Source: CSE analysis of Landsat 7 and Landsat 8 satellite images from United States Geological Survey (USGS) Earth Explorer.

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The clustering of high-rise commercial and residential buildings along major road stretches in Ward 186 has created dense urban canyons with limited ventilation and insufficient green infrastructure. Continuous stretches of tall buildings on both sides of the road obstruct natural wind movement and reduce airflow circulation, leading to heat accumulation within the built environment.

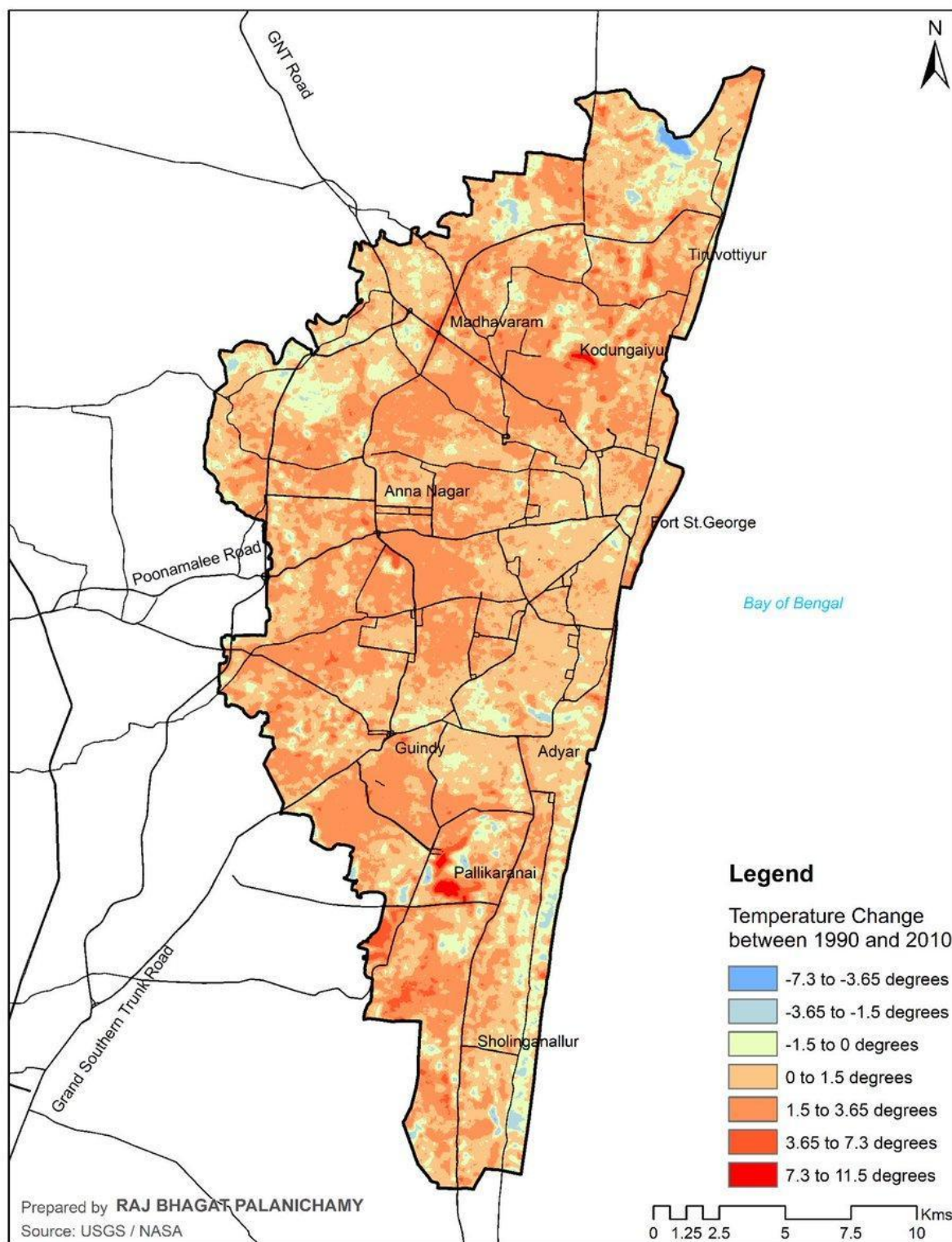
The absence of adequate tree cover, shaded open spaces, and green buffers further intensifies localized thermal pockets in the area. Large building surfaces, glass facades, concrete pavements, and asphalt roads absorb and radiate heat throughout the day, increasing ambient temperatures and reducing outdoor thermal comfort.

In addition, high traffic volume, air-conditioning systems, and concentrated human activities contribute to anthropogenic heat generation within the corridor. The cumulative effect of dense vertical development and limited climatic planning has therefore intensified Urban Heat Island conditions along this road stretch.

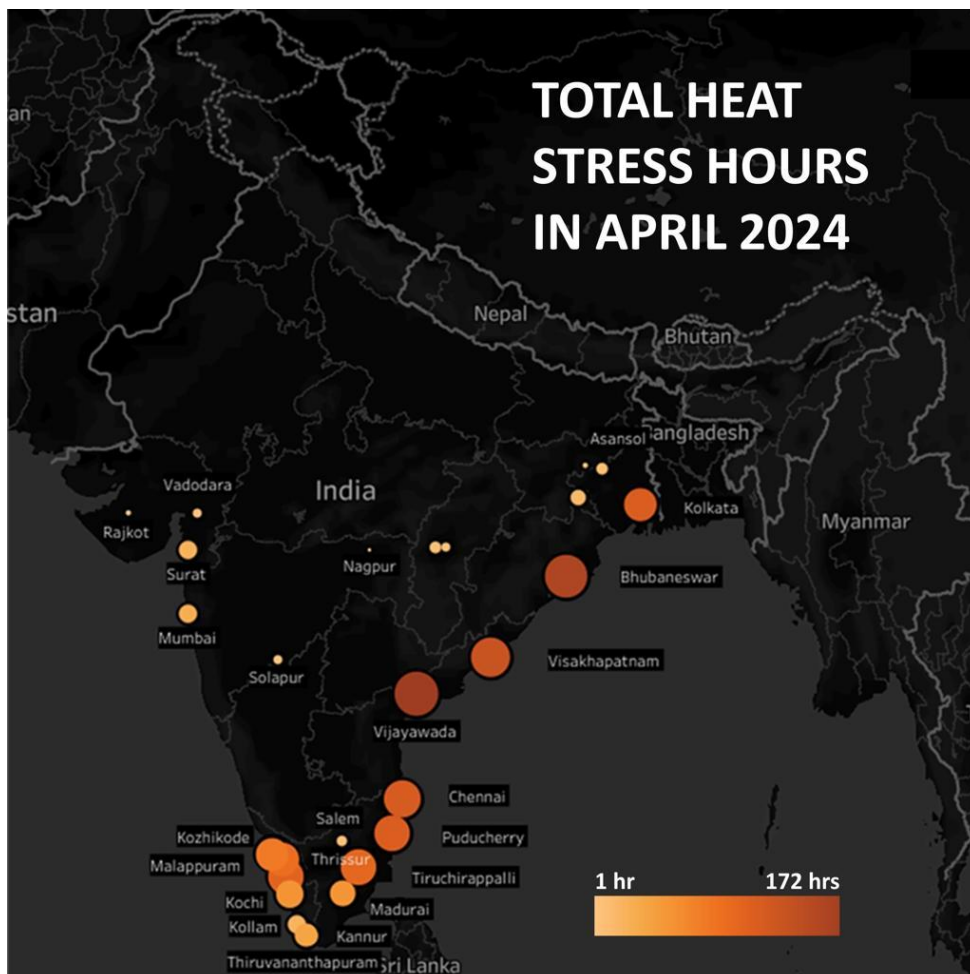
Coastal Humidity Interaction and Urban Heat Dynamics



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Chennai



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Chennai, being a coastal metropolitan city, experiences complex interactions between humidity, temperature, urban density, and sea breeze circulation. In naturally balanced coastal environments, sea breezes help moderate urban temperatures by providing cooling airflow from the coast toward inland regions. However, rapid urbanization and dense built-up development along the OMR corridor have altered local microclimatic conditions.

The concentration of heat-absorbing materials such as concrete, asphalt, and glass surfaces increases heat retention, while high building density obstructs natural ventilation pathways. Combined with high atmospheric humidity levels, these conditions reduce the effectiveness of evaporative cooling and increase perceived thermal discomfort for residents.

As a result, even though Chennai benefits from coastal proximity, urban morphology and infrastructural density largely dictate the severity of Urban Heat Island effects within inland IT corridor regions such as Sholinganallur.

Pollution and Encroachment of Pallikaranai Eri



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Chennai





The Pallikaranai Eri (lake) is facing severe environmental degradation due to uncontrolled encroachment, untreated sewage inflow, and continuous dumping of solid waste. Urban expansion and informal developments around the lake have reduced its natural extent and disrupted its ecological functioning.

Untreated domestic wastewater entering the lake has deteriorated water quality, leading to foul odor, water contamination, and ecological imbalance. Simultaneously, indiscriminate dumping of municipal solid waste and construction debris has affected both the visual and environmental quality of the lake surroundings.

The lack of regular maintenance, restoration measures, and effective environmental management has further accelerated the deterioration of the ecosystem. The degraded condition of the lake not only threatens biodiversity but also creates serious public health concerns for nearby residents through water contamination, mosquito breeding, and poor sanitation conditions.

Pollution of the Cooum Canal





The Cooum Canal within the study area is severely polluted due to continuous sewage discharge, illegal garbage dumping, and inadequate waste management practices. The canal, which historically functioned as an important drainage and water conveyance system, has gradually transformed into a heavily contaminated urban water channel.

Untreated wastewater from residential and commercial areas enters the canal directly, leading to poor water quality and foul environmental conditions. Solid waste accumulation obstructs water flow and reduces the drainage efficiency of the canal, increasing the risk of localized flooding during heavy rainfall.

The polluted condition of the canal poses significant environmental, health, and safety risks to surrounding communities. Stagnant polluted water contributes to mosquito breeding, unpleasant odor, and spread of waterborne diseases. Additionally, the canal has lost its ecological and climatic function as a cooling and hydrological corridor within the urban landscape.

Inadequate Streetscape Infrastructure in Puzhuthivakkam Ward





The roads within Puzhuthivakkam Ward lack essential streetscape and pedestrian infrastructure required for safe, comfortable, and climate-responsive urban mobility. Many road stretches have limited or no median plantation, resulting in the absence of shading and reduced environmental quality along the streets.

The lack of proper sidewalks forces pedestrians to share road space with vehicles, reducing walkability and increasing safety risks. Inadequate street lighting and insufficient road signage further affect accessibility, mobility, and overall user experience, especially during nighttime.

From an environmental perspective, the absence of roadside trees and green buffers contributes to increased surface temperatures and heat exposure for pedestrians and commuters. Large exposed asphalt surfaces absorb solar radiation and intensify localized heat conditions. The lack of integrated streetscape planning therefore negatively impacts both urban livability and thermal comfort within the ward.

CHAPTER 5

5.1 ROAD AND STREETScape PROPOSAL

Introduction

The Road and Streetscape Proposal focuses on transforming the existing transportation corridors within Sholinganallur into climate-responsive, environmentally sustainable, and pedestrian-friendly urban streets. The proposal primarily targets major road networks such as Velachery–Taramani Road, 109 Road, 49 Road, and 49A Road located within Wards 183, 184, 185, and 189. These corridors function as major urban connectors within the rapidly developing Old Mahabalipuram Road (OMR) IT Corridor and accommodate intense vehicular traffic, commercial activities, pedestrian movement, and continuous urban development.

Despite their importance, the existing road infrastructure within these wards lacks adequate green integration, pedestrian safety measures, and climate-sensitive planning approaches. The dominance of hard paved surfaces, increasing traffic volume, and dense built-up development have contributed significantly to rising surface temperatures and declining environmental quality within the streetscape environment.

Existing Road Conditions

Rapid urbanization within Sholinganallur has resulted in large-scale road widening, increased asphalt coverage, and reduction of roadside vegetation. Existing transportation corridors are primarily designed to prioritize vehicular movement, while limited consideration has been given to pedestrian comfort, thermal mitigation, and ecological integration.

Most roads within the selected wards currently experience:

- Inadequate pedestrian infrastructure
- Fragmented and narrow sidewalks
- Poor roadside plantation and lack of tree cover
- Traffic congestion and excessive vehicular heat emissions
- Lack of organized parking systems
- Insufficient public seating and shaded spaces
- Poor streetscape aesthetics and environmental quality
- Increased exposure to direct solar radiation

The widespread use of impervious materials such as asphalt roads, concrete pavements, parking surfaces, and paved commercial frontages has intensified heat absorption during

daytime. These materials store thermal energy and release heat slowly during nighttime, contributing to localized Urban Heat Island effects along transportation corridors.

The absence of continuous green buffers and shaded pedestrian infrastructure reduces thermal comfort for road users, discourages walkability, and negatively affects the overall livability of the urban environment.

Proposal Concept

The proposal aims to redesign these road corridors using Complete Street principles integrated with Green Infrastructure strategies. The concept focuses on balancing mobility, environmental sustainability, public comfort, and ecological resilience within the urban streetscape.

The proposed design transforms conventional transportation corridors into multifunctional green urban streets that support:

- Efficient vehicular circulation
- Safe pedestrian movement
- Non-motorized transportation
- Urban biodiversity enhancement
- Surface temperature reduction
- Improved stormwater management
- Public space activation
- Climate-responsive urban design

The proposal envisions roads not merely as transportation spaces but as active environmental corridors capable of improving thermal comfort and urban ecological performance.

Proposed Streetscape Interventions

Avenue Plantation and Tree Canopy Systems

One of the primary interventions involves the introduction of continuous avenue plantation and tree canopy systems along both sides of the roads and within central medians. Native and drought-resistant tree species are proposed to ensure long-term sustainability and lower maintenance requirements.

The tree-lined corridors provide multiple environmental benefits including:

- Reduction of direct solar exposure

- Improvement in pedestrian thermal comfort
- Shading of paved surfaces
- Reduction in surrounding land surface temperatures
- Improved air quality
- Carbon sequestration
- Noise reduction
- Enhancement of urban biodiversity

The evapotranspiration process from vegetation also contributes toward lowering ambient temperatures and mitigating Urban Heat Island effects along major transportation corridors.

Landscaped Medians and Green Buffers

The proposal introduces landscaped medians and roadside green buffers to improve both environmental performance and visual character of the streetscape. The medians function not only as traffic separators but also as ecological elements that reduce heat buildup and enhance urban aesthetics.

Roadside green buffers consisting of shrubs, bioswales, and plantation strips are proposed between pedestrian pathways and vehicular lanes. These buffers help reduce pedestrian exposure to traffic pollution and improve microclimatic conditions.

The green buffers additionally function as:

- Dust filters
- Visual barriers
- Rainwater infiltration zones
- Surface runoff management systems
- Ecological connectors within dense urban areas

Pedestrian-Friendly Infrastructure

The proposal prioritizes pedestrian safety and walkability through the development of wide, continuous, and universally accessible footpaths. Existing fragmented sidewalks are redesigned with proper paving, tactile indicators, shaded walkways, and organized crossings.

Dedicated pedestrian infrastructure includes:

- Continuous shaded footpaths

- Safe pedestrian crossings
- Barrier-free accessibility
- Seating areas and resting spaces
- Street furniture integration
- Improved lighting systems
- Wayfinding and signage elements

The introduction of shaded pedestrian corridors significantly reduces heat exposure and encourages walking as a sustainable mode of transportation within the study area.

Permeable Surfaces and Stormwater Management

The proposal recommends the use of permeable paving materials for sidewalks, parking edges, and selected landscape zones. Permeable surfaces allow rainwater infiltration into the ground, thereby reducing surface runoff and improving groundwater recharge.

Integrated stormwater management elements include:

- Bioswales
- Rain gardens
- Permeable pavements
- Recharge trenches
- Vegetated drainage channels

These interventions reduce urban flooding risks while simultaneously improving the environmental performance of the streetscape.

Organized Parking and Traffic Management

The proposal introduces organized parking zones and better traffic management systems to reduce congestion and improve road efficiency. Unregulated roadside parking currently reduces pedestrian safety and increases vehicular conflicts within the study area.

The proposed parking system includes:

- Designated parking bays
- Permeable parking surfaces
- Shaded parking areas
- Integrated green edges

- Improved traffic circulation patterns

Efficient traffic management also helps reduce anthropogenic heat emissions caused by idling vehicles and traffic congestion.

Urban Design and Public Realm Enhancement

The streetscape proposal enhances the urban identity of Sholinganallur by introducing aesthetically designed public spaces integrated with greenery and climate-sensitive urban elements. Public seating areas, shaded plazas, interactive landscape spaces, and well-designed urban furniture create a more vibrant and socially active public environment.

The improved streetscape contributes toward:

- Better visual quality
- Increased social interaction
- Enhanced pedestrian experience
- Safer public spaces
- Improved urban identity
- Higher environmental quality

The proposal therefore combines environmental performance with functional and aesthetic improvements within the public realm.

Urban Heat Island Mitigation Benefits

From an environmental perspective, the Road and Streetscape Proposal functions as a micro-scale Urban Heat Island mitigation strategy. Green transportation corridors reduce localized heat accumulation by increasing vegetation cover and minimizing exposed heat-retaining surfaces.

The proposal contributes toward:

- Reduction in surface temperature
- Improved thermal comfort
- Lower anthropogenic heat buildup
- Increased evapotranspiration
- Enhanced ecological connectivity
- Better air circulation
- Reduced carbon emissions through walkability

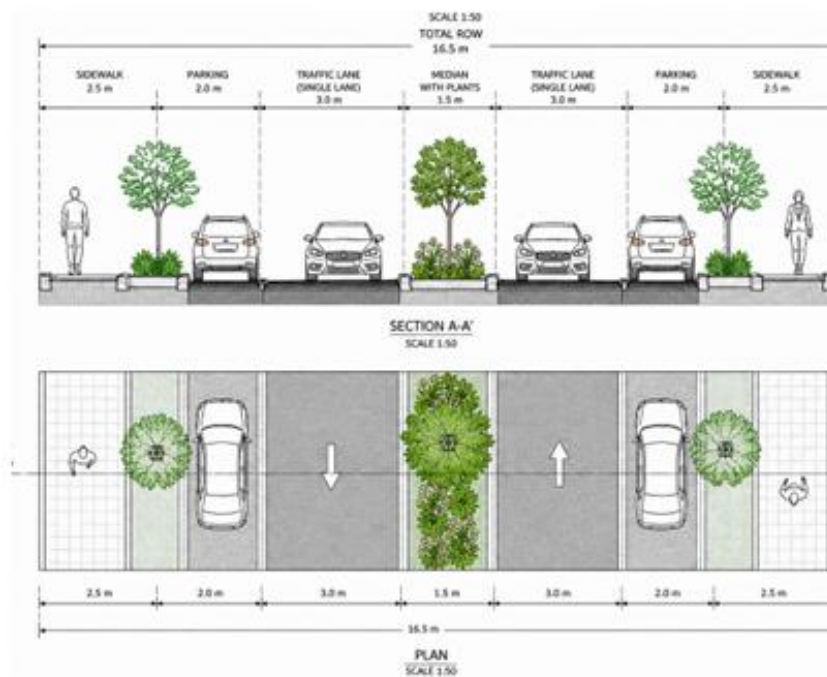
The integration of green infrastructure within transportation corridors strengthens climate resilience within the rapidly urbanizing IT corridor region.

Conclusion

Overall, the Road and Streetscape Proposal establishes a climate-responsive urban transportation framework that integrates mobility, environmental sustainability, public comfort, and ecological resilience within Sholinganallur. By transforming conventional road networks into green urban corridors, the proposal addresses critical environmental issues such as Urban Heat Island effects, poor walkability, thermal discomfort, and ecological fragmentation.

The proposed interventions not only improve transportation efficiency and pedestrian safety but also contribute toward long-term sustainable urban development within the rapidly growing OMR corridor.

AUTO CAD DRAFT PLAN



Benefits

- Improves traffic organization and safety
- Enhances walkability and pedestrian comfort
- Increases green cover and urban aesthetics
- Reduces roadside congestion through planned parking
- Provides a safer and more livable street environment
- Improves environmental quality and streetscape identity

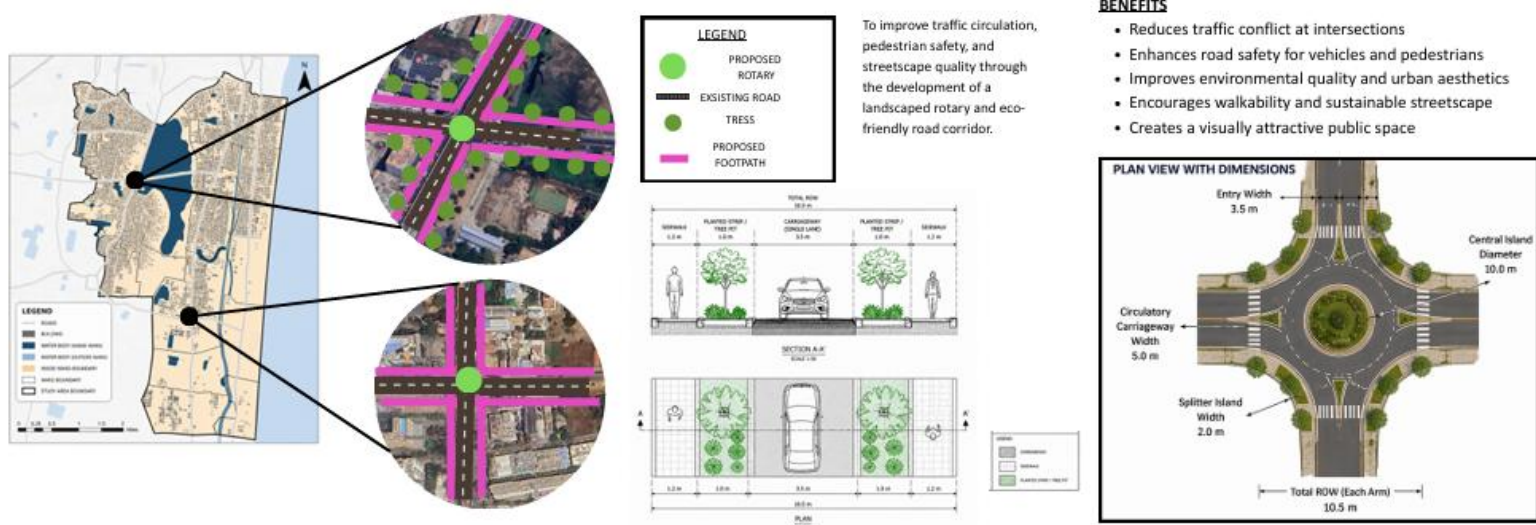
5.2 ROTARY AND ECO PARK DEVELOPMENT

The Rotary and Eco Park Development Proposal focuses on improving traffic circulation, ecological restoration, environmental sustainability, and public space quality within environmentally sensitive regions surrounding the Pallikaranai Marsh. The proposal combines transportation planning with ecological conservation by integrating landscaped rotary systems and a large-scale eco-park development within the urban framework of Sholinganallur.

The selected intersections within the study area currently experience traffic congestion, unorganized vehicular movement, unsafe pedestrian conditions, and lack of green infrastructure. Simultaneously, rapid urbanization around the Pallikaranai Marsh has weakened the ecological performance of the surrounding landscape due to encroachment, vegetation loss, and reduction of natural cooling systems. The proposal therefore aims to improve both urban mobility and environmental resilience through integrated planning interventions.

The rotary development introduces landscaped traffic circles designed to regulate traffic flow and reduce vehicular conflict points at major intersections. Traditional signal-based intersections often create traffic delays and heat accumulation due to prolonged vehicle idling. The rotary system improves continuous traffic movement and reduces fuel consumption, vehicular emissions, and localized anthropogenic heat generation.

ROTARTY AND ECO PARK



The proposed rotary design incorporates landscaped central islands, tree-lined pedestrian footpaths, traffic calming measures, and improved intersection geometry. Native plantation within the rotary spaces functions as a thermal buffer and enhances the visual quality of the streetscape. Safe pedestrian crossings and organized circulation systems improve accessibility and reduce road safety risks for pedestrians and cyclists.

A major component of the proposal is the development of a large eco-park adjacent to the Pallikaranai Marsh covering approximately 309 acres. The eco-park is envisioned as a multifunctional ecological landscape that combines wetland restoration, biodiversity conservation, recreation, environmental education, and climate adaptation functions.

The Wetland Restoration Zone covering approximately 68 acres focuses on restoring degraded marshland ecosystems and improving ecological balance. Native marsh vegetation, aquatic habitats, and biodiversity restoration measures help strengthen the hydrological and ecological functioning of the area. Wetland restoration also improves groundwater recharge and enhances the natural cooling capacity of the landscape.

The Bird Watching Zone covering approximately 18 acres introduces ecological observation areas, viewing decks, and habitat conservation spaces that support migratory and native bird species. This proposal enhances ecological tourism potential while simultaneously promoting biodiversity awareness and conservation.

The Eco Trails and Boardwalk Systems spread across approximately 20 acres provide walking, jogging, and cycling infrastructure integrated within natural landscapes. These trails encourage public interaction with ecological systems while promoting healthy recreational activities within a climate-responsive environment.

The Bio Garden component introduces native flora plantations and biodiversity gardens that showcase indigenous vegetation species adapted to local climatic conditions. Such vegetation systems improve urban cooling, enhance ecological diversity, and strengthen environmental education opportunities.

The eco-park also includes community plazas, recreational spaces, children's play zones, seating areas, pergolas, public amenities, and environmental interpretation centres. These spaces improve public accessibility and create socially inclusive green infrastructure systems within the urban environment.

From a climate perspective, the eco-park functions as a large urban cooling zone capable of reducing surrounding surface temperatures through evapotranspiration, shading, and moisture retention. The interconnected ecological landscape also improves flood resilience by acting as a natural stormwater retention and absorption system during heavy rainfall events.

Overall, the Rotary and Eco Park Development Proposal demonstrates how ecological restoration and transportation planning can be integrated to create environmentally

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resilient, socially active, and climate-responsive urban spaces within rapidly urbanizing metropolitan regions.



5.3 LAKE RESTORATION AND RIVERFRONT DEVELOPMENT

Introduction

The Lake Restoration and Riverfront Development Proposal focuses on rejuvenating environmentally degraded water bodies and canal systems within Sholinganallur through ecological restoration, hydrological improvement, and integrated blue-green infrastructure planning. The proposal primarily addresses Perungudi Lake, Pallikaranai Eri, and surrounding canal corridors that have experienced severe environmental degradation due to rapid urbanization, untreated sewage discharge, solid waste dumping, encroachment, and unregulated developmental activities.

Historically, lakes, marshlands, and canal systems played a critical role in regulating the urban microclimate of Chennai by supporting groundwater recharge, biodiversity conservation, stormwater storage, evaporative cooling, and ecological balance. However, rapid urban expansion along the OMR corridor has significantly altered the hydrological and ecological systems within Sholinganallur. The conversion of natural drainage systems into built-up land, combined with increasing pollution and land encroachment, has weakened the environmental performance of these blue infrastructure systems and intensified Urban Heat Island effects.

The proposal therefore aims to restore and integrate these water systems into a sustainable blue-green infrastructure network that improves ecological resilience, urban environmental quality, and climate responsiveness within the study area.

Existing Environmental Conditions

Degradation of Water Bodies

Perungudi Lake and Pallikaranai Eri currently face multiple environmental challenges that have reduced their ecological and hydrological functionality. Continuous urbanization and infrastructure expansion have led to:

- **Encroachment along lake boundaries**
- **Solid waste dumping**
- **Untreated sewage inflow**
- **Eutrophication of water bodies**
- **Silt accumulation and reduced water depth**
- **Invasive vegetation growth**
- **Reduction in biodiversity**
- **Decline in groundwater recharge capacity**

These issues have severely affected the water quality and environmental health of the lakes.

The reduction in open water surfaces and wetland vegetation has also weakened the natural cooling capacity traditionally provided by these ecosystems. As a result, nearby built-up areas experience increased thermal stress and higher land surface temperatures.

Canal Pollution and Ecological Decline

The canal systems surrounding the study area function as important drainage and hydrological corridors. However, these canals are presently heavily polluted due to sewage discharge, illegal dumping of waste, and poor environmental management practices.

The canal edges lack ecological treatment, green buffers, and proper stormwater filtration systems. Stagnant polluted water not only creates environmental and health hazards but also reduces the climatic and hydrological benefits of the canal network.

Degraded canal systems contribute toward:

- **Poor urban environmental quality**
- **Increased flood vulnerability**
- **Heat accumulation within surrounding built-up areas**
- **Reduced biodiversity and ecological continuity**

Proposal Vision

The proposal envisions transforming degraded lakes and canals into environmentally resilient blue-green infrastructure systems that support ecological restoration, public recreation, climate mitigation, and sustainable urban development.

The proposal framework integrates:

- Hydrological restoration
- Ecological conservation
- Flood mitigation
- Urban cooling strategies
- Public accessibility
- Recreational infrastructure
- Biodiversity enhancement
- Climate-responsive planning

The restored water systems are proposed not merely as isolated environmental assets but as interconnected ecological corridors that improve the overall environmental performance of Sholinganallur.

Lake Restoration Strategies

Lake Desilting and Hydrological Restoration

One of the primary interventions involves desilting and hydrological restoration of Perungudi Lake and Pallikaranai Eri. Over time, excessive silt accumulation has reduced the effective water-holding capacity of these lakes and weakened their flood buffering functions.

Desilting helps:

- Restore natural water depth
- Improve water storage capacity
- Enhance groundwater recharge
- Improve hydrological circulation
- Reduce flood vulnerability

The restoration of natural lake morphology improves the ecological performance of the water bodies and strengthens their environmental resilience.

Solid Waste Removal and Pollution Control

The proposal recommends systematic removal of accumulated solid waste and implementation of strict pollution control measures around the lakes and canal systems.

Major interventions include:

- Waste removal and site cleanup
- Prevention of illegal dumping
- Sewage diversion systems
- Decentralized wastewater treatment
- Water quality monitoring mechanisms

Reducing pollutant inflow significantly improves water quality and supports the recovery of aquatic ecosystems.

Wetland Restoration and Biodiversity Enhancement

Wetland restoration forms a critical component of the proposal, particularly around the Pallikaranai ecosystem. Native wetland vegetation and aquatic habitat restoration improve ecological continuity and biodiversity performance within the urban environment.

The proposal includes:

- Native marsh vegetation plantation
- Habitat restoration zones
- Bird conservation areas
- Ecological buffer landscapes
- Invasive species removal

Healthy wetland systems support biodiversity conservation while functioning as natural thermal cooling landscapes.

Native Plantation Buffers

The proposal introduces continuous native vegetation buffers around lake edges and canal corridors. These green buffers function as ecological transition zones between urban development and water systems.

The plantation buffers provide multiple environmental benefits:

- Surface temperature reduction

- **Evaporative cooling**
- **Soil stabilization**
- **Improved biodiversity**
- **Air quality enhancement**
- **Stormwater filtration**
- **Visual landscape improvement**

The vegetation belts also help reduce heat buildup within nearby built-up areas.

Riverfront and Public Realm Development

Peripheral Walkways and Recreational Spaces

The proposal includes the development of environmentally sensitive peripheral walkways and jogging tracks around restored lake edges. Public accessibility encourages greater social interaction with ecological landscapes while promoting healthy recreational activities.

The proposed public realm elements include:

- **Walking and jogging tracks**
- **Seating areas**
- **Shaded rest zones**
- **Landscape plazas**
- **Open recreational spaces**
- **Fitness and activity zones**

The integration of shaded pathways and green public spaces improves thermal comfort and urban livability.

Boardwalks and Viewing Decks

Boardwalk systems and viewing decks are proposed at selected ecological zones to provide controlled public access to natural landscapes without disturbing sensitive habitats.

These structures:

- **Enhance environmental awareness**
- **Promote eco-tourism and education**

- Encourage interaction with natural systems
- Protect ecologically sensitive areas through controlled circulation

Environmentally sensitive design ensures minimal ecological disturbance while improving public engagement with restored landscapes.

Bioswales and Stormwater Filtration Systems

The proposal integrates bioswales and vegetated stormwater filtration systems around roads, lake edges, and canal corridors. Urban runoff from surrounding built-up areas often carries pollutants, sediments, and waste into lakes and canals.

Bioswales help:

- Filter stormwater runoff
- Improve water quality
- Reduce pollutant inflow
- Increase groundwater infiltration
- Minimize urban flooding

These systems strengthen sustainable urban drainage infrastructure and improve the environmental performance of the hydrological network.

Canal Rejuvenation and Ecological Corridors

Canal Edge Greening

The canal rejuvenation strategy focuses on transforming polluted drainage corridors into green ecological spines integrated within the urban environment.

Vegetated canal edges improve:

- Urban aesthetics
- Microclimatic conditions
- Surface temperature reduction
- Ecological connectivity
- Pedestrian experience

Continuous plantation and green corridors along canals also function as urban cooling networks within dense built-up areas.

Pedestrian and Cycling Corridors

The proposal integrates pedestrian pathways and cycling tracks along rejuvenated canal edges to encourage sustainable mobility and improve public accessibility.

The shaded mobility corridors:

- Promote non-motorized transport
- Improve recreational opportunities
- Enhance urban connectivity
- Reduce vehicular dependency
- Lower anthropogenic heat generation

The integration of mobility infrastructure with ecological landscapes creates multifunctional urban environmental corridors.

Urban Heat Island Mitigation Benefits

From a climate-responsive planning perspective, restored lakes, wetlands, and canals significantly contribute toward Urban Heat Island mitigation within Sholinganallur.

Blue-green infrastructure systems improve urban thermal performance through:

- Evaporative cooling
- Moisture retention
- Surface temperature reduction
- Increased vegetation cover
- Improved airflow circulation
- Reduced heat absorption within built-up areas

Water surfaces combined with surrounding vegetation create localized cooling zones that reduce thermal stress and improve human comfort.

The proposal therefore strengthens urban climate resilience while improving ecological sustainability.

Flood Mitigation and Climate Resilience

The restored hydrological systems also improve flood resilience within the study area. Enhanced water storage capacity, improved drainage performance, and ecological filtration systems reduce flood risk during monsoon events.

The proposal contributes toward:

- **Improved stormwater management**
- **Groundwater recharge**
- **Reduced surface runoff**
- **Hydrological balance restoration**
- **Climate adaptation capacity**

Blue-green infrastructure thus functions as both an ecological and climate resilience strategy.

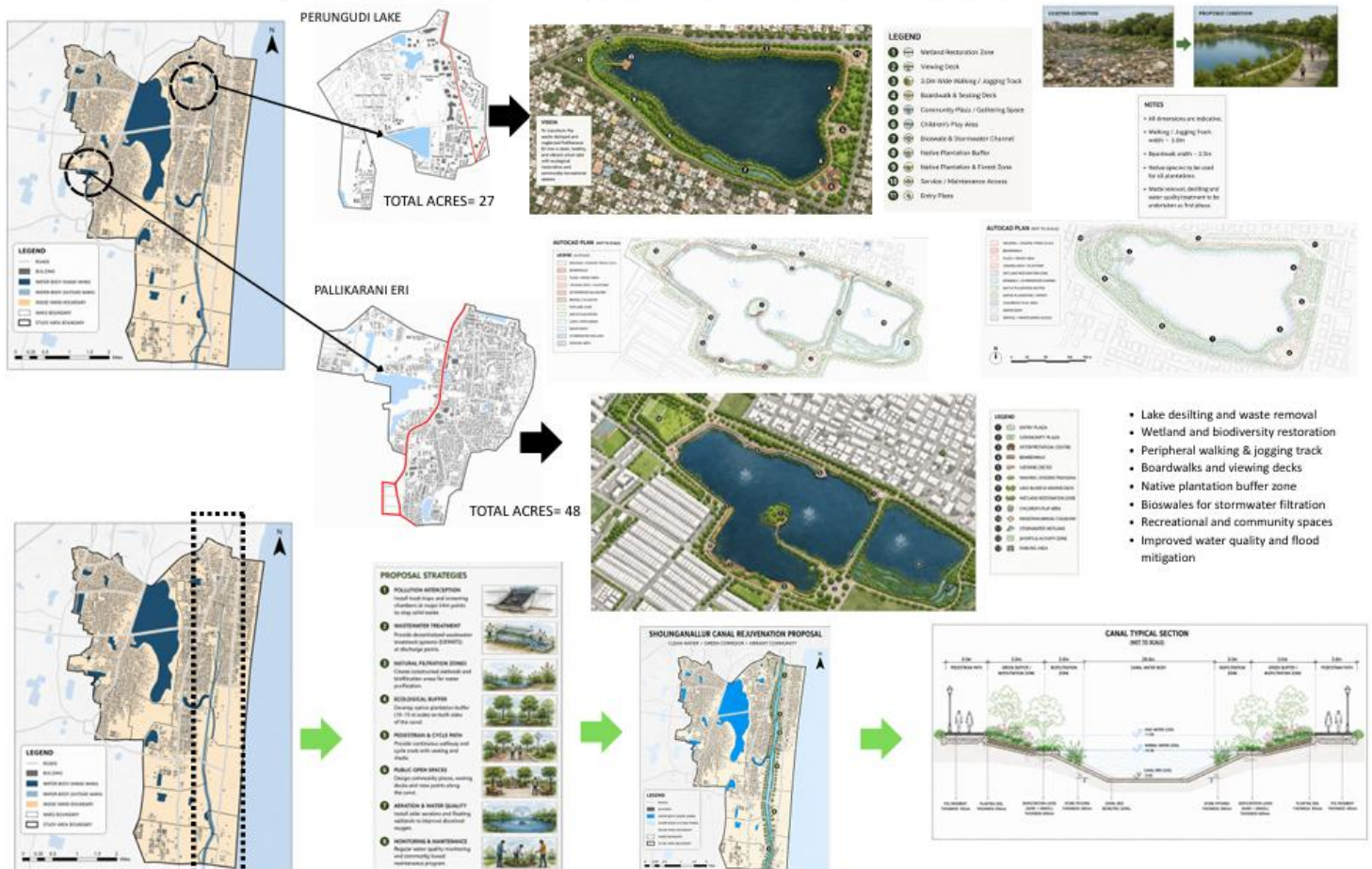
Conclusion

Overall, the Lake Restoration and Riverfront Development Proposal establishes a sustainable blue-green infrastructure framework for Sholinganallur that integrates hydrological restoration, ecological conservation, public recreation, and climate-responsive urban planning.

planning green infrastructure strategies for urban heat island mitigation in sholinganallur, Chennai

By restoring lakes, wetlands, and canal systems, the proposal addresses critical environmental issues such as Urban Heat Island effects, flooding, ecological degradation, and poor urban environmental quality. The integration of blue-green infrastructure within the urban landscape creates a resilient and environmentally responsive development model for the rapidly urbanizing OMR corridor.

LAKE RESTORATION AND RIVER FRONT



5.4 GREEN BUFFER IN BUILT-UP AREAS

The Green Buffer Proposal focuses on introducing climate-responsive Green Infrastructure systems within dense built-up zones identified through NDBI hotspot analysis. The study

area exhibits extensive impervious surface coverage and high built-up density due to rapid urbanization along the OMR IT Corridor. These conditions have intensified Urban Heat Island effects and significantly reduced environmental quality within the urban landscape.

The NDBI analysis indicates that wards such as Sholinganallur, Thoraipakkam, Pallikaranai, Neelankarai, and Palavakkam contain large concentrations of dense built-up surfaces characterized by concrete roads, high-rise developments, commercial complexes, parking areas, and paved infrastructure. The reduction of vegetation and open spaces within these wards has weakened natural cooling mechanisms and increased heat accumulation.

The proposal therefore aims to reintroduce ecological systems within dense urban environments through Green Infrastructure-based planning strategies. One of the major interventions includes the introduction of green roofs on residential, commercial, and institutional buildings. Green roofs reduce rooftop heat absorption and improve building thermal performance by providing vegetation cover over exposed surfaces.

Vertical greening systems and green walls are proposed for high-rise buildings and commercial corridors. These systems reduce heat absorption on building façades while simultaneously improving urban aesthetics and air quality. Vegetated façades also help lower surrounding ambient temperatures through evapotranspiration.

Cool roof technologies are proposed for buildings with large exposed roof surfaces. Reflective roofing materials reduce solar heat gain and improve indoor thermal comfort, thereby reducing energy consumption associated with air conditioning systems.

The proposal further recommends the introduction of permeable pavements and shaded pedestrian spaces within high-density urban corridors. Permeable surfaces improve groundwater infiltration and reduce surface heat accumulation, while shaded walkways improve pedestrian comfort and encourage non-motorized mobility.

Urban tree plantation and roadside green buffers form another major component of the proposal. Continuous avenue plantation systems improve ecological connectivity and create localized cooling corridors within dense urban areas. Native tree species are recommended to ensure climatic adaptability and long-term environmental sustainability.

The proposal framework is implemented through phased development strategies categorized into short-term, mid-term, and long-term interventions. Short-term interventions include roadside plantation, cool roof implementation, and pedestrian infrastructure improvements. Mid-term interventions focus on canal rejuvenation, lake restoration, bioswales, and green roof systems. Long-term strategies include biodiversity restoration, integrated Urban Heat Island zoning, eco-park development, and climate-responsive urban planning policies.

The proposal is further linked with existing policy frameworks such as the GCC Complete Streets Program, Chennai Climate Action Plan, Tamil Nadu Cool Roof Initiative, and CMDA Green Building Incentives. This policy integration strengthens implementation feasibility and supports institutional coordination.

planning green infrastructure strategies for urban heat island mitigation in sholinganallur, Chennai

Overall, the Green Buffer Proposal demonstrates how ecological systems can be reintroduced within dense urban environments to improve thermal comfort, environmental quality, biodiversity, and climate resilience.



SHORT TERM (1 - 3 YEARS)

PROPOSAL	OBJECTIVE	POSSIBLE CHENNAI POLICY
Roadside plantation & streetscape improvement	Reduce surface temperature and improve walkability	GCC Complete Streets Program
Footpath and pedestrian enhancement	Improve pedestrian comfort and safety	Chennai NMT Policy
Rotary development	Reduce traffic conflict and congestion	GCC Traffic Improvement Scheme
Cool roofs in dense built-up areas	Reduce heat absorption	Tamil Nadu Cool Roof Initiative
Green buffers along roads	Increase urban shade and greenery	Tamil Nadu Green Mission
Tree plantation in hotspot wards	Improve microclimate	GCC Urban Greening Program

MID TERM (3-7 YEARS)

PROPOSAL	OBJECTIVE	POSSIBLE CHENNAI POLICY
Canal rejuvenation	Improve water quality and reduce heat	Chennai Rivers Restoration Trust (CRRT)
Lake restoration & desilting	Flood mitigation and ecological restoration	Wetland Conservation Rules 2017
Bioswales & permeable pavements	Improve stormwater infiltration	Chennai Stormwater Drain Master Plan
Eco trails & cycling corridors	Promote sustainable mobility	Chennai Climate Action Plan
Green roofs & vertical greening	Reduce Urban Heat Island effect	CMDA Green Building Incentives
Blue-green roof systems	Improve thermal comfort and water retention	Sustainable Building By-laws

LONG TERM (7+ YEARS)

PROPOSAL	OBJECTIVE	POSSIBLE CHENNAI POLICY
Pallikaralai eco-park development	Ecological conservation and recreation	Pallikaralai Marsh Conservation Plan
Biodiversity restoration zones	Enhance urban ecology	Chennai Urban Forestry Policy
Transit-oriented compact urban form	Reduce heat trapping and sprawl	CMDA TOD Policy
High albedo & energy-efficient buildings	Improve energy efficiency	ECBC Building Regulations
Integrated UHI mitigation zoning	Long-term climate resilience planning	Chennai Climate Resilience Strategy
Blue-Green infrastructure network	Create connected ecological systems	Integrated Urban Water Management Policy

Implementation Framework and Policy Integration

The implementation framework for Urban Heat Island mitigation in Sholinganallur is structured into Short-Term, Mid-Term, and Long-Term strategies based on intervention

scale, urgency, feasibility, and expected environmental impact. The framework integrates climate-responsive urban planning measures with existing Chennai and Tamil Nadu policy mechanisms to ensure practical implementation and institutional coordination. The phased approach enables gradual transformation of the urban environment while addressing immediate thermal stress conditions and promoting long-term ecological resilience.

Short-Term Strategies (1–3 Years)

Short-term strategies focus on immediate and highly feasible interventions that can quickly improve thermal comfort, pedestrian conditions, and streetscape quality within the study area. These interventions mainly target public streets, hotspot wards, and dense built-up areas experiencing intense Urban Heat Island effects.

Roadside Plantation and Streetscape Improvement

The proposal recommends large-scale roadside plantation and streetscape enhancement along major transportation corridors within Sholinganallur. The introduction of avenue trees, shaded sidewalks, landscaped medians, and roadside green buffers helps reduce surface temperatures and improve thermal comfort for pedestrians.

Tree canopies reduce direct solar radiation on roads and pavements, thereby lowering heat absorption and minimizing localized heat buildup. Streetscape improvements also enhance walkability, public comfort, and urban aesthetics.

This proposal aligns with the Greater Chennai Corporation (GCC) Complete Streets Program, which promotes pedestrian-friendly and environmentally responsive street design across the city.

Footpath and Pedestrian Enhancement

The development of continuous pedestrian pathways and shaded sidewalks is proposed to improve pedestrian comfort and safety. Existing fragmented footpaths and inadequate pedestrian infrastructure within many wards reduce walkability and increase exposure to heat and vehicular traffic.

The proposal includes:

- Wide shaded sidewalks
- Barrier-free pedestrian access
- Tactile paving
- Seating areas
- Pedestrian crossings
- Street lighting and signage

Improved pedestrian infrastructure encourages non-motorized transport while reducing dependency on private vehicles, thereby contributing indirectly to reduced anthropogenic heat generation.

This intervention supports the Chennai Non-Motorized Transport (NMT) Policy.

Rotary Development and Traffic Improvement

Major traffic intersections within the study area experience congestion and inefficient vehicular movement, leading to increased heat emissions from idling vehicles. Rotary development and junction redesign are proposed to improve traffic circulation and reduce conflict points.

Landscaped roundabouts and traffic-calming measures also contribute toward urban greening and visual enhancement. Efficient traffic management reduces fuel consumption, vehicular emissions, and anthropogenic heat accumulation.

The proposal aligns with GCC Traffic Improvement Schemes implemented across Chennai.

Cool Roofs in Dense Built-Up Areas

Dense residential and commercial zones within hotspot wards experience excessive heat absorption due to exposed concrete rooftops and dark roofing materials. The proposal recommends promoting cool roof technologies using reflective paints, heat-resistant coatings, and high-albedo roofing materials.

Cool roofs significantly reduce indoor temperatures, lower heat absorption, and decrease energy consumption from air-conditioning systems. Such interventions are particularly beneficial for low-income settlements and highly dense urban neighborhoods.

This strategy supports the Tamil Nadu Cool Roof Initiative and climate-responsive building practices.

Green Buffers Along Roads

Roadside green buffers consisting of shrubs, trees, bioswales, and vegetated strips are proposed along major roads and transportation corridors. These buffers function as environmental filters that reduce dust, noise, heat exposure, and air pollution.

Green buffers also improve microclimatic conditions through evapotranspiration and shading effects while enhancing ecological continuity within urban areas.

The proposal supports the Tamil Nadu Green Mission and urban greening initiatives.

Tree Plantation in Hotspot Wards

Urban Heat Island hotspot wards identified through LST analysis require immediate tree plantation programs to improve thermal comfort and environmental quality. Native and drought-resistant species are proposed to ensure long-term sustainability and reduced maintenance.

Tree plantation programs improve:

- Urban shading
- Air quality
- Carbon sequestration
- Biodiversity
- Thermal regulation

This intervention aligns with GCC Urban Greening Programs and local environmental initiatives.

Mid-Term Strategies (3–7 Years)

Mid-term interventions focus on larger environmental restoration projects, integrated stormwater management systems, and sustainable urban mobility infrastructure aimed at improving ecological performance and climate resilience.

Canal Rejuvenation

The polluted canal systems within the study area require ecological restoration and rejuvenation to improve water quality and reduce thermal stress. Canal restoration includes:

- Sewage diversion
- Desilting
- Edge landscaping
- Bio-remediation
- Public realm enhancement

Restored canals function as urban cooling corridors and improve hydrological performance during monsoon periods.

This proposal aligns with the Chennai Rivers Restoration Trust (CRRT) initiatives.

Lake Restoration and Desilting

Lakes and water bodies such as Pallikaranai Eri and Perungudi Lake require restoration to recover their ecological and hydrological functions. The proposal includes desilting, removal of encroachments, wetland restoration, and improvement of water quality.

Healthy water bodies help:

- Moderate urban temperatures
- Improve groundwater recharge
- Reduce flood risk
- Enhance biodiversity
- Strengthen ecological resilience

The proposal aligns with Wetland Conservation Rules 2017 and regional environmental restoration programs.

Bioswales and Permeable Pavements

The introduction of bioswales and permeable paving systems is proposed to improve stormwater infiltration and reduce surface runoff. Impervious surfaces currently dominate the urban environment and contribute significantly to heat absorption and flooding.

Permeable systems allow rainwater infiltration while reducing thermal buildup within paved urban areas.

This strategy supports Chennai Stormwater Drain Master Plan objectives.

Eco Trails and Cycling Corridors

The proposal recommends creating eco-trails, cycling corridors, and shaded pedestrian pathways integrated with green corridors and water bodies. Sustainable mobility infrastructure improves public health, reduces vehicular dependency, and enhances environmental quality.

Cycling corridors integrated with urban greenery contribute toward:

- Reduced vehicular emissions
- Lower heat generation
- Improved urban connectivity
- Better recreational opportunities

This proposal aligns with the Chennai Climate Action Plan.

Green Roofs and Vertical Greening

The introduction of green roofs and vertical greenery systems is proposed particularly within high-density commercial and IT corridors. These systems reduce heat absorption by buildings and improve thermal insulation.

Green roofs provide:

- Surface temperature reduction
- Rainwater retention
- Improved air quality
- Urban biodiversity enhancement
- Reduced cooling energy demand

This proposal supports CMDA Green Building Incentives and sustainable development frameworks.

Blue-Green Roof Systems

Blue-green roof systems integrate vegetation with rainwater storage and stormwater management functions. These systems improve thermal comfort while reducing urban runoff and enhancing building-level climate resilience.

Blue-green infrastructure contributes toward:

- Urban cooling
- Water retention
- Reduced flooding
- Sustainable building performance

The proposal aligns with sustainable building by-laws and climate-responsive planning approaches.

Long-Term Strategies (7+ Years)

Long-term strategies focus on large-scale ecological restoration, climate-resilient urban planning frameworks, and integrated environmental infrastructure aimed at creating a sustainable and resilient urban ecosystem.

Pallikaranai Eco-Park Development

The proposal recommends developing ecological conservation zones and eco-park systems around the Pallikaranai Marsh. The eco-park integrates biodiversity conservation, recreation, environmental education, and wetland restoration.

The restored ecological landscape functions as a major urban cooling zone and ecological buffer for southern Chennai.

This proposal aligns with the Pallikaranai Marsh Conservation Plan.

Biodiversity Restoration Zones

Dedicated biodiversity restoration zones are proposed to strengthen ecological networks within the urban environment. Native vegetation restoration improves habitat connectivity and environmental quality.

These zones contribute toward:

- Urban ecology enhancement
- Carbon sequestration
- Temperature regulation
- Ecological resilience

The intervention aligns with Chennai Urban Forestry Policies.

Transit-Oriented Compact Urban Form

The proposal promotes Transit-Oriented Development (TOD) and compact urban growth to reduce urban sprawl and minimize heat-trapping development patterns. Mixed-use, high-density, walkable development near public transport corridors improves land-use efficiency and reduces dependency on private vehicles.

Compact development reduces:

- Surface heat accumulation
- Vehicular emissions
- Infrastructure pressure
- Land consumption

The strategy supports CMDA TOD Policies.

High Albedo and Energy-Efficient Buildings

Future developments are encouraged to adopt high-albedo materials, energy-efficient building envelopes, passive cooling systems, and climate-responsive architectural design.

Such buildings improve:

- Indoor thermal comfort
- Energy efficiency
- Heat reflection
- Reduced cooling demand

The proposal aligns with ECBC Building Regulations and sustainable building codes.

Integrated UHI Mitigation Zoning

The study recommends introducing Urban Heat Island mitigation zoning within future planning frameworks. Thermal-sensitive planning regulations can guide land use, green cover requirements, building materials, and environmental infrastructure within hotspot zones.

This approach strengthens long-term climate resilience planning within rapidly urbanizing regions.

The proposal aligns with Chennai Climate Resilience Strategies.

Blue-Green Infrastructure Network

The final long-term strategy focuses on creating an integrated Blue-Green Infrastructure Network connecting wetlands, lakes, canals, green corridors, urban forests, and transportation landscapes.

This ecological network improves:

- Urban cooling
- Biodiversity connectivity
- Flood resilience
- Groundwater recharge
- Environmental sustainability

The proposal supports Integrated Urban Water Management Policies and sustainable urban development frameworks.

Conclusion

The phased implementation framework provides a comprehensive roadmap for mitigating Urban Heat Island effects and improving environmental resilience within Sholinganallur. By integrating short-term thermal mitigation measures, mid-term ecological restoration strategies, and long-term climate-responsive planning approaches, the proposal creates a sustainable urban development model for rapidly urbanizing IT corridor regions.

The integration of these interventions with existing Chennai and Tamil Nadu policies ensures greater feasibility, institutional coordination, and long-term implementation potential for climate-responsive urban transformation.

5.5 CONCLUSION

The proposal framework for Sholinganallur presents a comprehensive and sustainable approach toward mitigating Urban Heat Island effects through Green Infrastructure planning. By integrating ecological restoration, streetscape redesign, wetland conservation, lake rejuvenation, and climate-responsive urban design, the proposals aim to improve urban thermal comfort, environmental quality, and climate resilience.

The study highlights the importance of combining Remote Sensing-based thermal analysis with practical planning interventions to create environmentally sustainable urban environments. The proposed strategies provide a replicable planning framework that can support future climate-sensitive urban development not only in Chennai but also in other rapidly urbanizing metropolitan regions across India.

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