

Urban Heat Island (UHI) Assessments for Sustainable Cooling & Extreme Heat Urban Planning

National Workshop on Heat Wave 2024, organised by NDMA

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United Nations Environment Programme
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The image is a composite. The left side shows a multi-lane highway completely clogged with cars, illustrating urban congestion. The right side shows a dense city skyline with various skyscrapers under a warm, orange-hued sunset sky. In the center, a dark silhouette of a person stands with their back to the viewer, looking out over the city. The overall theme is urbanization and its environmental impact.

Urbanization – is
changing our Planet

2014 to 2020 was the hottest in 140 years .



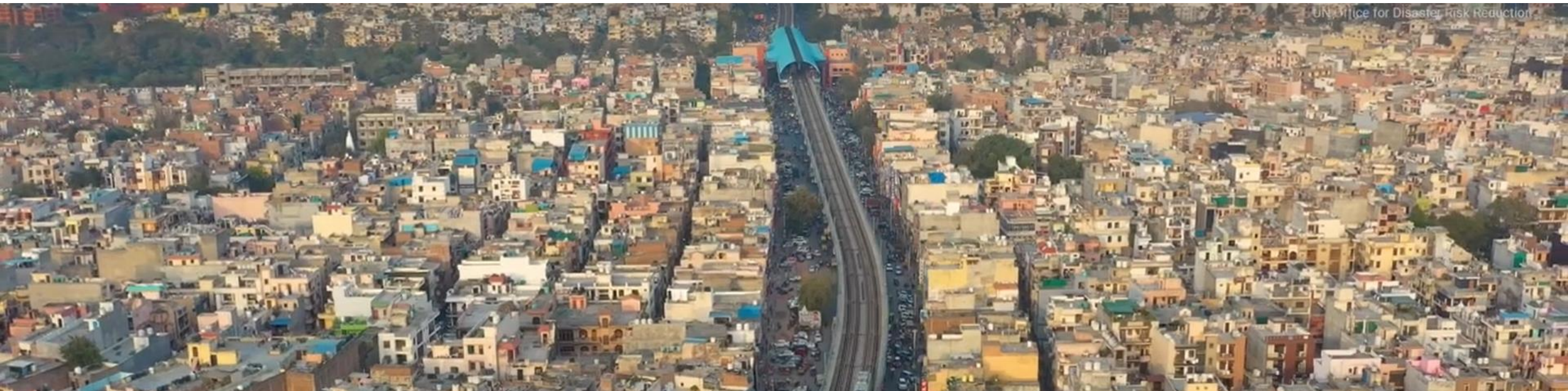
Heat Waves in India

Urban poor are more vulnerable to heat

Poor housing construction methods and materials

9% of Indian households have air-conditions

Limited access to natural cooling (with vegetation or water)





A Cool Coalition: A Global Network

Building on UNEP's long-standing expertise, knowledge and a large network in cooling, UNEP took the lead with its partners to create the **Cool Coalition**.

The Coalition is working with its 120+ partners to support to countries and industry take comprehensive action to meet growing demands for cooling in an efficient, climate-friendly manner, contributing to the SDGs, Kigali Amendment, Paris Agreement.

The Coalition promotes a 'reduce-shift-improve-protect' holistic and cross-sectoral approach to cooling.

26 Country Governments



34 Civil Society Organisations



30 Private Sector Stakeholders



18 International Organisations



4 Academia Stakeholders



10 City Governments



KNOWLEDGE EXCHANGE:

Building an active learning community that breaks down silos and promotes cross-cutting approaches

ACTION:

Support governments & industry in taking action to meet cooling demand in comprehensive sustainable manner, connecting to global policy processes

ADVOCACY:

Highlighting benefits and opportunities of efficient, climate friendly cooling



- Detailed guidance and encyclopaedia of options to help cool cities sustainably
- 80 case studies from around the world, to help cities find an approach best suited to their unique contexts
- Launched at COP26, with 16 cities committing to action using the Handbook



Discover the Handbook by scanning this QR code

UNEP India Cooling Programme

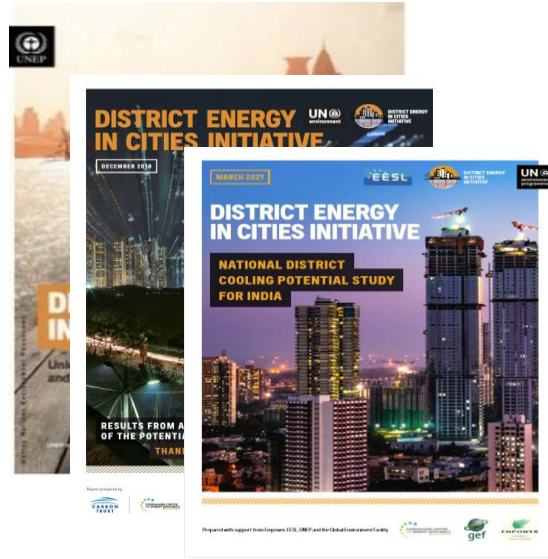
Objective

Support India at the national and sub-national level in creating an enabling environment for accelerated investment and adoption of sustainable cooling solutions in line with the ICAP

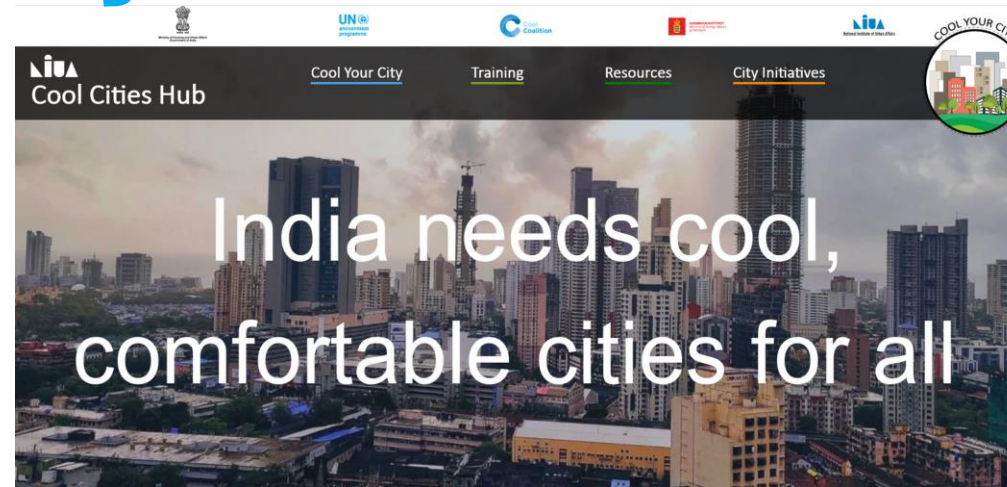
Components

1. Targeted technical assistance and technology demonstrations in **identified gaps** (district cooling, integrated cold chain, materials)
2. Accelerating an **integrated approach to cooling** – across passive cooling, efficiency and refrigerants
 - Multi-level coordination, governance and policy delivery
 - Private sector engagement
 - Finance mechanisms and matchmaking
3. Standards, guidelines and methodologies for India on cooling and thermal comfort
4. Knowledge sharing and convening (e.g. NIUA Cool Cities Hub)

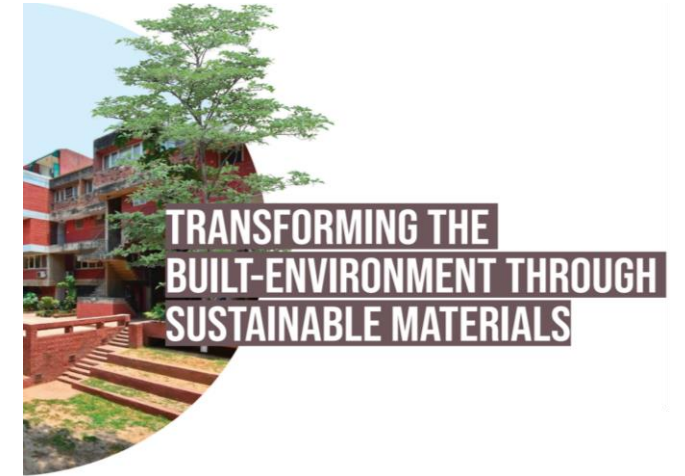
India Urban Cooling Programme



District Energy Initiative



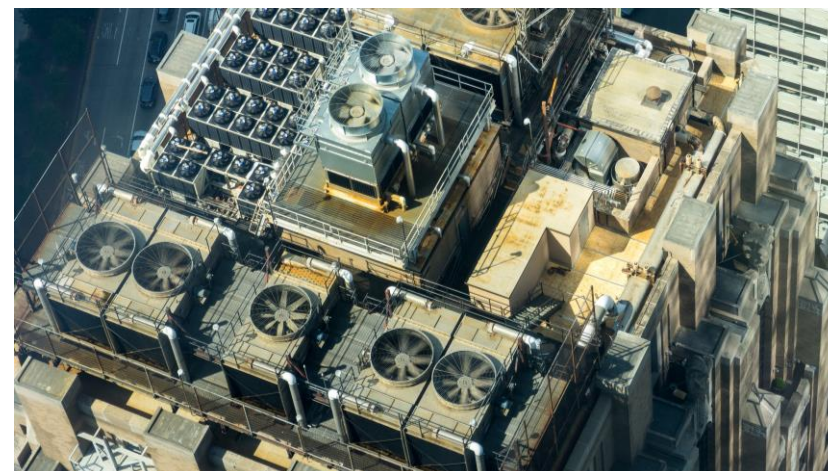
Cool Cities Hub



Sustainable Building Materials



Cool Roofs, Urban Heat Island Study



District Cooling



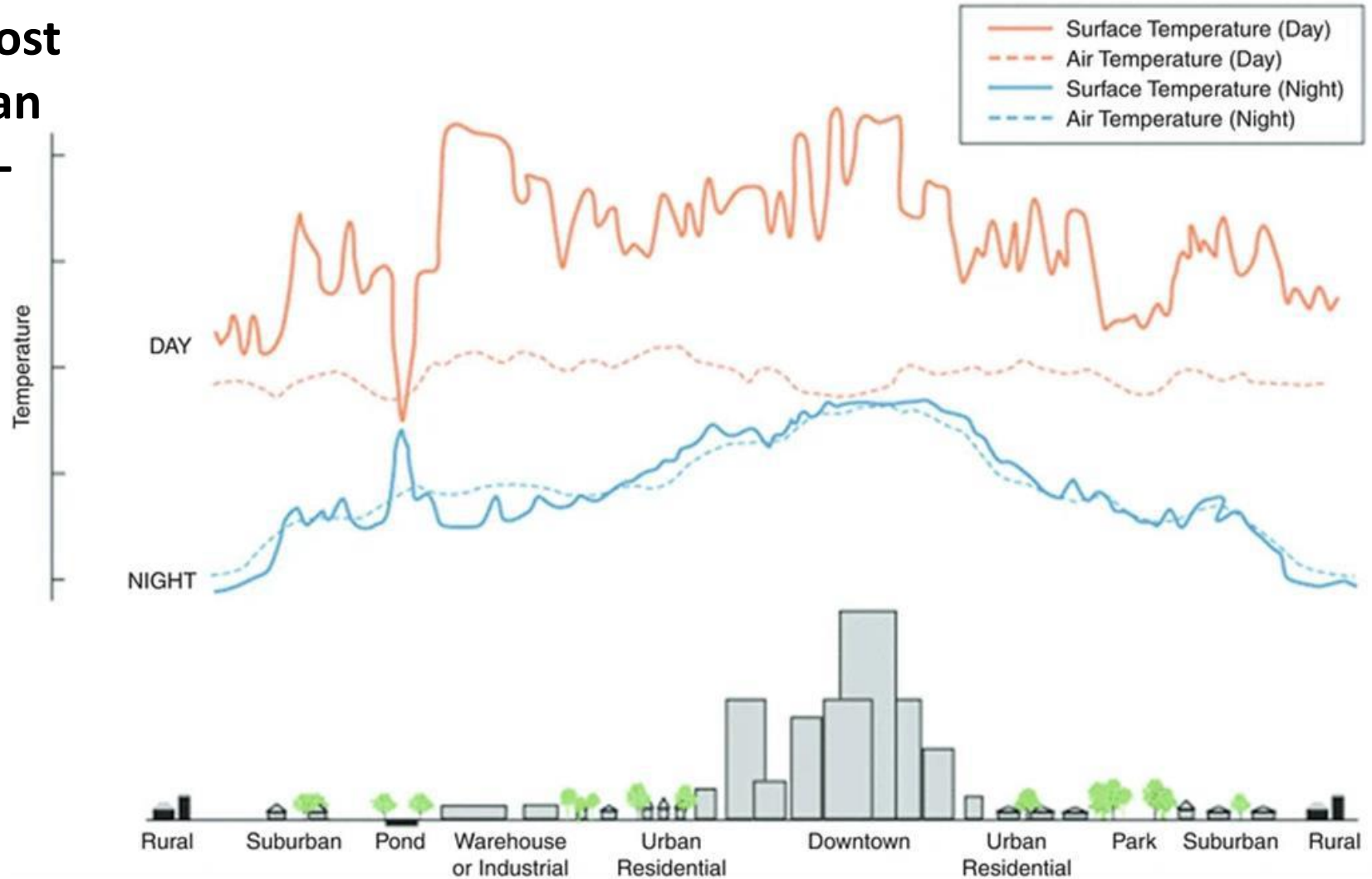
Cold Chains



Urban Heat Islands - Most Evident Impact of human Intervention on Planet - Earth

Urban areas are warmer than rural areas. This phenomenon is termed as Urban Heat Island.

Urban Heat Island Effect
(up to 10°C higher)



Urban heat island effect diagram (Source: U.S. Environmental Protection Agency, 2021)

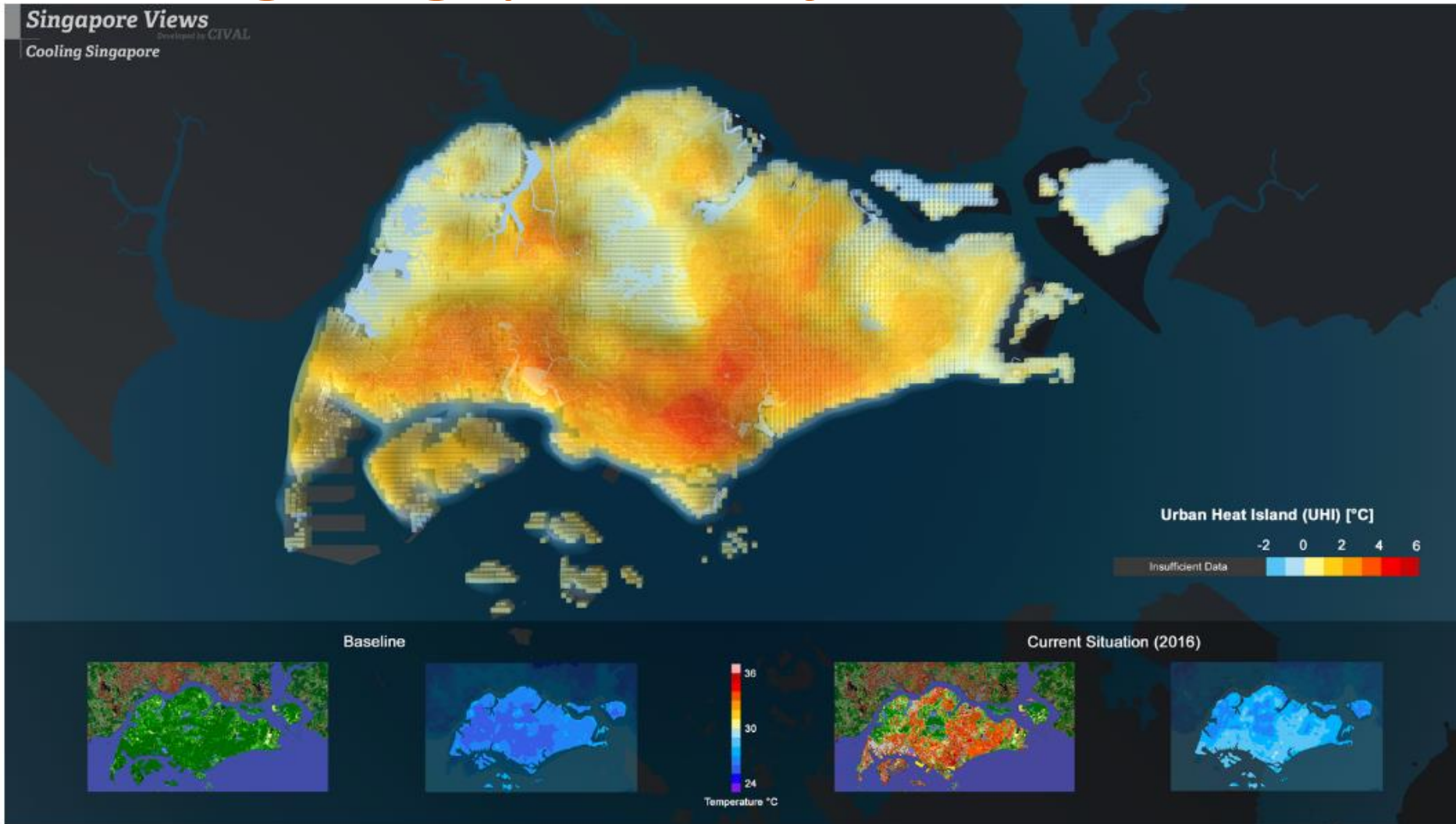


Medellin, Colombia – Interconnected Green Corridors

- 30 green corridors interconnected – in 3 years able to reduce UHI by 2^o C.
- Expected a reduction of 4 – 5^o C in next 28 years.



Cooling Singapore Project



Urban Heat Island Studies

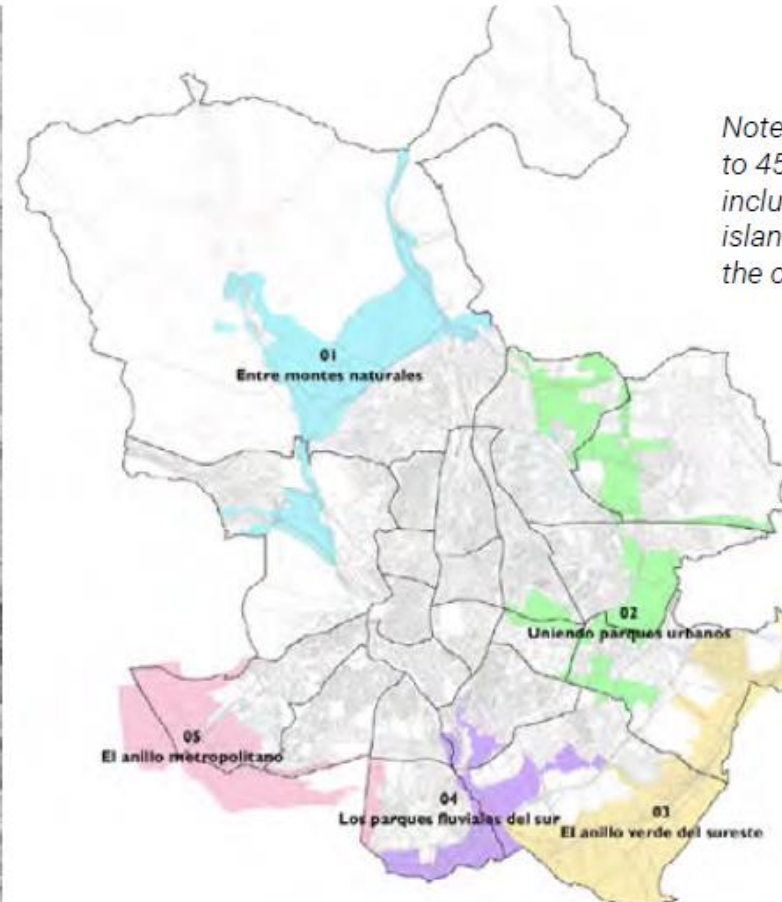
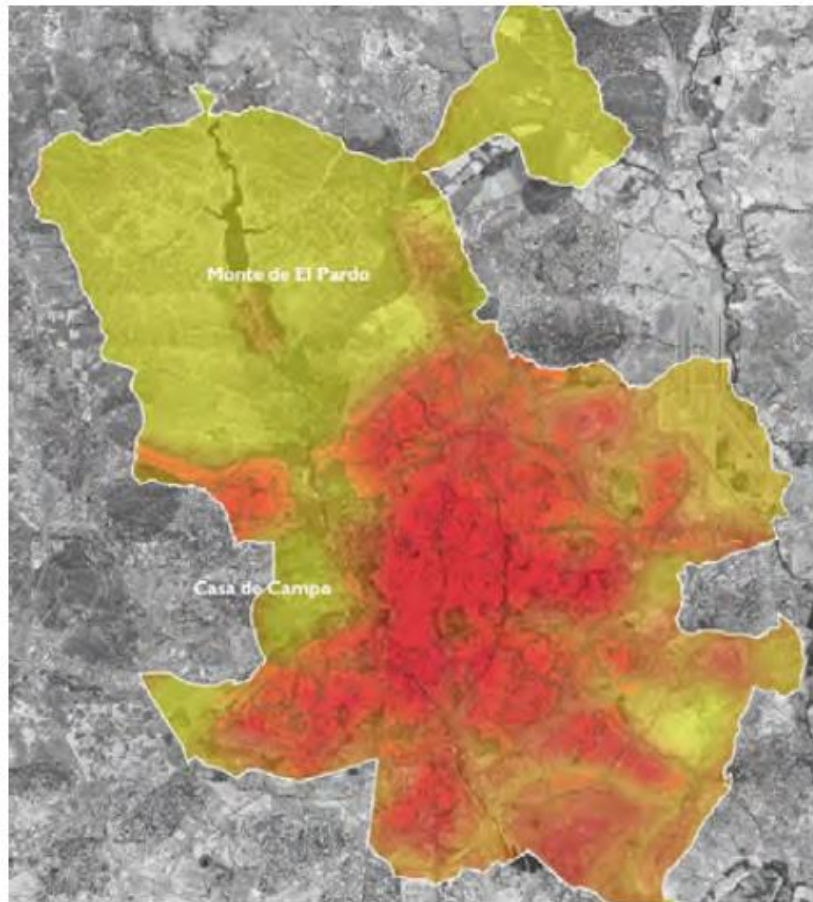
Benefits of Green Infrastructure on UHIE

- Surface temperature of green roofs could be reduced by 15°C in comparison to nongreen roofs.
- Nearby microclimate air temperature can be reduced by 2 – 5°C.
- Reduced energy demand depending upon type of buildings.
- Temperature difference between Urban areas and big city parks is between 1.5 – 4°C.
- Green walls/ facades can reduce nearby outdoor temperature between 0.5 – 4°C





Madrid, Spain

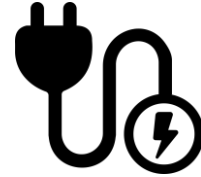


Note: Madrid's plan to plant up to 450,000 native trees by 2030 includes attention to urban heat islands in the south and east of the city.

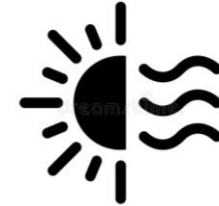
Tree Planting initiative in Madrid based upon UHI Assessment.



- Highest urbanization rate in the country - Tamil Nadu will be the most urbanized state **with 67 % of its population living in urban area by 2030.**



- Tamil Nadu's peak power demand is estimated to grow 65% to 27,392 MW by 2026-27 from 16,541 MW in 2021-22.
- **Air conditioning demand is rising and contributing to Peak Demand**



- Rise in Humidity due to higher evaporation and moisture in the atmosphere is happening at a faster pace.
- The coastal areas like Chennai is getting vulnerable due to higher humid heat.
- **The May-June 2023 witnessed the worst heat waves across Tamil Nadu.** It impacted the labor well-being and the economy.



Comprehensive digital mapping of **hotspots, urban nature, and cooling demand in Chennai city.**

Convened Stakeholder Meetings to achieve extreme heat resilience and sustainable cooling - Setting up Guidelines, Standard Methodologies etc.

Training and capacity building of urban planners of CMDA, local stakeholders on UHIE

Integration of sustainable cooling and heat resilience into **Chennai's masterplan.**



Thermal comfort in the affordable building - A pilot on cool roof at a lighthouse project with RMI.

- Baseline creation, paint selection, vendor selection ongoing



Public procurement of Sustainable cooling technologies Superefficient fans and air-conditioners - update PwD SoRs



District Cooling – Feasibility study with TIDCO on pilot district cooling project integration in a large green field project – Fintech City, Chennai



Study tour to Singapore and GIFT City for Capacity building and awareness raising on District Cooling.

Objective

- Develop and test a methodology for assessing urban heat island for national replication.
- To support CMDA to deliver sustainable cooling into various urban plans. Urban Heat Island Assessment and Actions feeding into the third masterplan for the Chennai Metropolitan Region.
- Training and capacity building of urban planners in the State

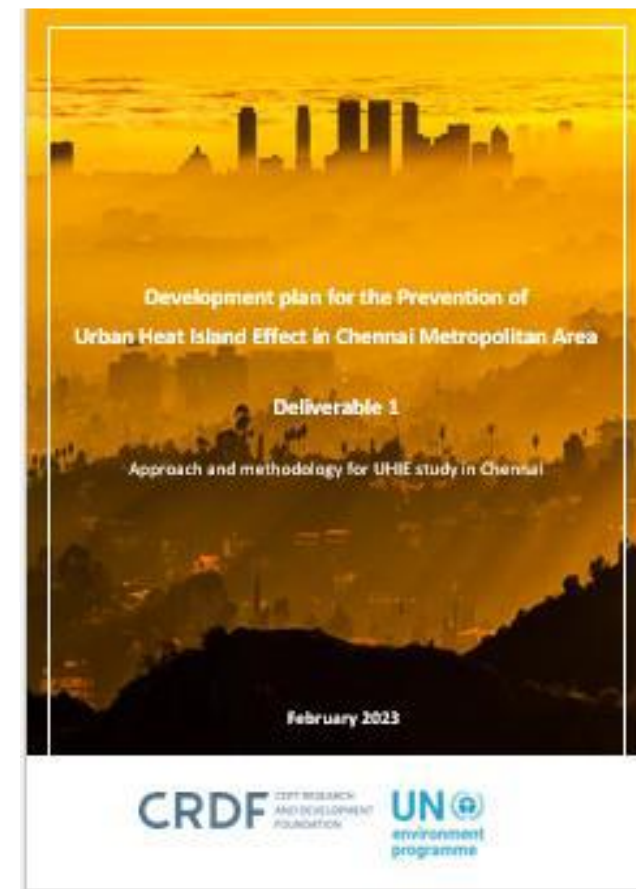
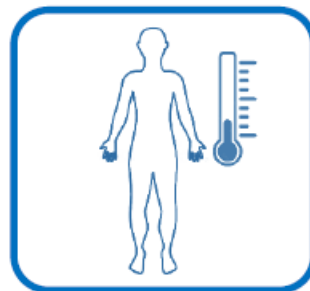
Urban Heat Island Effect - CMA

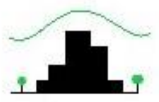
1. Development of Heat Action Plan

2. Impact due to Urban Planning

3. Improving the Outdoor Thermal Comfort

4. Reduction in the GHG emission

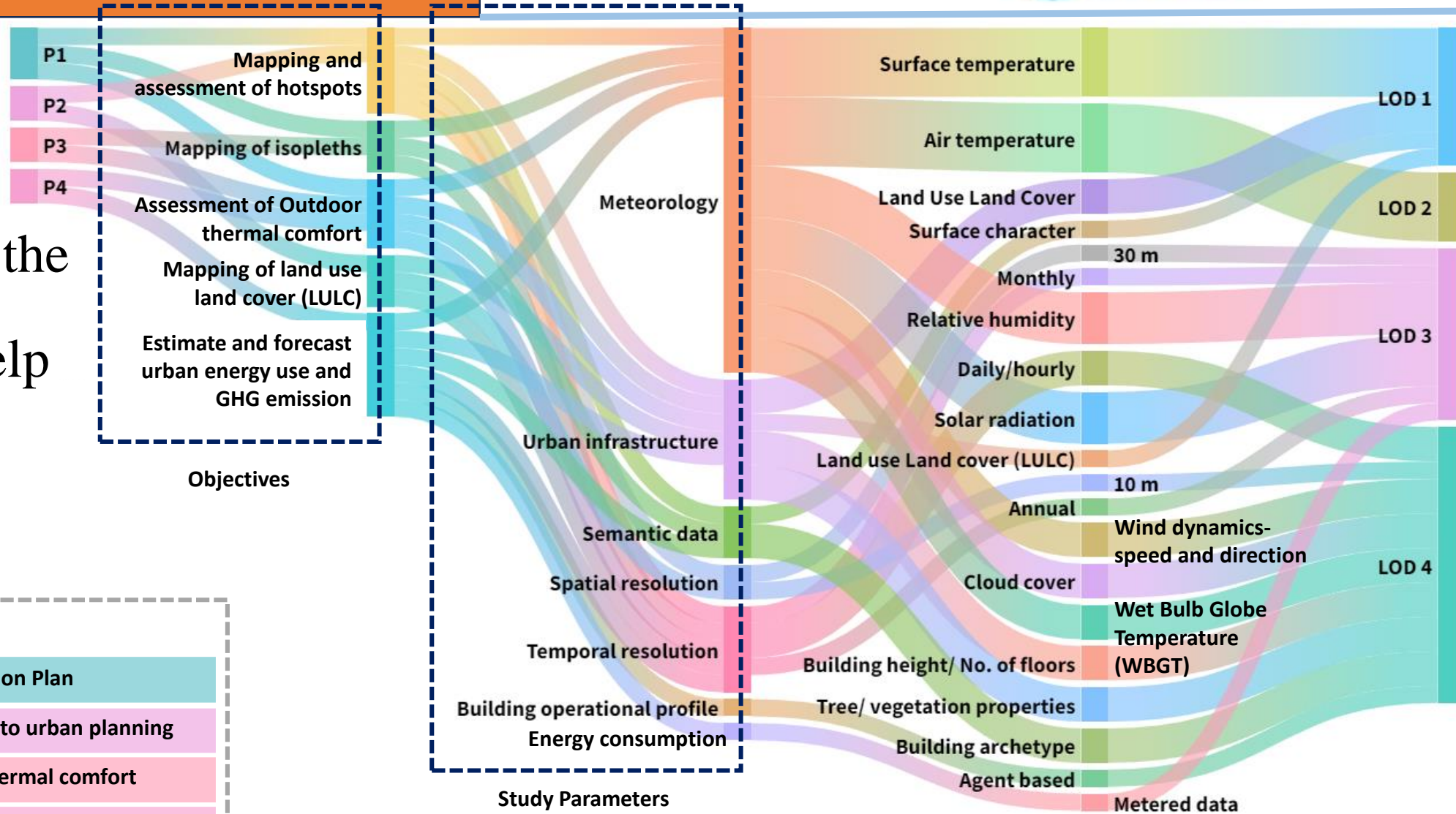




UHI Assessments for Sustainable Cooling & Heat



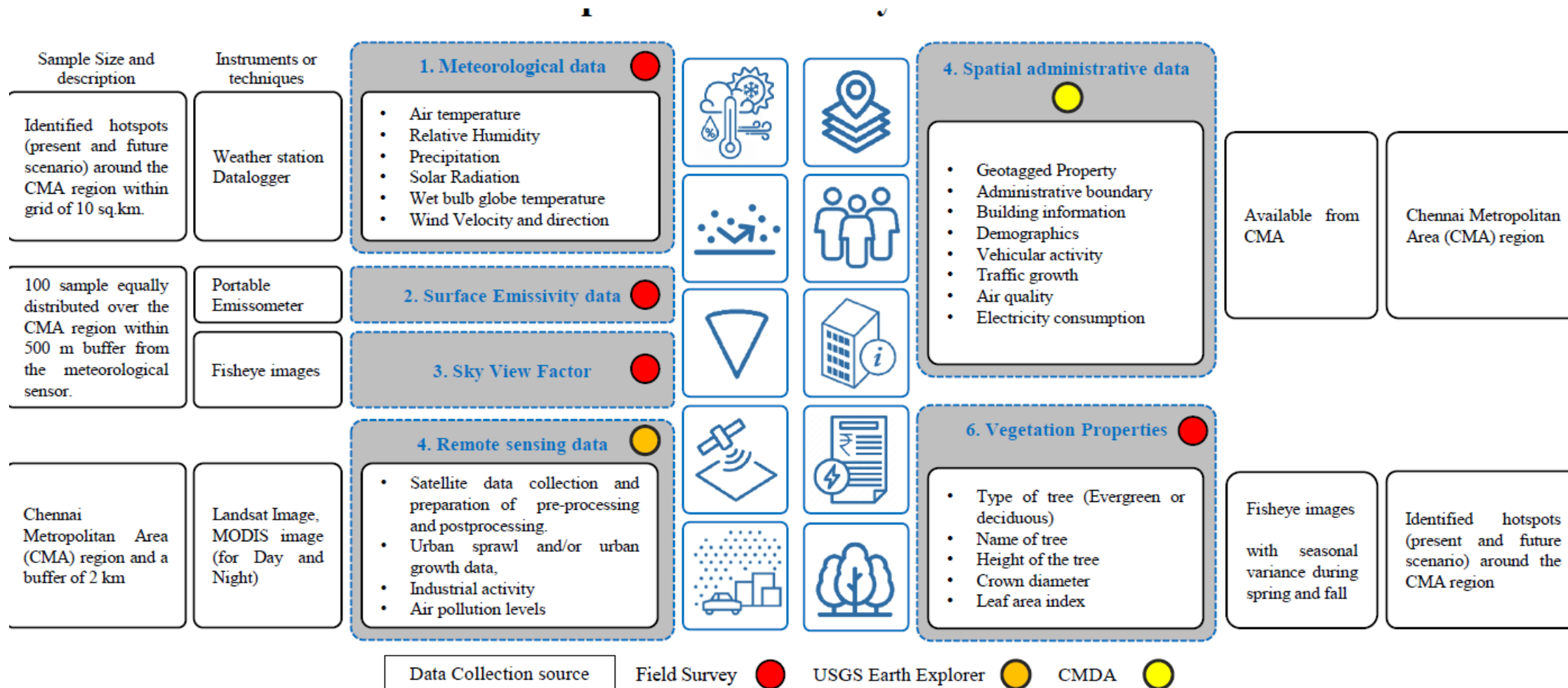
Standardized methodology for the UHIE study to help Indian cities.



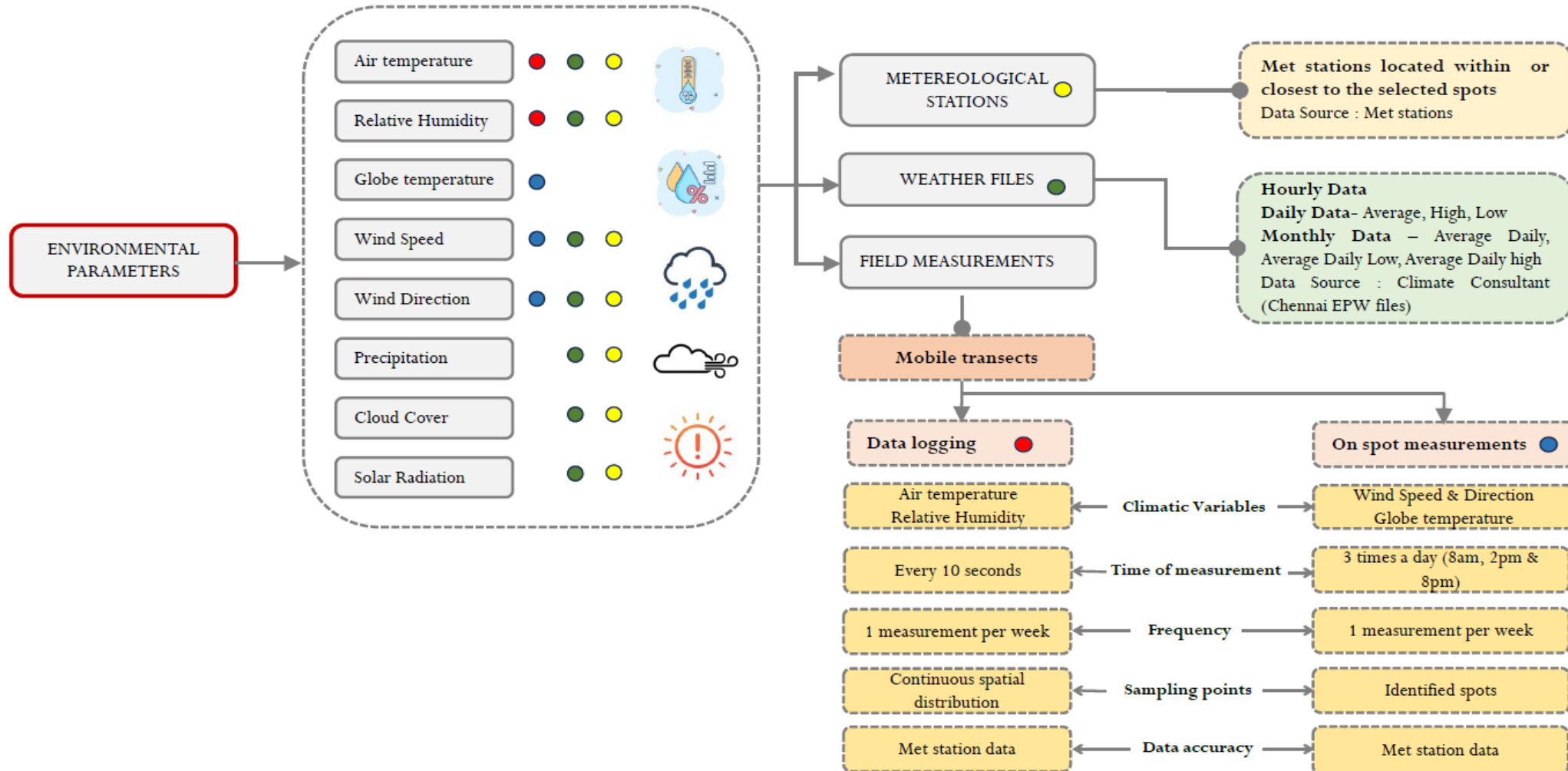
Purposes

P1	Development of Heat Action Plan
P2	Assessing the impact due to urban planning
P3	Improving the outdoor thermal comfort
P4	Reducing the GHG emission

Data collection Chennai Metropolitan Area Study- Methodology

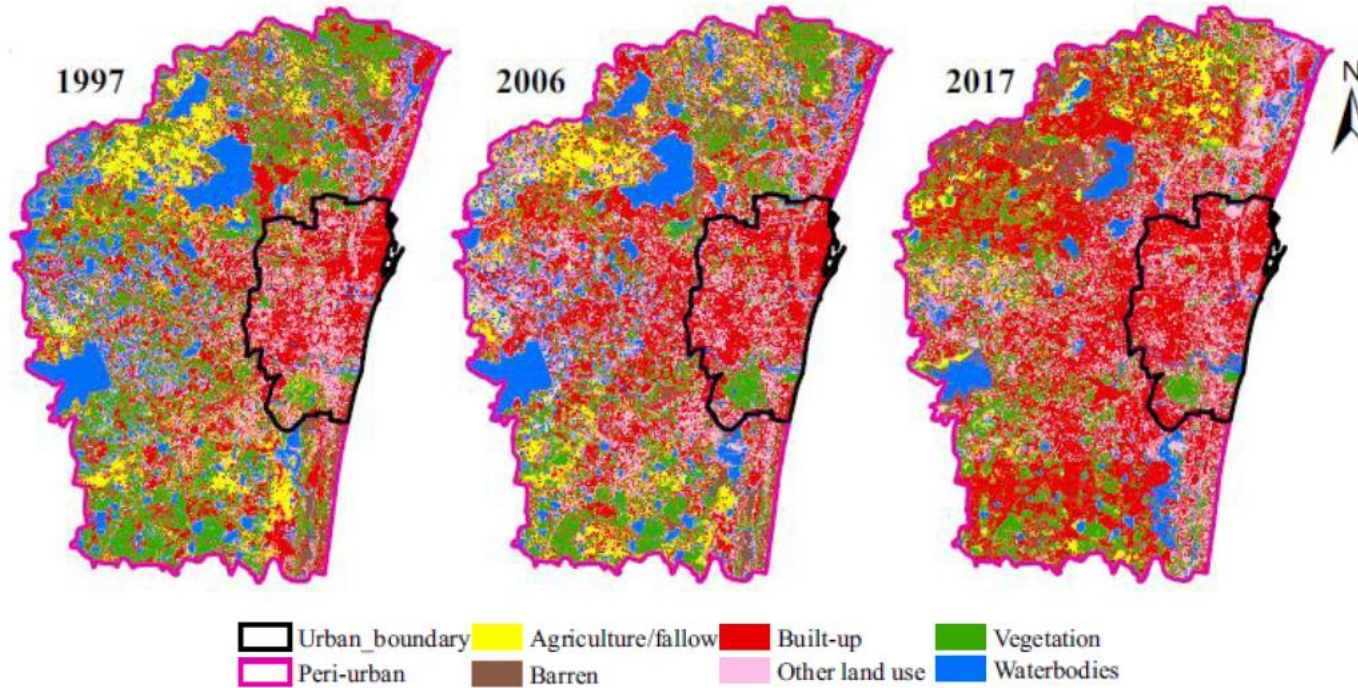


Hotspots identification - Methodology



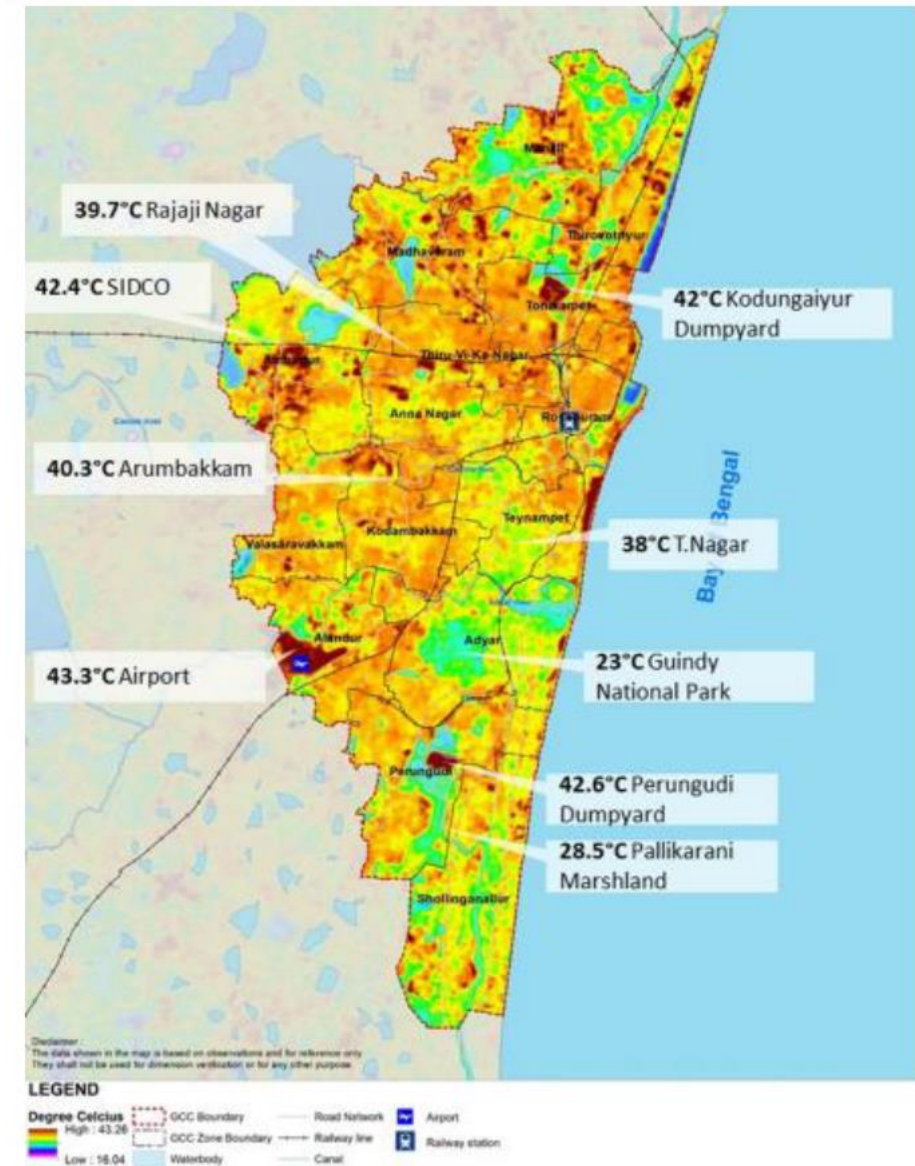


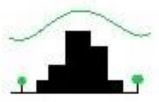
UHI Assessment for Chennai



Dynamics of Land Use Land Cover & Land Surface Temperature of Greater Chennai Corporation 2021

(Source: Rawal, R., Shukla, Y., Das, S., Chavda, T. (2023, August). *Literature review and assessment report of UHIE in CMA*)



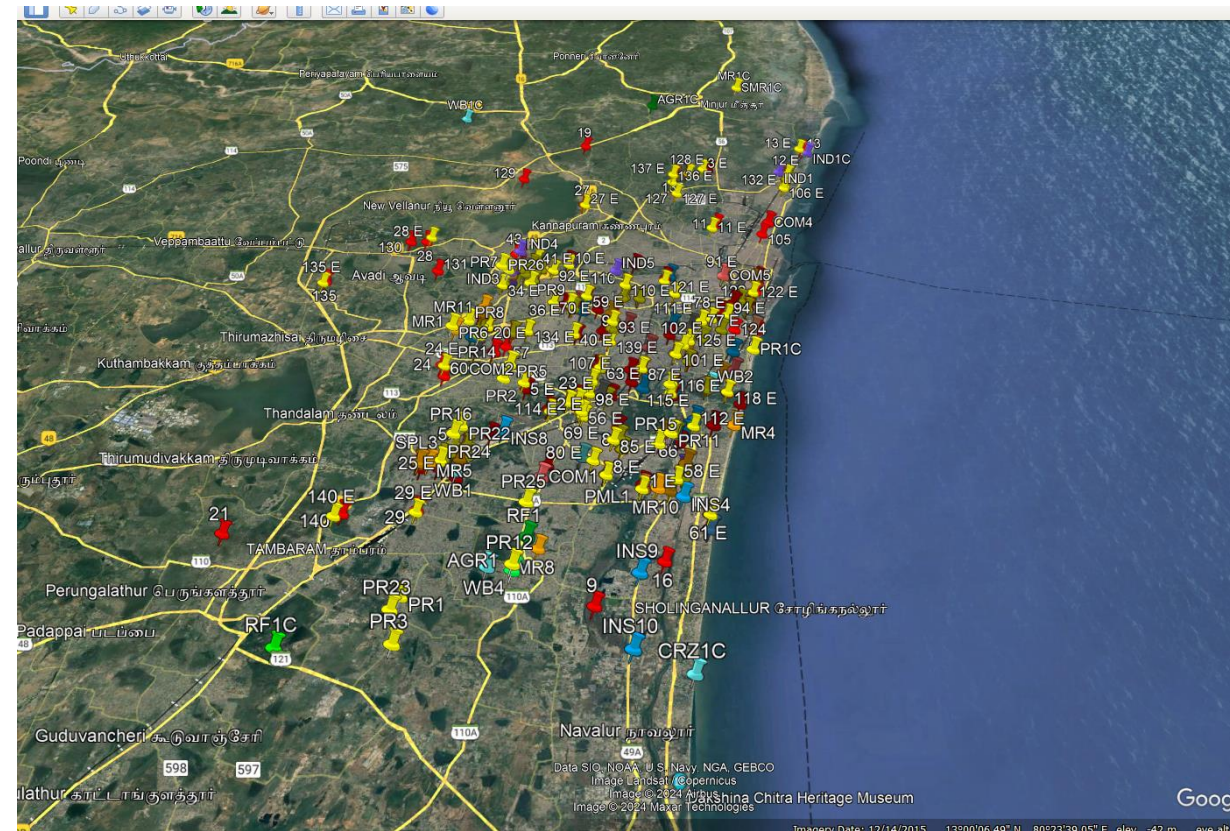
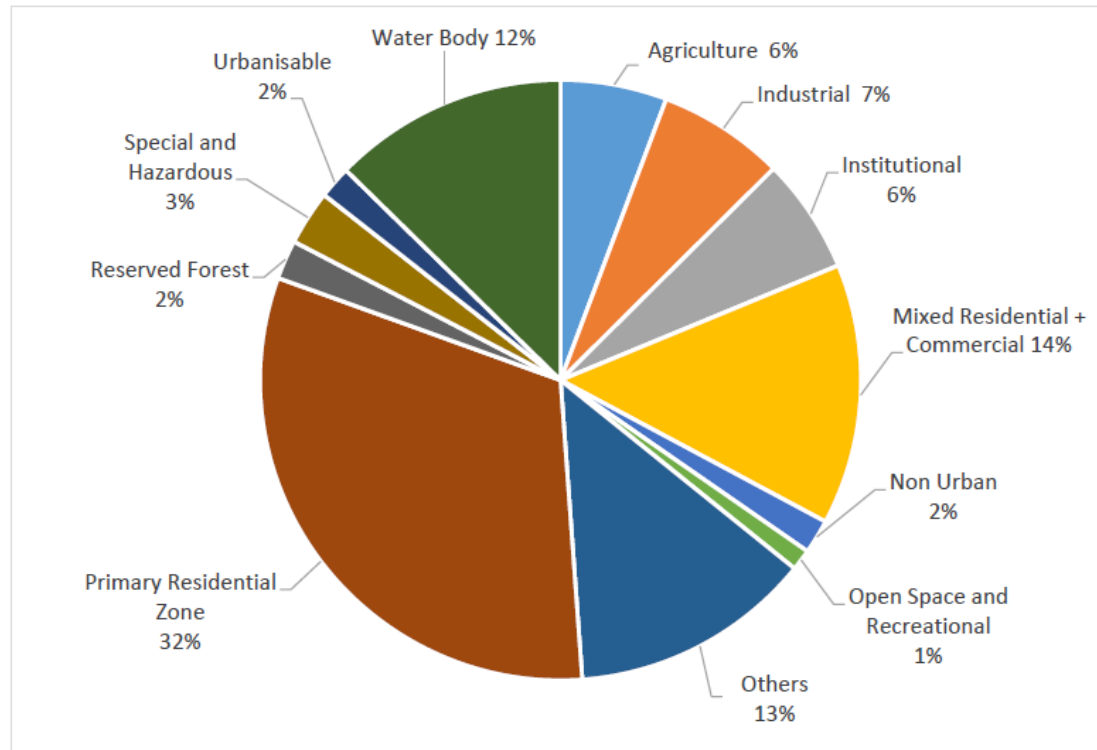


Selection of Hot & Cold Spots

SCHOOL OF ARCHITECTURE AND INTERIOR DESIGN
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY, KATTANKULATHUR



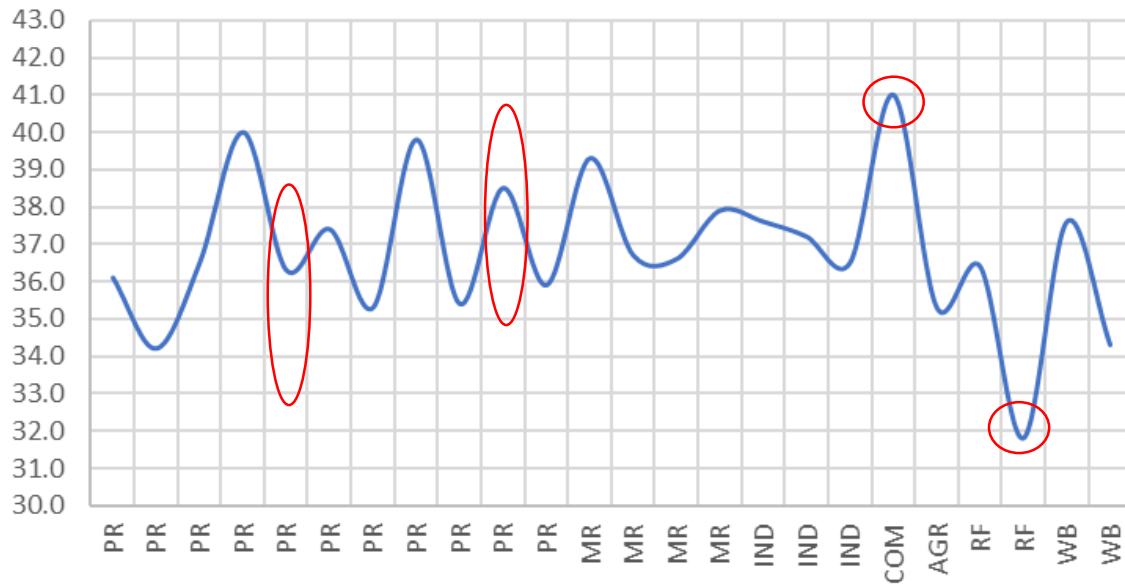
1.3 LAND USE DISTRIBUTION % AS PER CMA



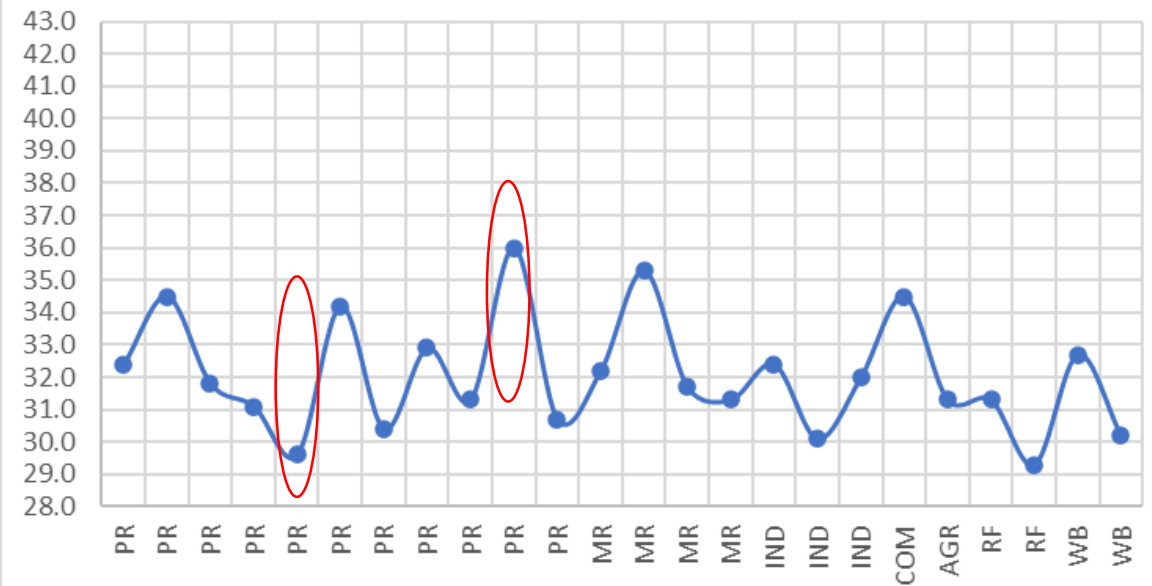


Initial Results - Chennai

UHI Intensity on 5th Oct, 2023 - 14:00-16:00 hrs



UHI Intensity on 5 Oct, 2023 - 19:00-21:00 hrs



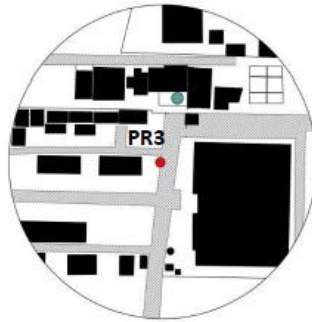


Data Collection and Surveys during UHI monitoring through Mobile Traverse method in Chennai

GOOGLE EARTH IMAGE



AUTOCAD TRACED WITH GOOGLE SATELLITE MAP AND GOOGLE MAP STREET MAP(DEFAULT MAP)



USING PYTHON CODING ON QGIS WITH GOOGLE EARTH ENGINE AND OPEN STREET MAP



QGIS USING GOOGLE SATELLITE VIEW AND OPEN STREET MAP



PR3

Primary Residential



Glass Aluminum frame window (E = 0.89)

Brick (E = 0.90)

Steel railing (E = 0.82)

Concrete blocks (E = 0.90)

Bitumen Road (E = 0.86)



Way Forward

Development of a plan for the Prevention of the Urban Heat Island Effect with suggestions for incorporation of results in Chennai Master Plan (2026 – 46)/New Area Development Plans.

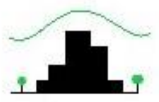
Tools to quantify benefits from Long Term - UHI Mitigation Measures

- ➔ Urban Form
- ➔ Green & Blue Infrastructure – Treen Canopies, parks, urban forests, water bodies
- ➔ Shading, Roof Surfaces, Cool Surfaces

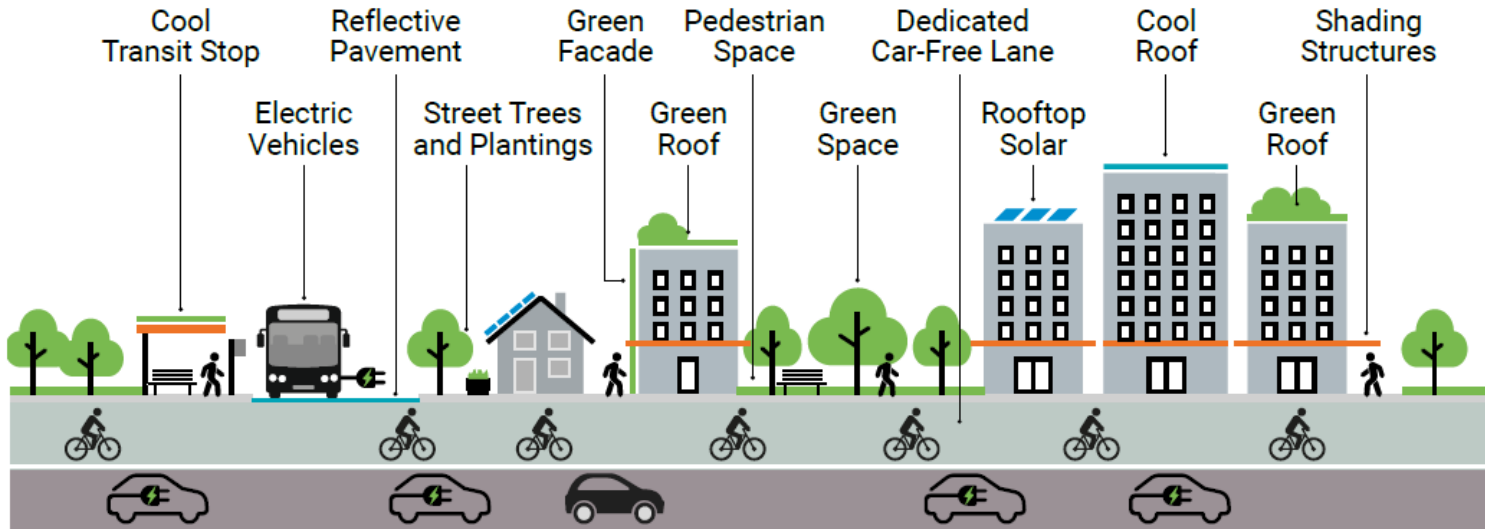
Impact Assessment of UHIE (historic evidence & projections)

- ➔ Energy Related Impact
- ➔ Health & Well being
- ➔ Urban Growth & Economic Development

Urban Heat Adaptation Guidelines to be included in the master plan and new area development plans by CMDA



Conventional



versus

Sustainably Cooled Heat Resilient Urban Areas

Source: RMI

Note: In the figure, the conventional urban area has a high proportion of impervious surfaces and single-occupancy vehicles. By comparison, the heat-resilient urban area has a higher proportion of green space, cool surfaces, alternative modes of transport and electric vehicles.



Urban Planning for Sustainable Cooling & Reducing Heat

- Heat Minimising Planning
 - Optimising shape and planning of built environment
- Thermally Favourable use of materials
 - Composition of streets, sidewalks and other surfaces
- Nature based cooling
 - Green & blue spaces
- Reducing anthropogenic heat

Plan Land use with open spaces, water bodies, enhance ventilation, shading

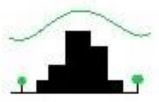
Use light colour surfaces – reflect sunlight maintaining cooler surfaces

Reduce Heat from vehicles & waste heat from air conditioning of buildings.

Benefits of Long Term UHI Mitigation Measures

- Reduction in ambient temperature – upto 10^o C
- Upto 20% Reduction in Cooling energy demand & GHG emissions
- Resilient Urban population
- Economic Development





Thank You

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