Aga Khan Agency for Habitat
India

Urban Heat Island Mitigation Project 2021-2022

Piloting solutions and conducting research & disemmination for cooling urban areas

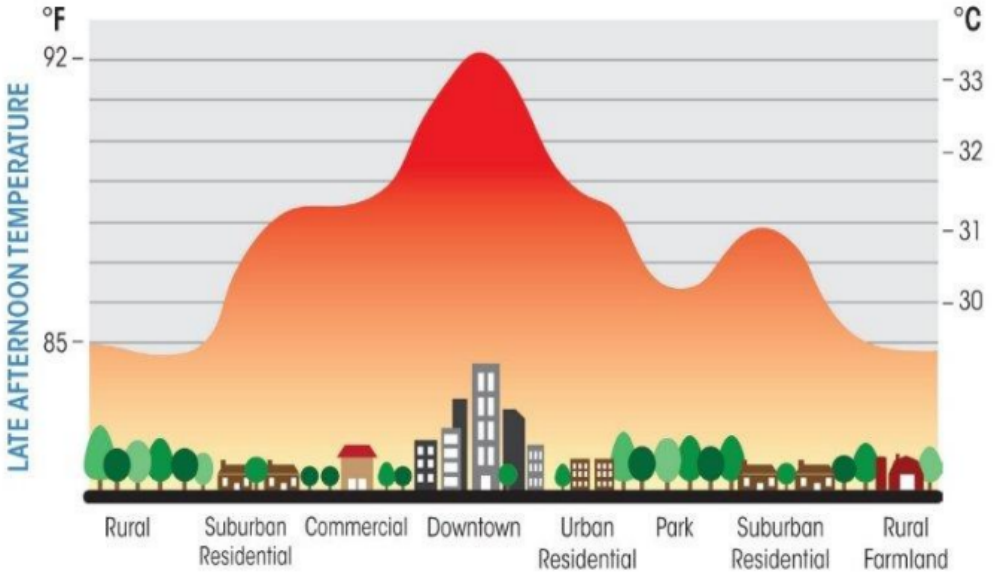
What is Urban Heat Island ?

An urban heat island (UHI) is an urban area or metropolitan area that is significantly warmer than its surrounding suburban and rural areas due to human activities. The term "heat island" describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1–3° C warmer than its surroundings. In the night, the difference can be as high as 12° C.

MAJOR CAUSES

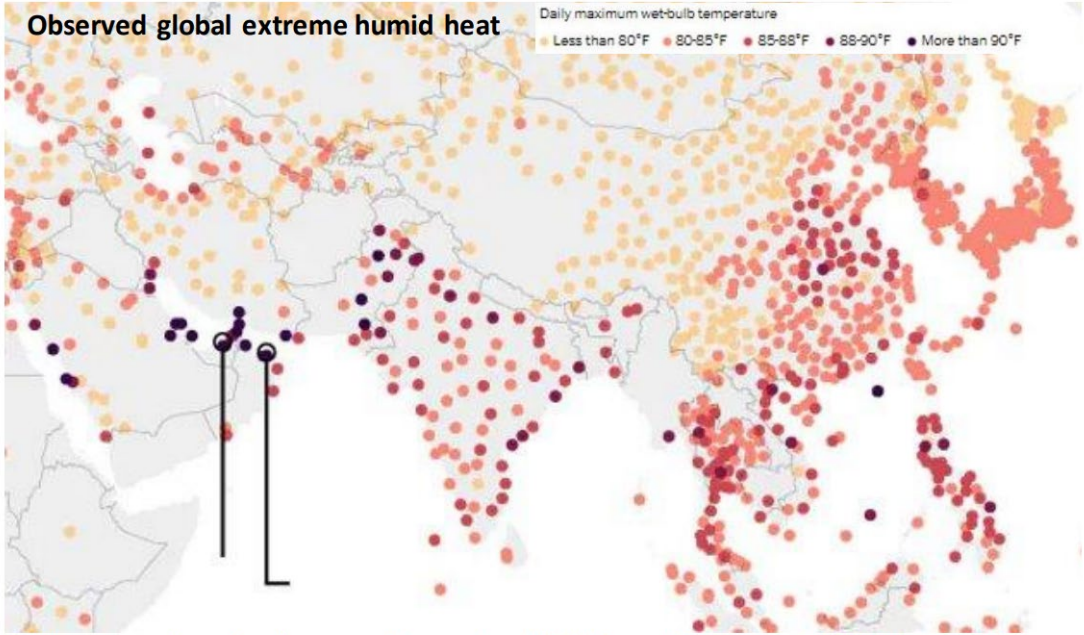
- Changing land cover (LULC)
- Releasing pollutants
- Releasing greenhouse gases
- Increasing concrete areas
- Reducing green surface

Rapid urbanization and industrialization have brought microclimatic change.



Source: Urban Heat Island Basics, 2008, Reducing Urban Heat Islands, U.S. EPA

Need for UHI mitigation



Source: "The emergence of heat and humidity too severe for human tolerance" by Colin Raymond, Tom Matthews and Radley M. Horton, world bank.

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India Could Soon Experience Heat Waves Beyond Human Survival Limit: World Bank

The World Bank report titled "Climate Investment Opportunities in India's Cooling Sector" said the country is experiencing higher temperatures that arrive earlier and stay far longer.

India News | Press Trust of India | Updated: December 07, 2022 1:23 pm IST

IPCC report: Heat, humidity, sea rise to make India uninhabitable if emissions not cut

India is one of the most vulnerable countries globally in terms of the population that will be affected by sea-level rise, IPCC reports.

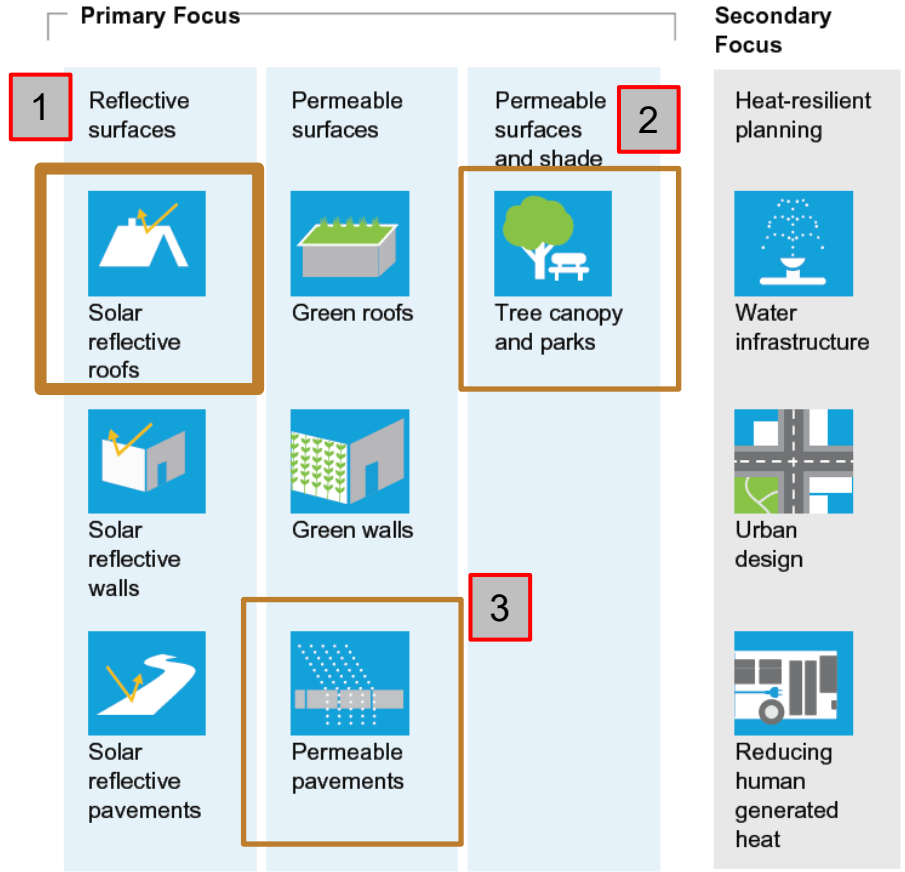
Need for UHI mitigation –

1. 34% population of India is exposed to the effect and this number is increasing with urbanization
2. For every 0.6 degree rise in temperature there is increase in electricity consumption by 2%
3. UHI also intensifies heat waves which has significant health issues
4. In 50 years, Hyderabad will be in hot and harsh climate zone: A projection by National Geographic
5. Telangana is third in heatwave deaths in India

Urban Heat Island Mitigation Project Activities

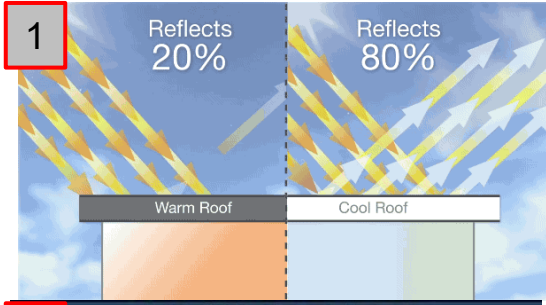
Cool Roof & China Mosaic	Certified Green Building material – Cool roof from Panache Greentech Solutions to provide and apply its cool roof technology on all residential buildings' rooftops. Comparing cool roof coating with chipped tiles that also act as water proofing material for roof tops that also have high reflectance.
Research Study	IIIT, Hyderabad to measure the outcomes of cool roof application with beneficiary surveys, data collection using instruments and analysis through long term & short term studies
UHI Assessment for Hyderabad	Assessing Urban heat island for Hyderabad City with Temperature Trend Analysis, Extreme Heat Events data, Land Surface Temperature Analysis and Future climate projections
Disemmination	Workshop at Hyderabad and videos – case study of cool roof pilot, UHI – problem and solutions

Innovative Solutions for Urban Heat Island Reduction



Community level mitigation Measures identified by AKAH for pilot interventions

1. **Increasing solar reflectance with cool roof / china mosaic**
2. **Increasing vegetation and shading with urban micro forest**
3. **Reducing / Substituting concrete / paved surfaces**



UHI Mitigation Intervention

Garden Housing, Kompally, Hyderabad

Cool Roof impact monitoring at Garden Society, Kompally

January 5th, 2023

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
HYDERABAD

Vishal Garg

Cool roof & China mosaic

IIITH & AKAHI

Garden Housing, Kompally, Hyderabad

Intervention

15 residential buildings were coated with Cool Roof
China Mosaic was installed on one building
Area of roof (Sq.m.): 9000
Total Site Area: 10 acres

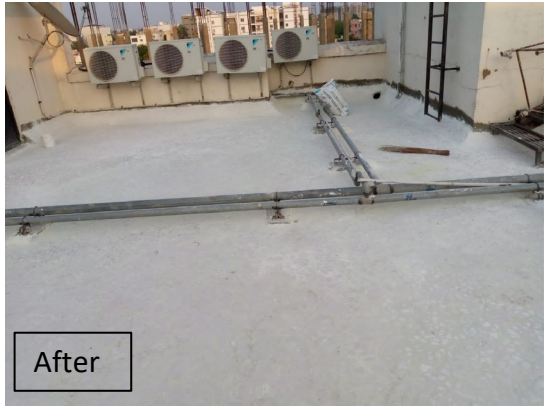
Methodology

Before installation, surface temperatures of roof and the indoor temperature of the top floor flats was recorded. Temperature sensors were fitted to monitor the change before, during and after installation.

Cool roof & China mosaic

IIITH & AKAHI

The installation of cool roof done in the Garden Housing Society, Kompally.



China Mosaic

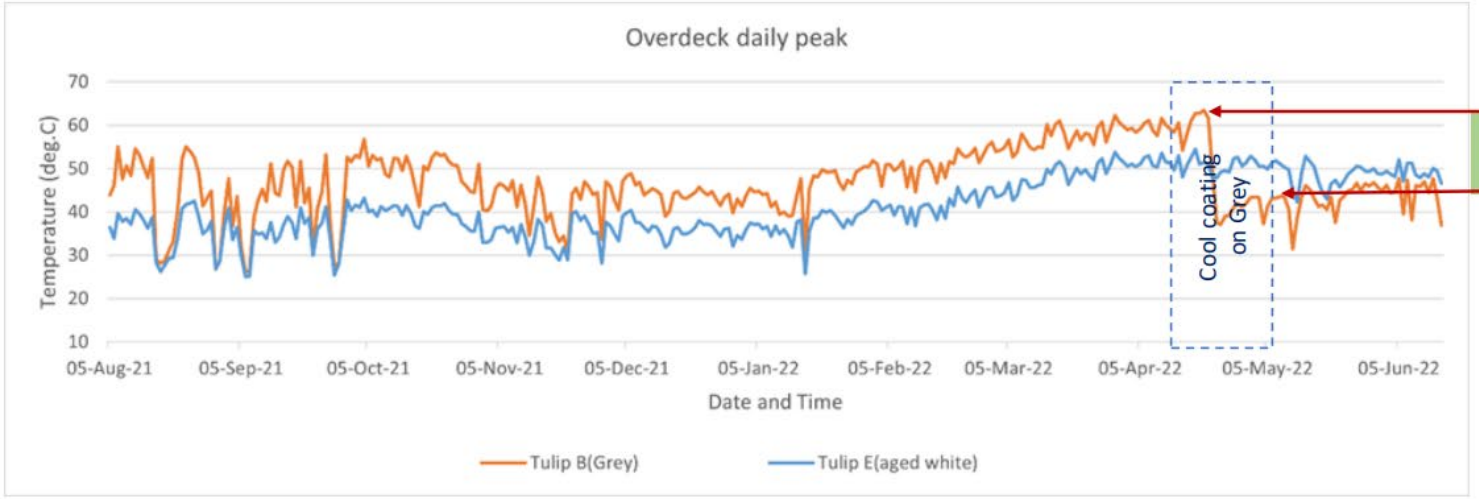
- Flooring patterns made from broken tiles
- Acts as a Waterproofing
- Durability: 10-15 years
- Surface Temperature decline: 15-20°C
- Ideally to be installed while the slab is being casted.

Cool Roof

- Flooring coated with reflective paint
- Durability: 3-5 years
- Surface Temperature decline: 15-20°C
- Can be done on any type of roof surface – even after the slab and flooring is completed.

Outcome of Research Study

IIIT, Hyderabad



A drop of **~20 °C** is seen after cool coating the grey roof

	Average reduction in hourly temperature	Maximum peak reduction in hourly temperature
Indoor temperature	1.8ºC	3.6ºC
Overdeck temperature	5.4ºC	19.8ºC

Peak and average temperatures of grey and cool roofs in summer months of 2022

INDOOR TEMPERATURE	PEAK	AVERAGE
COOL ROOF	33°C	28.9°C
GREY ROOF	37.3°C	30.2°C
DIFFERENCE	4.3°C	1.3°C

Research Study by IIIT Hyderabad

Monitoring temperature and thermal comfort at Garden Housing Society, Kompally.

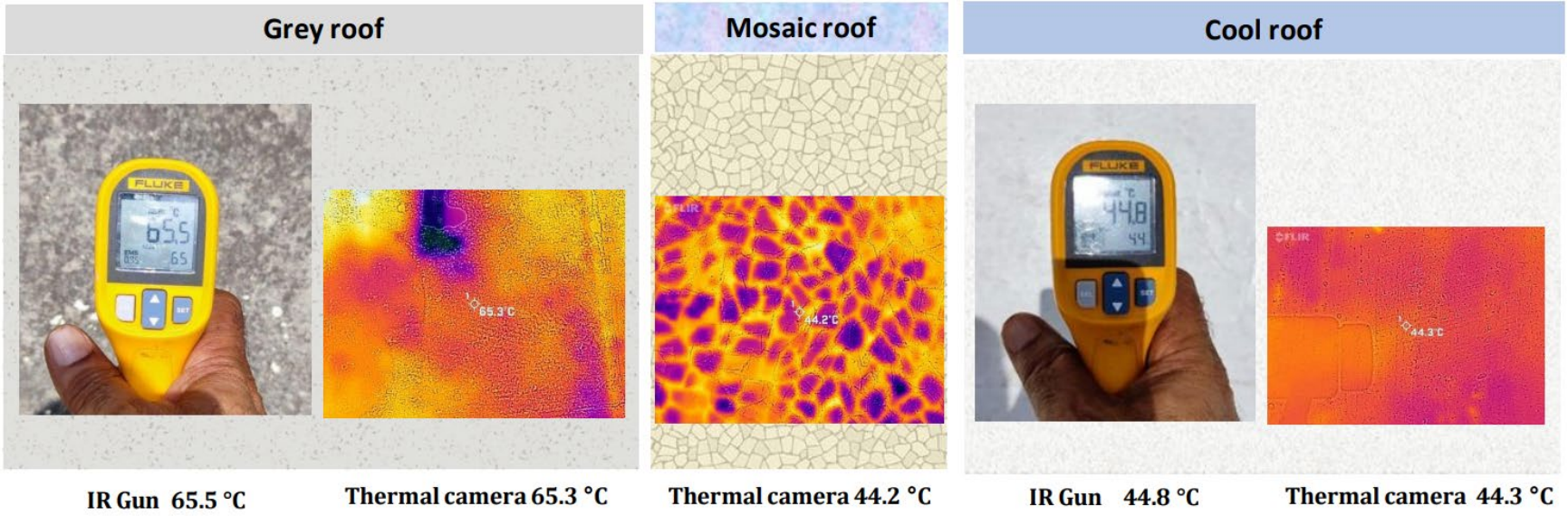
1. The maximum reduction in the indoor air is 4.3°C, underdeck is 6.1°C and Overdeck temperature is 17.3°C for the white room as compared to the grey room. As per Bureau of energy efficiency in India, every One Degree can save 6% energy for air conditioning. Effectively, this can help in reducing up to 24% peak energy demand.
2. The thermal comfort range for buildings without air conditioners for Hyderabad is between 26 - 32 degrees with average of 29 degrees – The cool roof and China mosaic helps in keeping indoor air temperature within that range and this has been confirmed through surveys & testimonials at Garden Housing.

Temperature sensors installed for underdeck temperature measurement

Box for aggregator for overdeck sensor data logging

Outcome of Research Study

IIIT, Hyderabad



Conclusions from the experiment -

- Energy simulation results show that for the peak summer month May, a reduction in AC electricity consumption in the range of **4.2% -18.8%** are possible with high albedo roof (0.5-0.9).
- Thermal comfort survey conducted showed a **slight improvement** in the perception of comfort.
- The on-spot measurements for roof surface temperature of a **China mosaic roof** were found to be similar to freshly coated cool roof.

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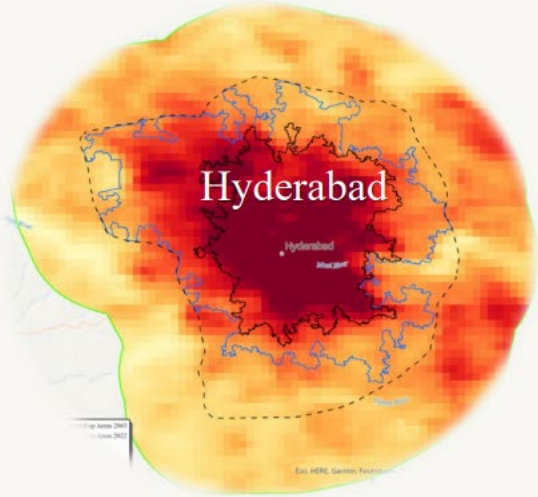
Urban Heat Island – Macro Level Assessment



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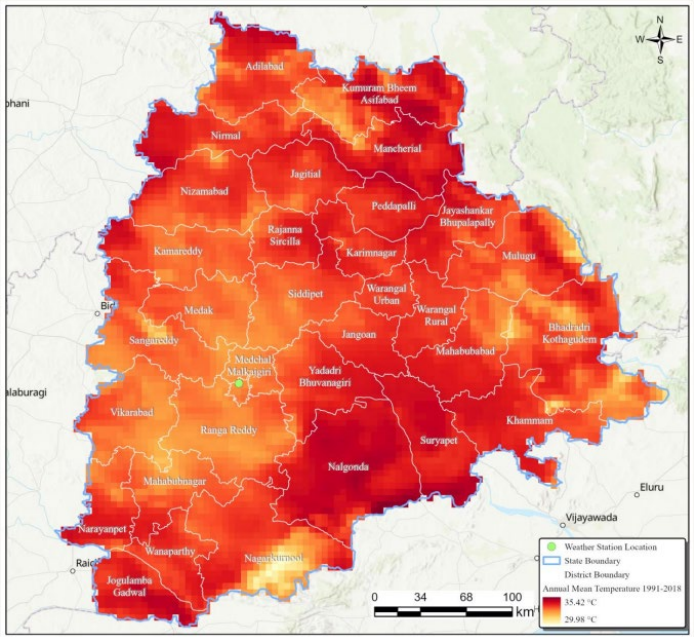
UHI Assessment, Hyderabad

AKAH India

Evolution & its effects



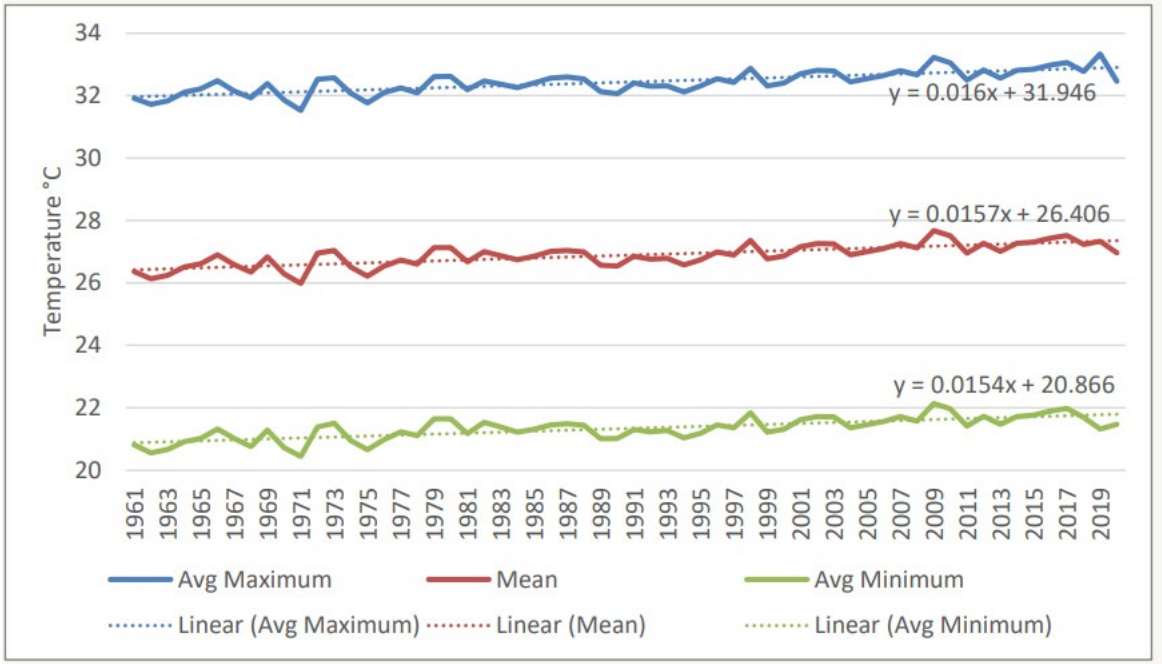
Heat map of Hyderabad
Source : AKAHI

Extreme heat events posing Survival threat

44ºC + temperature recorded for consecutive 5 years in most areas of Hyderabad – TOI, march ’22

UHI Assessment, Hyderabad

Temperature trend behavior



Trend analysis for Hyderabad – 1961-2020 using WorldClim modelling dataset
Source : AKAHI

The above trend analysis graph indicates that temperature is increasing by **0.016 °C annually**.

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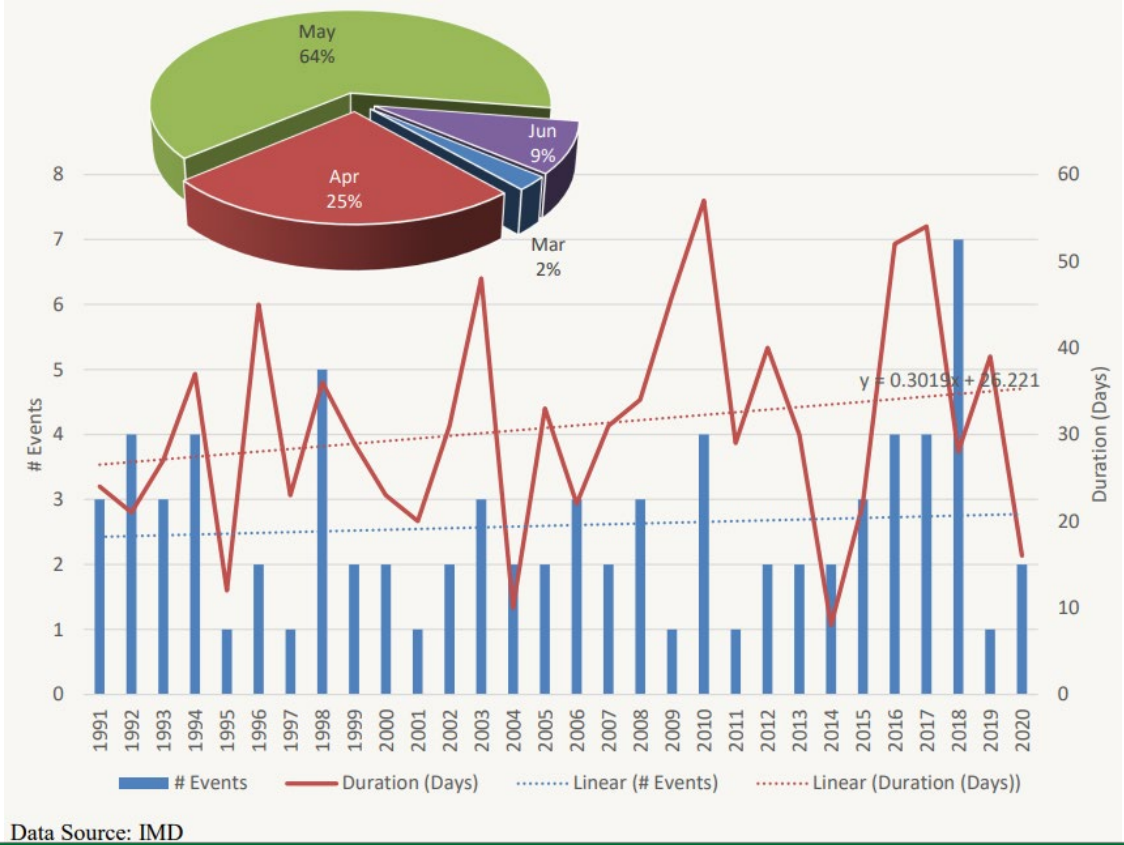
Extreme events in Hyderabad



Data Source: IMD

A total of 78 heatwave events were recorded between 1991 to 2020, representing 927 heat wave days. The **majority of the heat days were experienced during May**, followed by Apr, Jun and March.

The annual average of the heat events and duration are 2.6 and 31 days, respectively.

Linear trend analysis indicates that heatwave days will be increased by 2-3 days in each decade!

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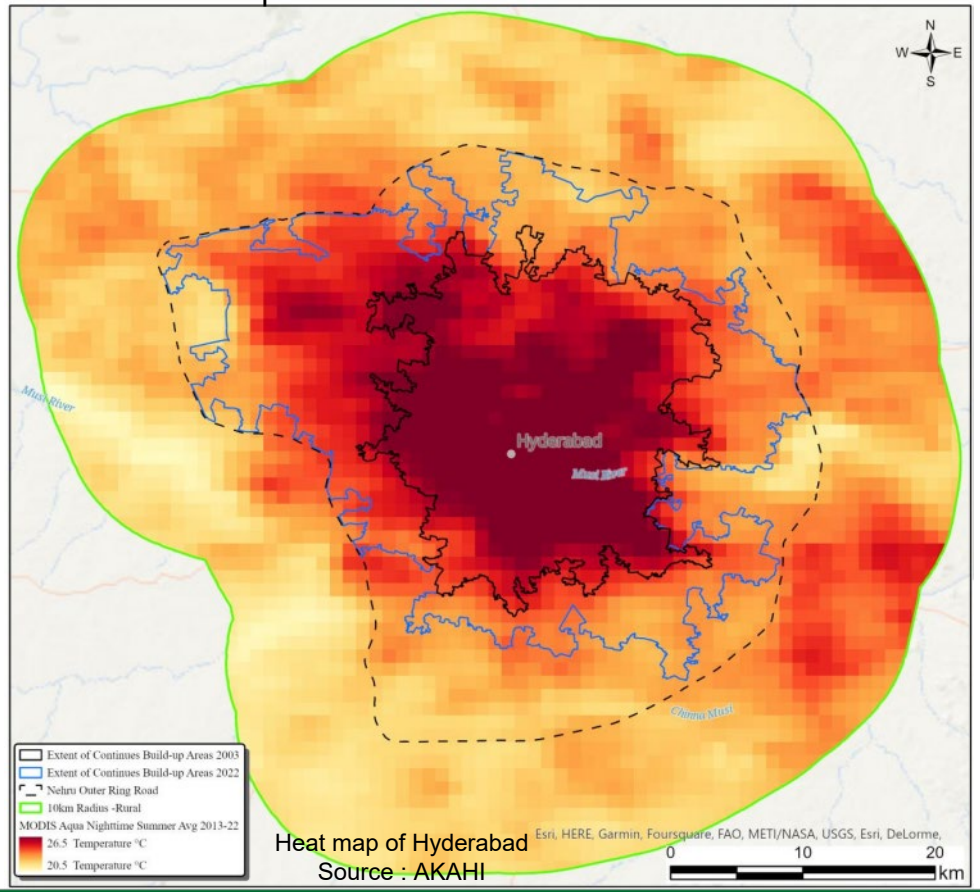
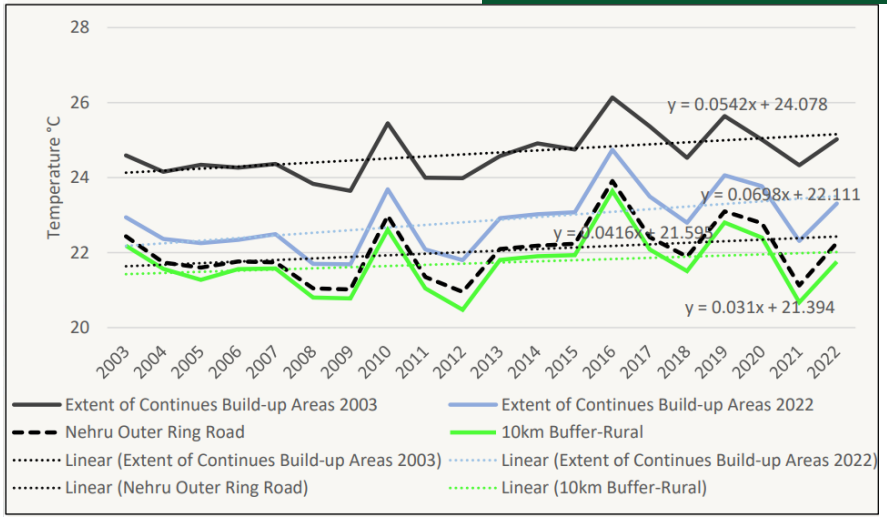
Increment in temperature with urbanization



Heat map of Hyderabad
Source : AKAHI



- Extent of Continues Build-up Areas 2003: 0.05 °C annually
- Extent of Continues Build-up Areas 2022: **0.067°C** annually
- Within Nehru Outer Ring Road: 0.04°C annually
- 10km Buffer-Rural: 0.03°C annually

UHI Assessment, Hyderabad

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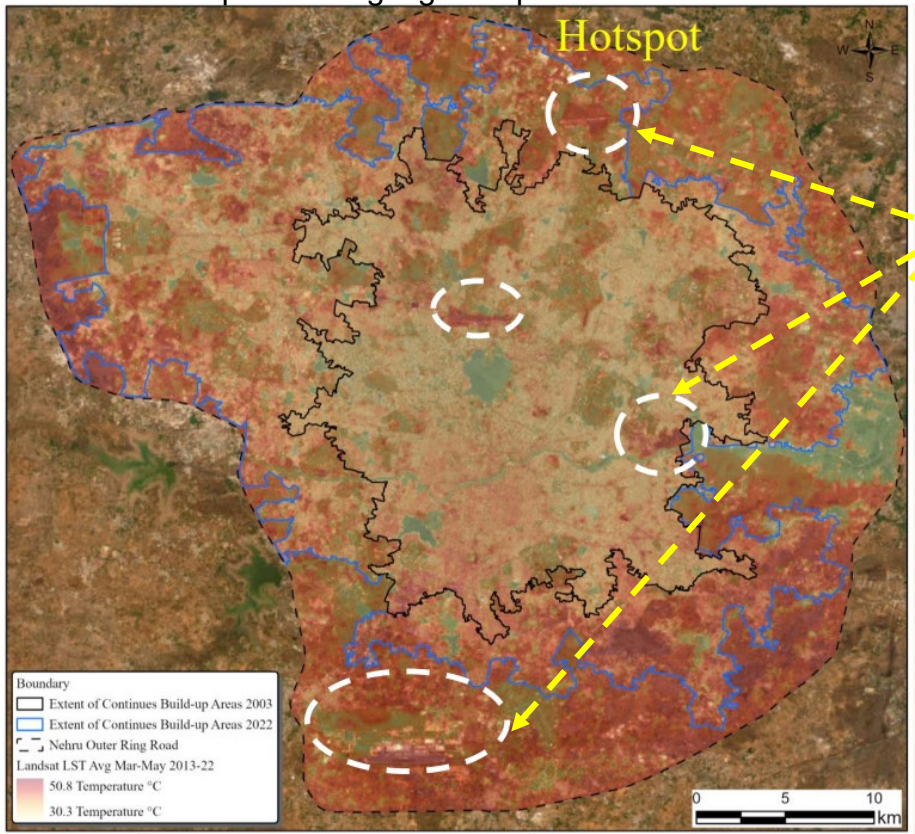
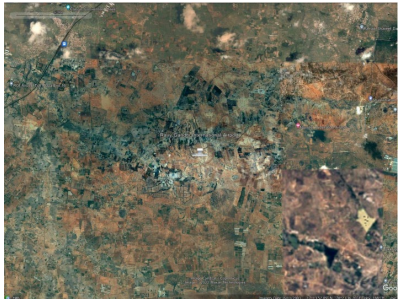
Observed Hotspots having high temperatures



Following hotspots were identified for recording high temperatures

The high temperatures are being recorded mostly in built-up area 2022 – showing how the current urbanization trend acts a catalysing agent for UHI effects



Google Sept 2004

Google Dec 2021

Rampant urbanization adding to UHI & Climate change effects

UHI effect in & around urbanized areas

UHI Assessment, Hyderabad

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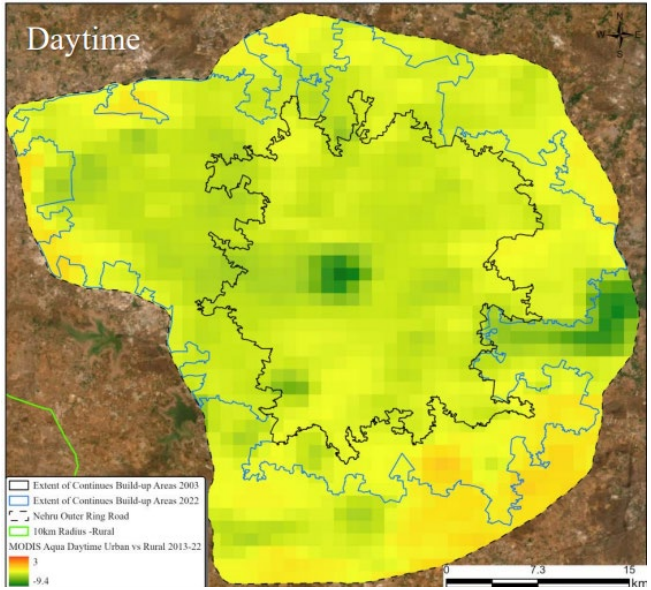

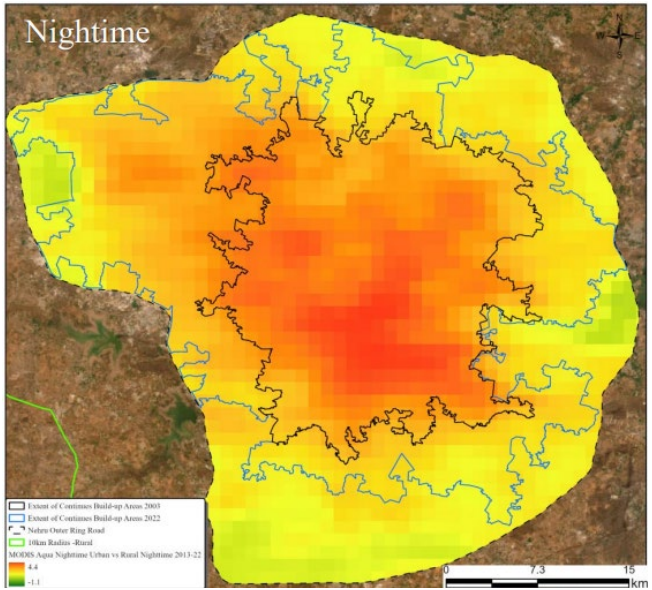

Due to the urbanization on the outskirts – around the Nehru Outer ring road, there is an increase in temperature observed during night time

Area	Within Nehru Outer Ring Road	10km Buffer-Rural	Temperature °C Difference
Landsat Day 2016-21 Mar-May	42.4	44.0	**-1.6**
MODIS Aqua Day 2013-22 Mar-Jun	43.1	44.1	**-1.0**
MODIS Aqua Night 2013-22 Mar-Jun	23.6	22.1	**1.5**
Trend Daytime 2003-22 (°C Annually)	-0.127	-0.118	-0.1225
Trend Nighttime 2003-22 (°C Annually)	0.056	0.031	0.0435

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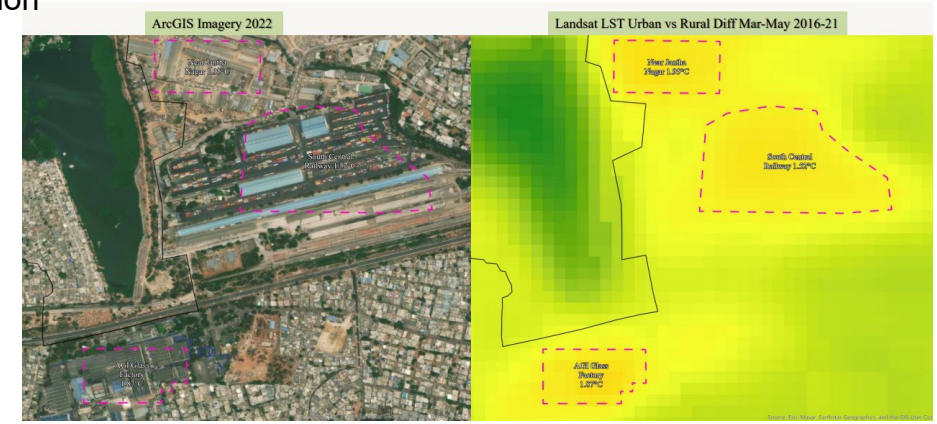
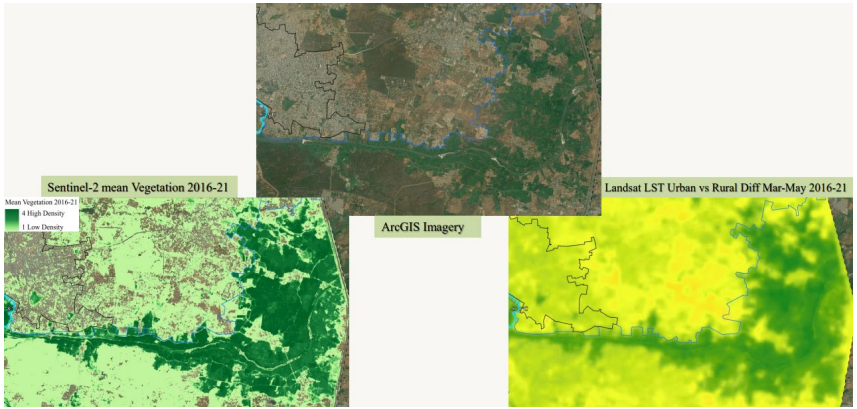
Effect of Vegetation in UHI regulation



Increment in Green cover, regulates the temperature



Source : Author

Conclusions from the assessment

- UHI will further intensify
- More frequent spells of extreme temperature
- Temperature is increasing every decade
- Increment in green cover will reduce UHI effects
- Extreme events – drought & flood will increase in Hyderabad - needing local-level adaptation
- Huge scope for increasing cool roofing and vegetation.

Dissemination

Stakeholder consultation workshop

(L-R) Dr. Vishal Garg (Professor, IIIT Hyderabad), Ms. Prerana Langa (CEO, AKAH India), Mr. V Krishna, IFS (Additional Commissioner, GHMC)

JAN 06, 2023, 06:18 ET

Aga Khan Agency for Habitat (AKAH) India organised a workshop on Climate Action through Urban Heat Island (UHI) Mitigation in partnership with IIIT Hyderabad

Aga Khan Agency for Habitat (AKAH) India in partnership with the International Institute of Information Technology Hyderabad (IIITH) and National...

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ANI Press Releases

Aga Khan Agency for Habitat (AKAH) India organises a workshop on Climate Action through Urban Heat Island (UHI) Mitigation in partnership with IIIT Hyderabad

ANI PR 6 January, 2023 06:15 pm IST

Aga Khan Agency for Habitat (AKAH) India in partnership with the International Institute of Information Technology Hyderabad (IIITH) and National Institute of Urban Affairs (NIUA) conducted a workshop on Urban Heat Island (UHI) studies done in Hyderabad, and to explore opportunities for implementation of mitigation measures in alignment with draft Cool Roof Policy for Hyderabad in collaboration with government and non-governmental partners.