

# Framework for Urban Cooling Plan (Rajkot, Gujarat)

*- Supported by UNEP*



**ACTIVE IN**  
125+ COUNTRIES

**24 OFFICES**  
WORLDWIDE

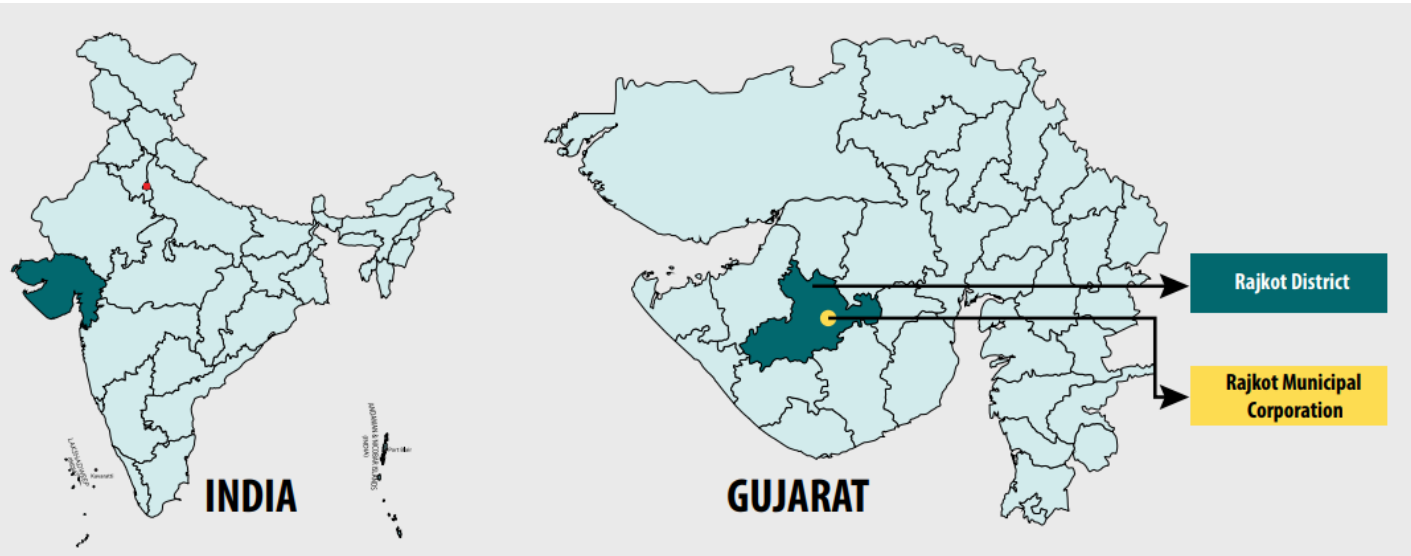
**2500+ LOCAL**  
AND REGIONAL  
GOVERNMENTS

**IMPACTING**  
MORE THAN **25% OF**  
PEOPLE LIVING  
IN CITIES

## Urban Heating and Cooling projects in India

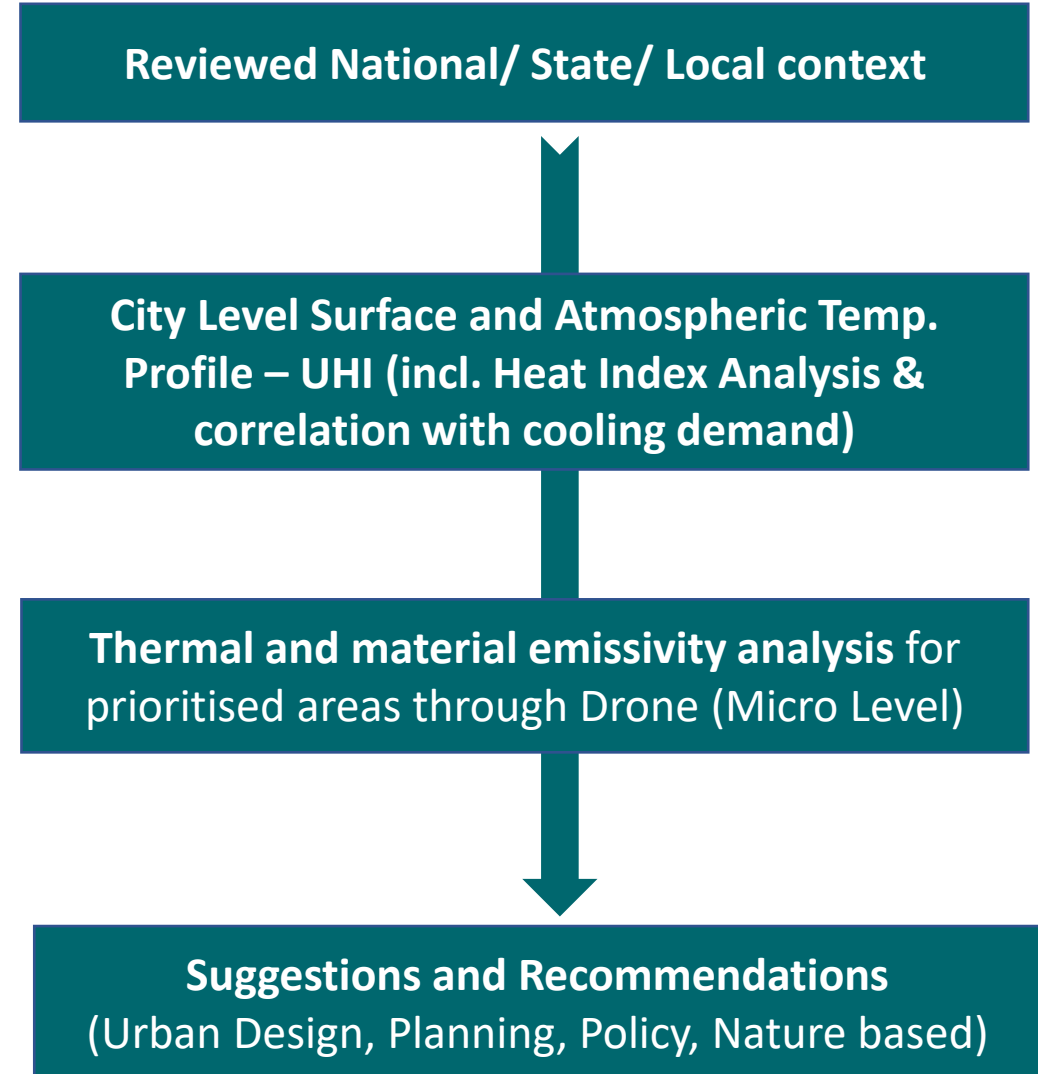
- Rapid assessment for District Cooling Potential of 5 Indian cities (Rajkot, Bhopal, Thane, Coimbatore and Pune)**
- Rajkot Urban Cooling Plan Framework – focused Urban Heat Island (UHI) in the city and strategizing feasible interventions to create thermally comfortable environment**
- Building Energy Accelerator (Phase I : Green Building Guideline for Rajkot; Phase II: Guidelines on EE housing Nagpur & Benchmarking on energy use in 10 commercial & 10 government buildings)**
- Zero Carbon Building Accelerator: City level Zero Carbon Building Road Map & Action Plan**

# Rajkot Urban Cooling Plan Framework

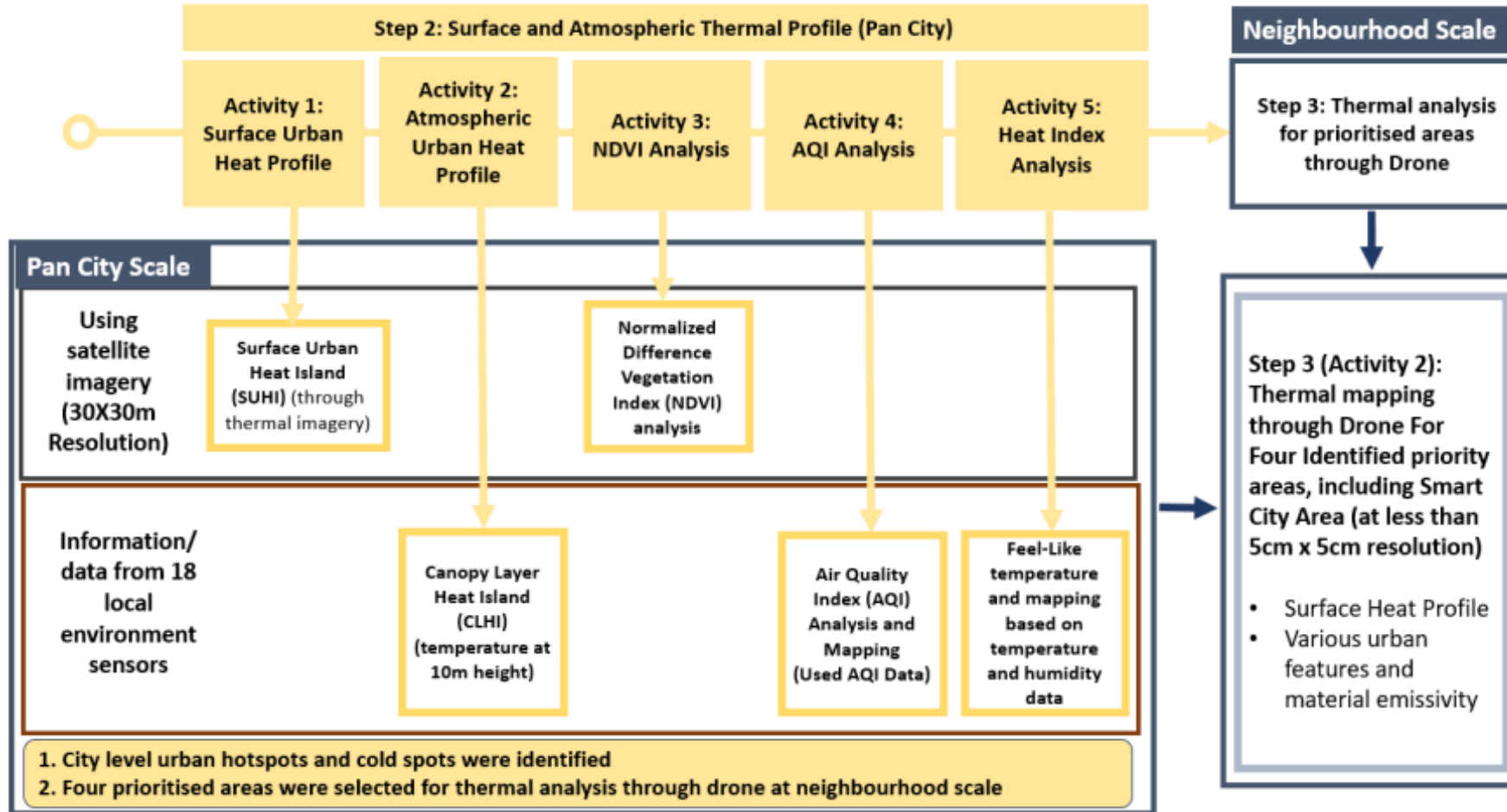


 <p><b>Area</b> 161.86 sq.km</p>	 <p><b>Population</b> 1.7 Million</p>	 <p><b>Climatic Condition</b> Hot &amp; Dry</p>
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- 4<sup>th</sup> largest city of Gujarat
- 22<sup>nd</sup> global fastest growing city and urban area from 2006 to 2020



## Methodology for UHI

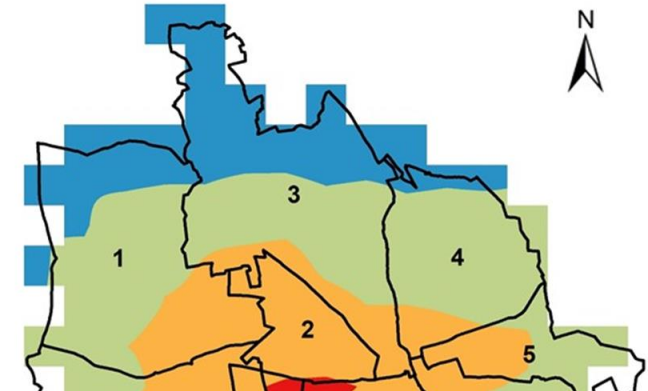
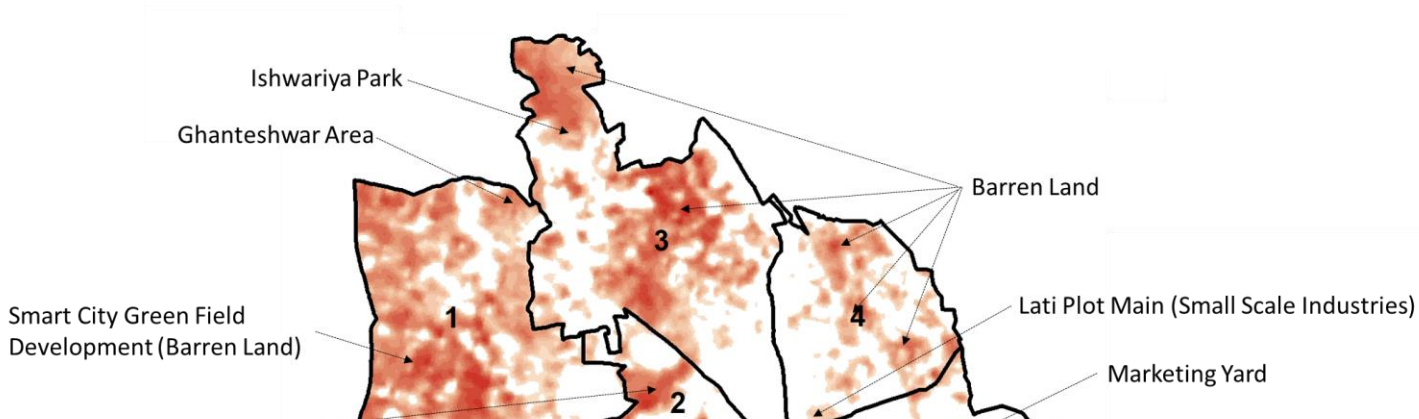


- Analysed surface Heat Island & Canopy Layer Heat Island (Boundary layer is not analysed)
- Used open source satellite image for Surface Heat Island (seasonal analysis for 2010, 2015 & 2020 – considered May for further analysis)
- Used data from 18 environment sensors for canopy layer heat island and city level heat index (2020)

# Surface Urban Heat Island

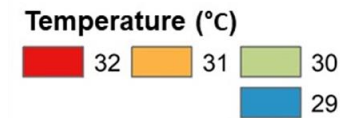
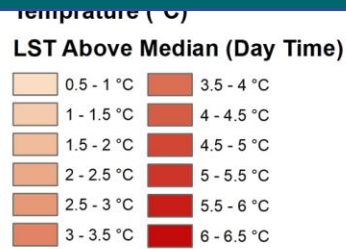
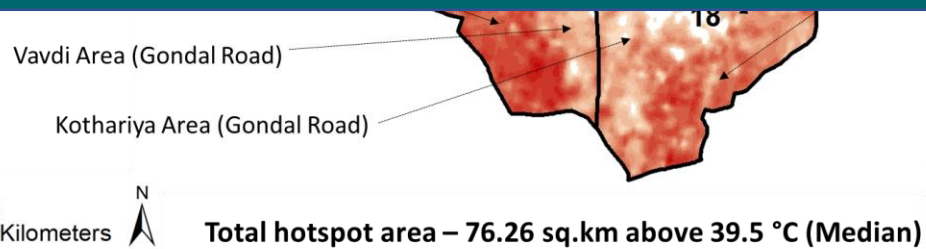
Day time (Landsat 8 – 30X30m)

Night time (MODIS – 500X500m)



## Challenges/ Limitation:

1. Time and Resource Constrain (short-term assignment) - Couldn't procure and analysed high resolution imagery from National Remote Sensing Center (NRSC)
2. As satellite thermal imagery of 30X30m resolution from Landsat 8 for night time was not available, considered satellite image of 500X500m resolution from MODIS



Statistics  
 Min Temp.- 28.25°C  
 Max Temp.- 31.17°C  
 Mean Temp.- 29.78°C

## Canopy Urban Heat Island

Air Temperature, May 2020			Relative Humidity, May 2020			'Feel Like' Temperature, May 2020		Temperature (°C)				
Ward Number	Area of ward (sq. km)	Total no. of residential properties	Total no. of commercial properties	Property density <sup>30</sup> (properties/ sq. km)	Estimated total electricity consumption for space cooling in residential and commercial properties (Million kWh/ year)	Development characteristic of the ward	Surface and Feel Like Temperature	29	30	31	32	33

### Challenges/ Limitation:

#### 1. Lack of data availability:

- As temperature and humidity related data from 18 environment sensors was available only for the year 2020, analysis for atmospheric urban heat island has been undertaken for year 2020.
- As ward level/ city wide information on electricity use for space cooling, electricity consumption figures for year 2020 have been estimated based on secondary studies and appropriate assumptions.

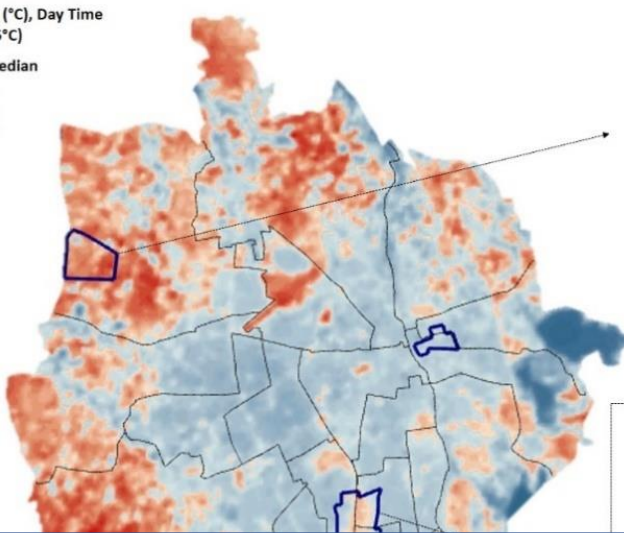
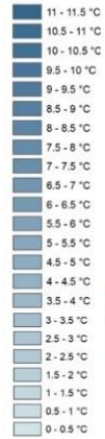
						demand for space cooling as compared to average, with high property density.	feel like temperature (39°C)					
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relative humidity of 71%.

Neighbourhood Level Assessment (Using Drone mounted with RGB and Thermal Sensor)

Temperature (°C), Day Time Median (39.5°C)

LST Below Median



**Smart City – Green Field**

Type of Built Form:  
Barren land, Water Body, Vegetation

Surface Temperature:  
Water Body - ~35°C  
Barren Land - ~43°C to 45°C

**Malaviya & Atika**

Type of Built Form:

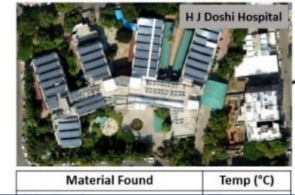
Malaviya and Atika



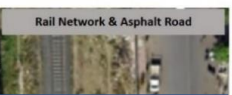
Material Found	Temp (°C)
Tree Cover	31 to 32
Bare Ground	34
Concrete Roof	39
Reflective roof	36 to 37
Green coated metal Sheet	39
Red clay roof	36 to 37



Material Found	Temp (°C)
Blue coated metal sheet	41
Old corrosive metal sheets	37 to 40
Bitumen coated roofs	39
Silver coated metal sheets	38 to 39
Scrap material storage	36 to 39



Material Found	Temp (°C)
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**Challenges/ Limitation:**

1. Considering time and resource constrain, thermal analysis through drone for land surface temperature, urban features and material emissivity etc. was proposed for four locations (limited to 4 sq. km of total area) for one season (monsoon)
2. Few potential areas were not considered for thermal survey through drone considering its close proximity to 'drone flying prohibited areas' like; Airport, Research and Analysis Wing (RAW) office and IOC depot etc.

## Example of Results (Material wise surface temperature):

Land use	Type various material used	Observed Surface Temperature Range (°C)	Average Surface Temperature (°C)																																																	
	Concrete roof	30	30																																																	
Reside	Concrete roof	<table border="1"> <thead> <tr> <th>Sr. No.</th> <th>Base material of roofing</th> <th>Roofing intervention</th> <th>Colour of roofing intervention</th> <th>Base material temperature<sup>12</sup> (°C)</th> <th>Post roofing intervention temperature (°C)</th> <th>Potential temperature reduction range (°C)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td>Heat resistant tiles</td> <td>White</td> <td>36.3 °C</td> <td>34.9 °C</td> <td>1-2.5 °C</td> </tr> <tr> <td>2</td> <td></td> <td>White roof paint</td> <td>White</td> <td>36.4 °C</td> <td>34 °C</td> <td>1.5-3 °C</td> </tr> <tr> <td>3</td> <td></td> <td>Shadow from the nearby tree/vegetation<sup>13</sup></td> <td>Shadow</td> <td>36.3 °C</td> <td>33.7 °C</td> <td>2-3 °C</td> </tr> <tr> <td>4</td> <td></td> <td>Shading from green garden matt<sup>14</sup></td> <td>Green</td> <td>36.3 °C</td> <td>34.2 °C</td> <td>2-3 °C</td> </tr> <tr> <td>5</td> <td></td> <td>China mosaic</td> <td>Multi-color</td> <td>36.7 °C</td> <td>35.3 °C</td> <td>1-3 °C</td> </tr> <tr> <td>6</td> <td></td> <td>Green roof (having garden / vegetation on roof)</td> <td>Green</td> <td>36.4 °C</td> <td>32.8 °C</td> <td>2-4 °C</td> </tr> </tbody> </table>	Sr. No.	Base material of roofing	Roofing intervention	Colour of roofing intervention	Base material temperature <sup>12</sup> (°C)	Post roofing intervention temperature (°C)	Potential temperature reduction range (°C)	1		Heat resistant tiles	White	36.3 °C	34.9 °C	1-2.5 °C	2		White roof paint	White	36.4 °C	34 °C	1.5-3 °C	3		Shadow from the nearby tree/vegetation <sup>13</sup>	Shadow	36.3 °C	33.7 °C	2-3 °C	4		Shading from green garden matt <sup>14</sup>	Green	36.3 °C	34.2 °C	2-3 °C	5		China mosaic	Multi-color	36.7 °C	35.3 °C	1-3 °C	6		Green roof (having garden / vegetation on roof)	Green	36.4 °C	32.8 °C	2-4 °C	
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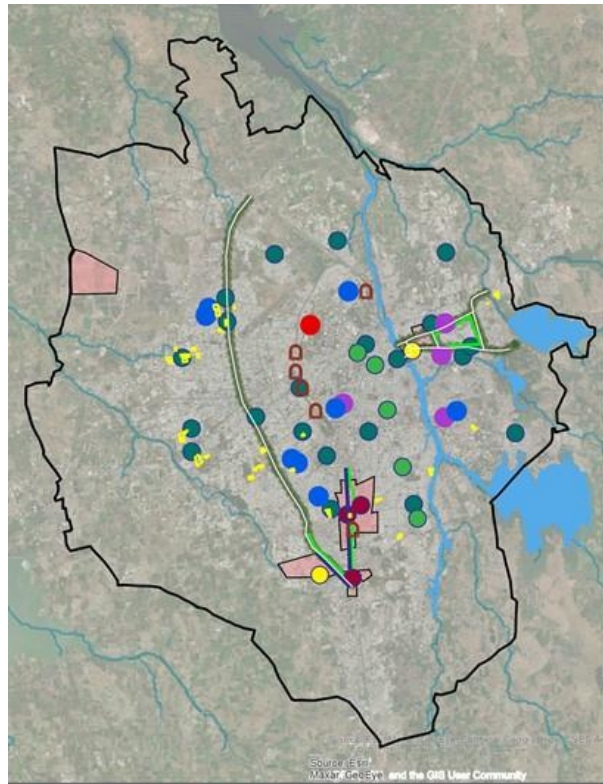


## Recommendations

	Establish cooling cell and prepare long term strategy	Policy implementation and financial incentives	Implement planning interventions	Implement cooling interventions	Implement pilots to demonstrate cooling solutions	Advocate and Promote
Short Term	A cooling cell within the Smart City SPV RSCDL can coordinate with multiple stakeholders		Reflective surfaces and lighter colour at urban roofs, walls, and pavements, Expand green cover and tree canopy, Increase shading and permeable surfaces, Involve community as a key stakeholder for cooling policies			City administration needs to play the role of an anchor to motivate and enable coordinated action, On-board various stakeholders
Medium Term	Undertake a heat island mapping exercise, Undertake city wide tree density analysis	Develop guideline to support the effective development of green cover and land zoning		Adopt cooling solutions in upcoming municipal buildings, Create knowledge material of use cases which highlight and quantify the energy and cost savings	Adopt cooling solutions in upcoming municipal buildings, Create knowledge material of use cases which highlight and quantify the energy and cost savings	
Long Term	Incorporate appropriate cooling measures and solutions in upcoming TP schemes, Promote voluntary green building certifications, Monitor & feedback for implementation of cooling intervention	Offer incremental benefits in a manner corresponding to the certification level/grade achieved in green building certification, Offer tax incentives	Improve blue spaces, Promote wind-induced air flow, Promote energy efficiency, energy audit to reduce waste heat, Reduce air pollution		Adopt emerging technologies/approaches by tapping into private sector finance, Prepare a guidebook on building and neighbourhood level cooling solutions	Undertake awareness campaigns to educate citizens on the heat island effect and solutions to address the same at the building scale.

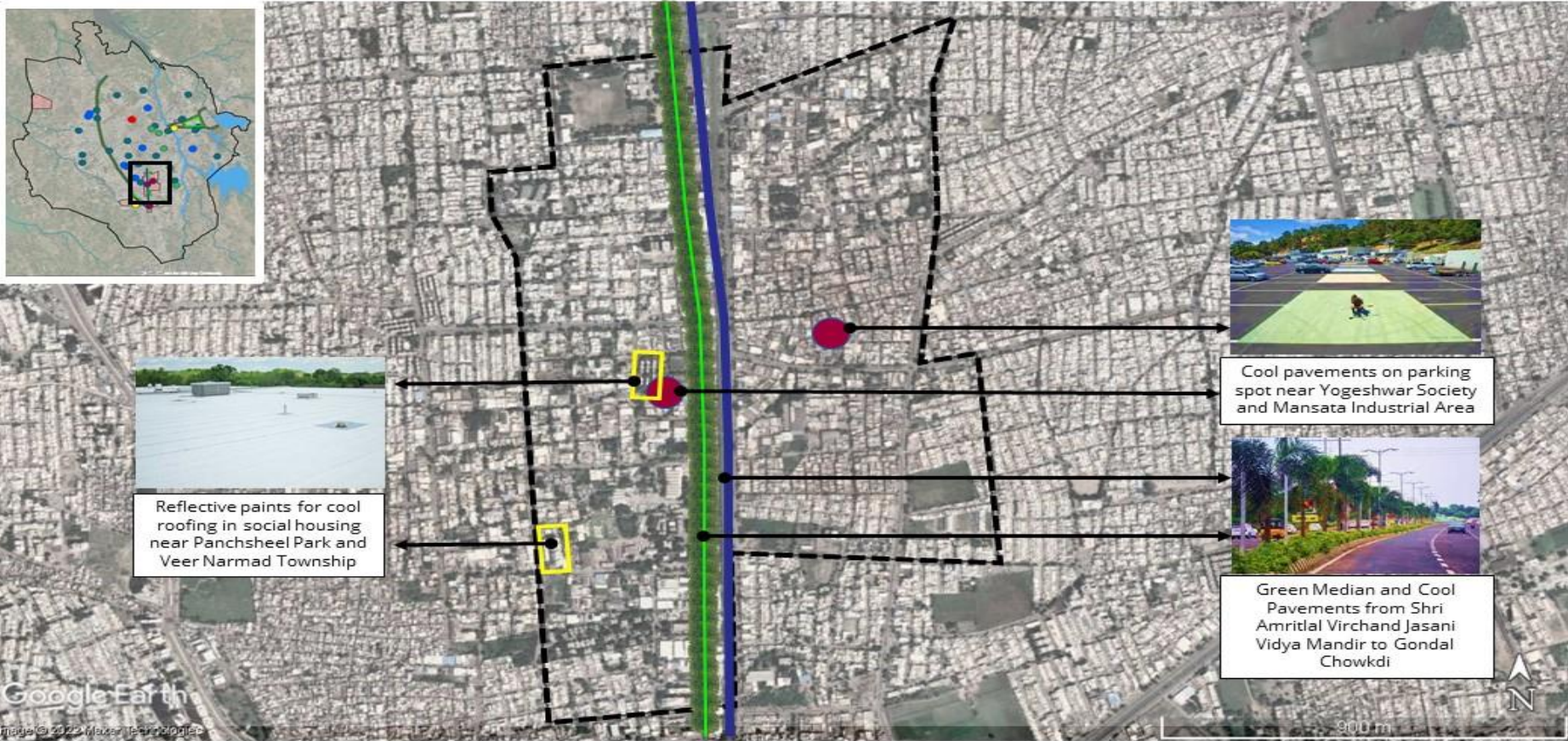
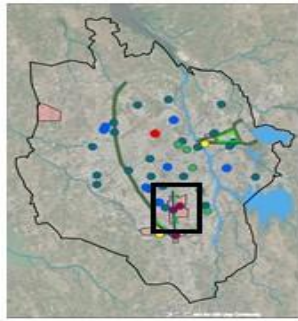
Ankit Makvana, Manager, ICLEI South Asia, April 12, 2023, New Delhi

## Project and Site Specific Recommendations



- Hawkers Zone
- Auditorium
- Tree Corridor
- Vegetable Market
- Under bridge
- Parking
- Schools
- Trees
- Social Housing
- UHC
- Green Median
- City Boundary
- Community Hall
- Reflective Footpath
- Neighbourhood Boundary

### Malaviya and Atika



- Green Median
- Tree Corridor
- Social Housing
- Reflective Footpath
- Parking



Cool pavements on parking spot near Yogeshwar Society and Mansata Industrial Area



Green Median and Cool Pavements from Shri Amritlal Virchand Jasani Vidya Mandir to Gondal Chowkdi

## Other Challenges:

- 1. Urban heat issues and cooling solutions is not city's priority/ mandate**
- 2. No dedicated department/staff to coordinate or implement urban cooling solutions and monitoring impact**
- 3. City has limited control on specific areas (e.g., industrial estates, forest land, railway etc.), which are also governed by specific planning guidelines - creating barrier for the city to implement urban cooling interventions.**
- 4. Lack of dedicated policy focus and enforcement mechanisms**
  - Example: 1) Provision of tree plantation depending on built up area as per GDCR; 2) Reserved area under town planning scheme and priority;
- 5. No demand for green and energy efficient buildings from the consumer side**
- 6. Inadequate financial support for adoption of cooling solutions**
  - Example: Incentives in the form of 5% discount in the chargeable Floor Space Index (FSI) for certified green buildings as per GDCR
- 7. Limited information to quantify benefits associated with urban cooling solutions, makes it hard to attract private capital and external financing for scalable implementation.**

Thank You!

Ankit Makvana (Manager, Gujarat Operations, ICLEI South Asia)

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