Aga Khan Agency for Habitat

Urban Heat Island Assessment and Mitigation Project

at Hyderabad (2021-2022)

Deoraj Gurung - Programme Coordinator for Preparedness & Safety

Rahim Dobariya - Programme Manager Geospatial Information

Rajlakshmi Dubey - Programme Manager – Habitat Planning and Research

Sana Dharani - Head of Department - Habitat Improvement

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1. UHI Macro level assessment for Hyderabad City (2022)
- City scale assessment and identification of hotspots in the city
- Stakeholder consultation workshop with GHMC – City planning, urban biodiversity

2. UHI mitigation at Garden housing, Hyderabad (2021-2022)
- Applied China Mosaic & Cool-roof coating over 1 lac sq.ft. area.
- IIIT Hyderabad researched the outcome - Avg 1.8ºC - max 3.6ºC indoor temperature and 19.8ºC Surface temperature reduction. Improved thermal comfort

3. UHI mitigation with vegetation in peri urban & urban areas (2022)
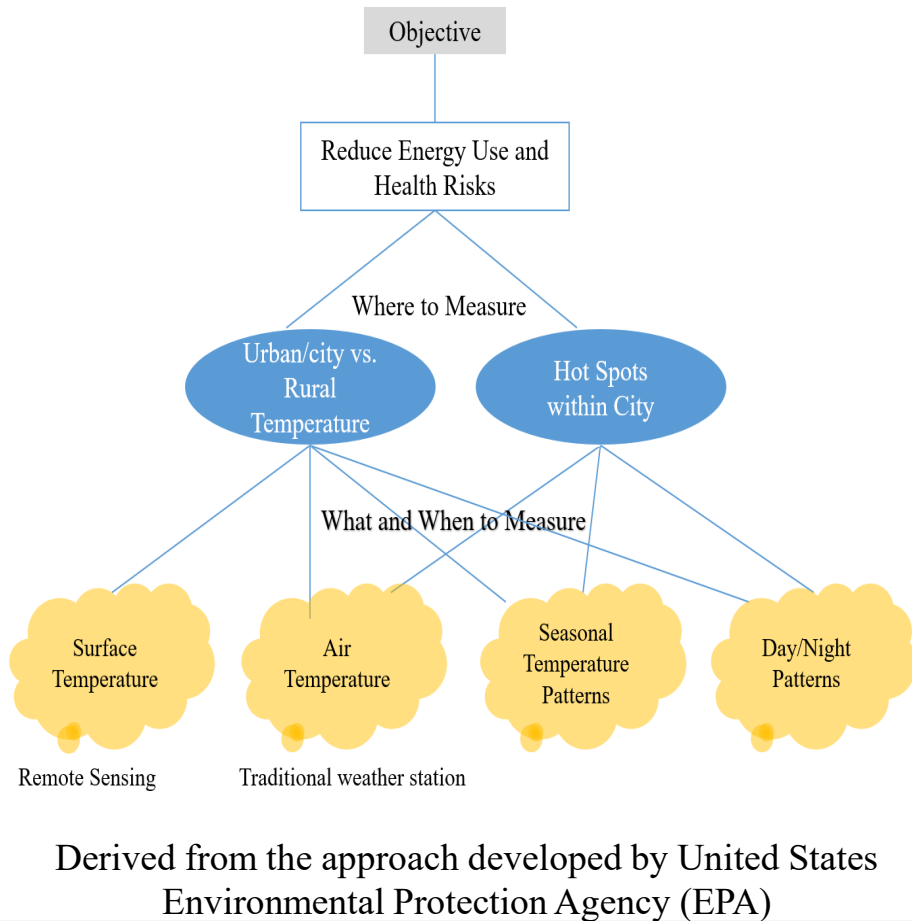- Miyawaki plantation (urban micro forests) in **at Maliya and Rajkot**
- Air and water quality, micro-climate improvement and biodiversity enhancement, decarbonisation along with heat reduction

4. Community Based Disaster Risk Reduction for Heatwave (2020)
- Heatwave alerts and awareness campaign on adaptation measures

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Methodology for UHI macro level assessment

Derived from the approach developed by United States Environmental Protection Agency (EPA)

Objectives of the project:

- Study change in land use land cover (LULC) and analyse air and surface temperature to understand its impact on Urban heat island and identification of hotspots within the city.
- To pilot mitigation measures at community scale that reduce energy use, improve thermal comfort and reduce emissions.
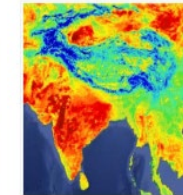
Data Sources

IMD Air Temperature & Rainfall

Daily observation 1991 to 2020

WorldClim

Monthly aggregated modeling data 1961-2018

Aqua Land Surface Temperature and Emissivity Daily Global 1km

Dataset Availability
2002-07-04T00:00:00 - 2021-06-02T00:00:00

Dataset Provider
NASA LP DAAC at the USGS EROS Center

Earth Engine Snippet
ee.ImageCollection("MODIS/006/MYD11A1")

14610 images = 22 yrs x 365 days x 2 times
Daytime: 8 to 9:20 (13:30 to 14:50)
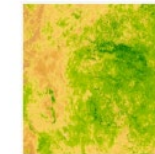Nighttime: 20:20 to 22 (1:50 to 3:30)

USGS Landsat 8 Surface Reflectance Tier 1

Dataset Availability
2013-04-11T00:00:00 - 2021-05-26T00:00:00

Dataset Provider
USGS

Earth Engine Snippet
ee.ImageCollection("LANDSAT/LC08/C01/T1_SR")

66 images 2003 to 2021 Mar to May months

Seasonal Vegetation and Surface Water
MODIS Terra Daily NDVI

Dataset Provider
Google

Earth Engine Snippet
ee.ImageCollection("MODIS/MOD09GA_006_NDVI")

Tags
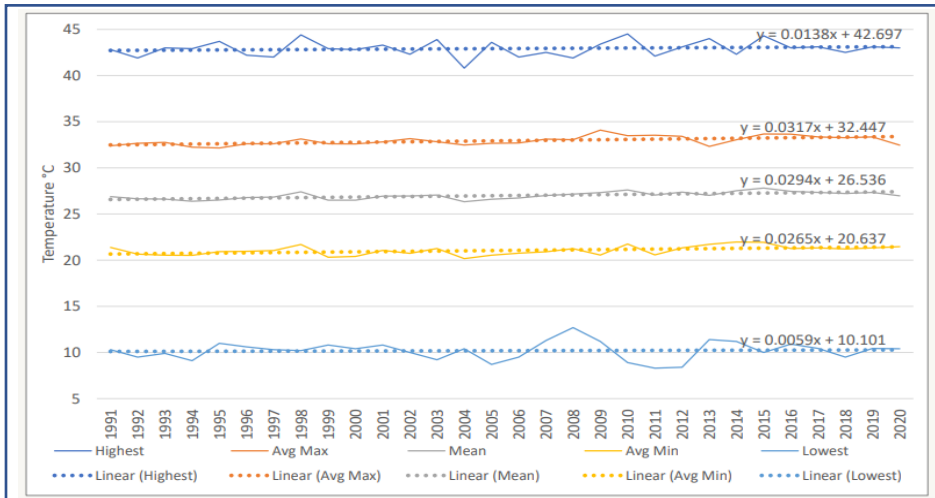ndvi   or   surface-reflectance

459 images = 15 days composite
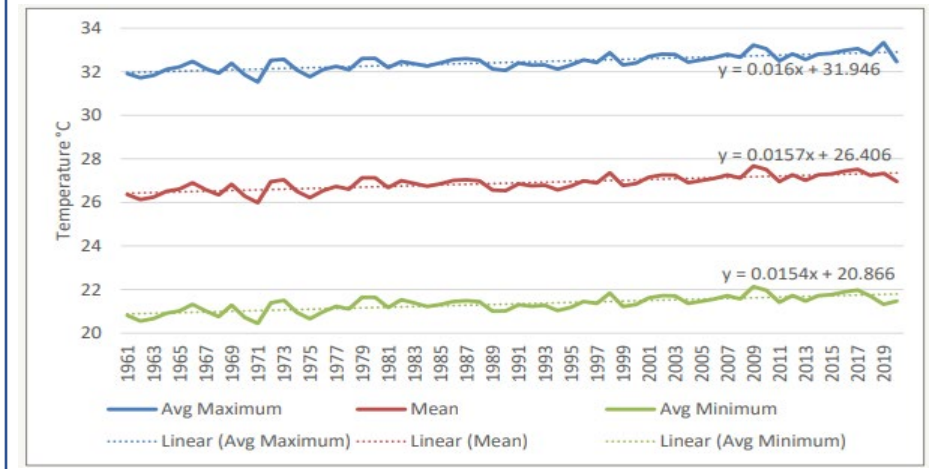
Sentinel-2 MSI: MultiSpectral Instrument, Level-1C

Dataset Availability
2015-06-23T00:00:00 - 2021-01-27T00:00:00

Dataset Provider
European Union/ESA/Copernicus

Earth Engine Snippet
ee.ImageCollection("COPERNICUS/S2")

128 images (2016 to 2021)

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$y = 0.0138x + 42.697$

$y = 0.0317x + 32.447$

$y = 0.0294x + 26.536$

$y = 0.0265x + 20.637$

$y = 0.0059x + 10.101$

Legend: Highest — Avg Max — Mean — Avg Min — Lowest
Linear (Highest) · Linear (Avg Max) · Linear (Mean) · Linear (Avg Min) · Linear (Lowest)

Mean temp increased by 0.029° C annually (0.3° each decades). The maximum temp increased higher (0.031) than the minimum (0.026).

Data Source: IMD

$y = 0.016x + 31.946$

$y = 0.0157x + 26.406$

$y = 0.0154x + 20.866$

Legend: Avg Maximum — Mean — Avg Minimum
Linear (Avg Maximum) · Linear (Mean) · Linear (Avg Minimum)

Data Source: WorldClim

Process of assessment

1. **Temperature trend analyses** for 30 years done to validate past and present heatwave events. Monthly aggregated modeling for data from 1961-2018 and future projection data using WorldClim data. Cross verification with heatwave incidents reported.

2. **Seasonal temperature patterns and variations** studied to map the overall impact throughout the year – summer, monsoon and winter changes.

3. **Understand the extent of built-up** using LULC and spatial growth patterns were studied and overlapped with land surface temperatures, to analyze the impact of certain heat absorbing and dissipating surfaces – vegetation, water body, dense built areas.

4. **Vegetation trends analysis-** mapping areas where vegetation has regulated temperature were identified

5. **Identification of hotspots**

Uniqueness

- **Use of GeoAI and cloud computing** to analyze large volume of data
- **Using multiple data sources** - IMD, Satellite (Landsat and MODIS) and WorldClim modeling data
- **LULC (continuous built-up area not just city boundary analyzed)** using Google Earth 2003 & 2022 and vegetation trend using Sentinel images 2016-2022

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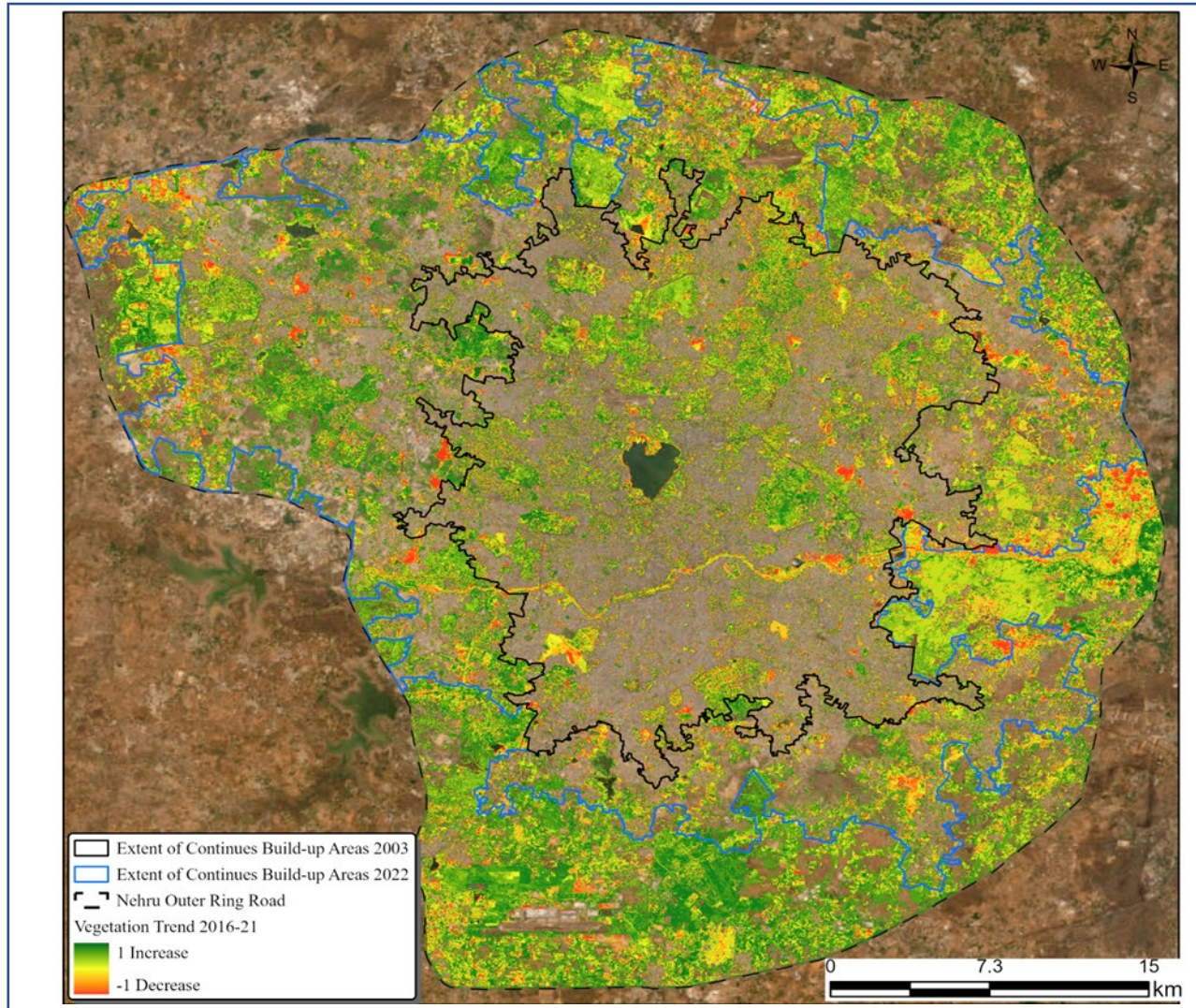*India*
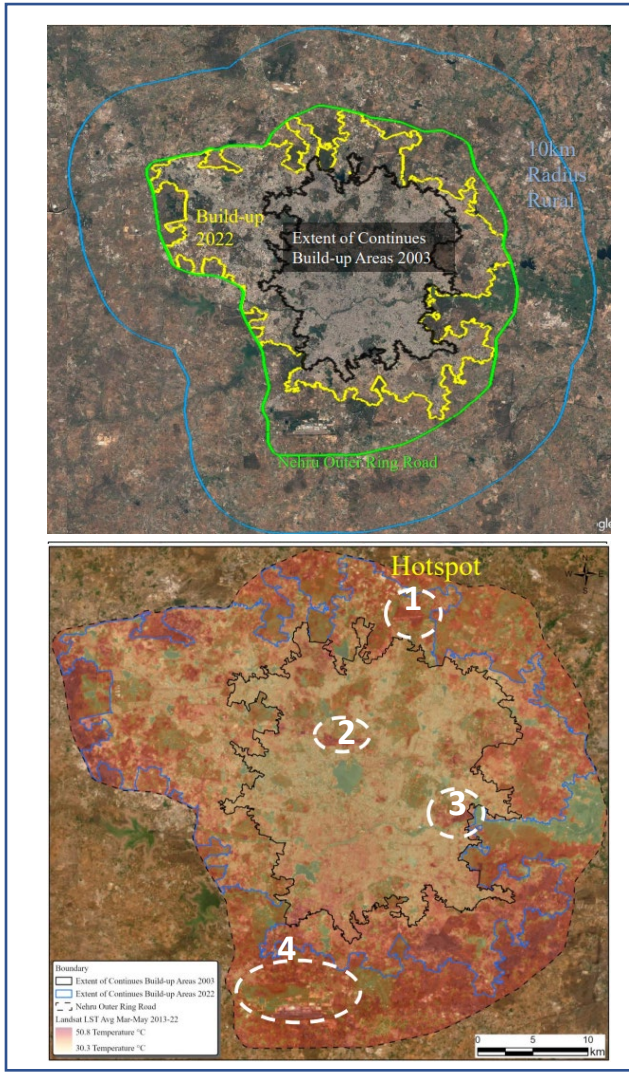
Outcome of the Research

1. **Temperature difference of +1.3°C** was observed between city and outskirt area
2. **78 heatwave** events, **927 heat days** observed in last 30 years – 1991-2022
3. **Predicated all days in May to be heat days** by end of century
4. Overall temperature has been rising annually by 0.023°C in summer, 0.029°C in monsoon, 0.05°C in winter
5. Study also shows **increase in precipitation** in Hyderabad city increasing risk of urban flooding - needing local-level adaptation
6. **Built-up area increased over 200%** in last 2 decades.

$y = 0.3019x + 25.221$

Data Source: IMD

Area of Hyderabad under study	Sq km
Extent of Continuous built-up 2003	459
Extent of Continuous built-up 2022	999
Nehru Outer ring road	1457
10 km radius (buffer from ORR) rural	3290
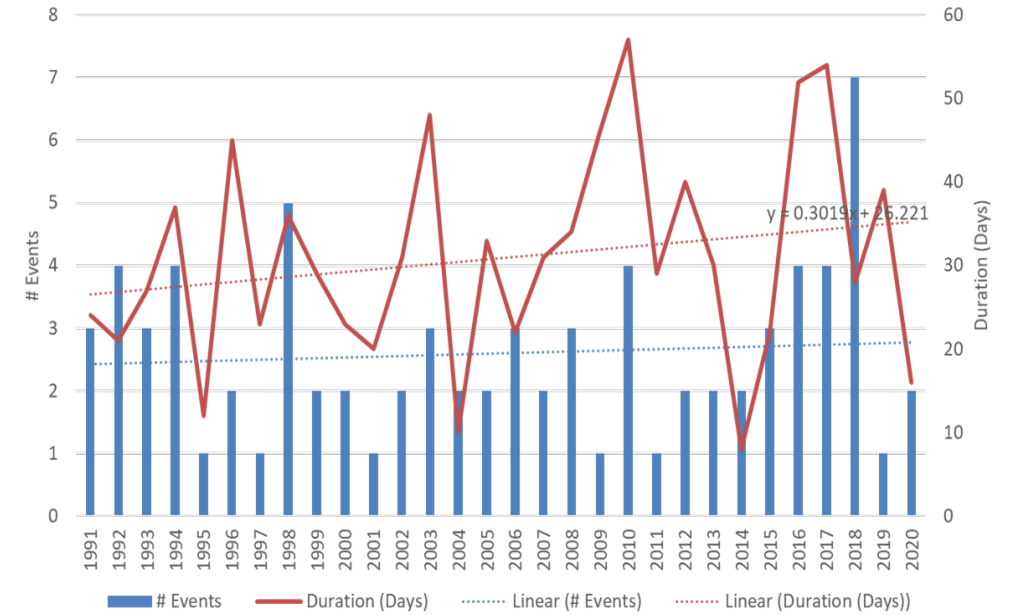
Decade	Avg Events (Annual)	Duration (Avg Days)				
		Annual	Mar	Apr	May	Jun
1991-2000	2.7	27.7	0.9	6.3	17.7	2.8
2001-2010	2.3	33.2	0.5	9.6	20.1	3
2011-2020	2.8	31.8	0.9	8.4	21.2	2.2
Overall Avg	2.6	30.9	0.8	8.1	19.7	2.7

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Extent of Continues Build-up Areas 2003
Extent of Continues Build-up Areas 2022
Nehru Outer Ring Road
Vegetation Trend 2016-21
1 Increase
-1 Decrease

7. **Areas with Blue-green infrastructure - shows a positive impact and reduced land surface temperatures-** validated during the stakeholder workshop by urban biodiversity department that showcased increase in green cover since 2013 under the Green Mission of GHMC.

Challenges
- **IMD data** procurement can be time consuming and slightly expensive. Partnering with IMD may be helpful.
- **LULC dataset** creation is tedious and time intensive. LULC data from municipal corporation can help.

Way Forward:
- **Macro to micro level using drone** - mapping land surface temperature with high-resolution thermal camera - ranking buildings by land surface temperature covering rooftop and around 2-5 meter radius.
- **Identification of high impact buildings** to implement intervention and monitor outcome.
- **Pilot cool pavements / green roof** at community scale

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Thank You

You may reach out to our team for questions and feedback

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