



Urban Heat Stress in major cities of India: Hyderabad (South Peninsular India)

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The Urban Lab of Centre for Science and Environment (CSE) has analyzed the temperature trends for India from Jan 2015 till May 2022. This is an effort to understand the warming trend in a comprehensive way by covering all three dimensions of heat stress—Surface air temperature, Land surface temperature, and relative humidity (heat index). This city report is part of the larger study that has analyzed heat stress trends at global, national, regional, and local level. The city level analysis of this study covers metropolises of Delhi, Mumbai, Kolkata and Hyderabad (each located in different IMD's homogenous region). Objective of the city analysis is to understand the combined effect of climate change induced unseasonal heatwaves and urbanisation induced heat Island effect on the thermal comfort and heat stress among these topographically and climatically diverse in cities.

This is part of the larger report on heat stress in India. For the main report please follow this [link](https://www.cseindia.org/heatwave-paper-National.pdf) (<https://www.cseindia.org/heatwave-paper-National.pdf>).

Data and method

Freely accessible data is available on United States Geological survey (USGS) Earth Explorer website. Landsat 8 operational land imager/thermal infrared sensor (OLI/TIRS) satellite imagery were downloaded and used to analyze the land surface temperature.

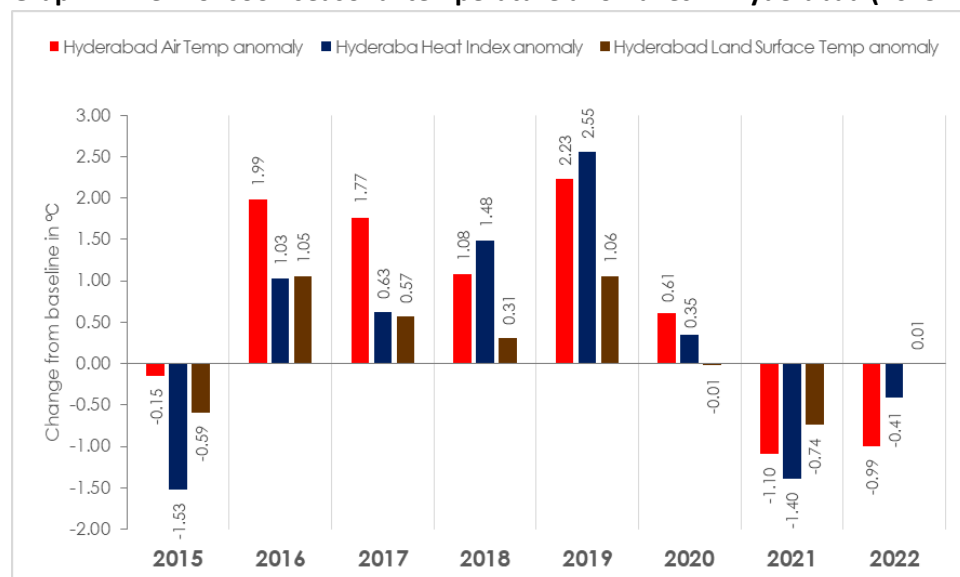
This city level assessment is focused on two things: Change in heat patterns over years for pre-monsoon season; and the land surface temperature variation on days with high air temperature during the pre-monsoon season of 2014, 2016, 2018, 2020 and 2022. For Hyderabad the later analysis is based on 16 April 2014, 5 April 2016, 27 April 2018, 16 April 2020 and 6 April 2022.

Please refer the main report for further details on data and methodology employed in this study.

Findings-Heat patterns during pre-monsoon season

Air temperature and heat index in Hyderabad declining since 2019, land surface temperature normal this summer: Hyderabad recorded significant negative anomaly on all three temperature parameters last and this year's pre-monsoon season. Air temperature has been 0.99°C cooler than 1981-2010 baseline, while land surface temperature has been just 0.01°C hotter. Heat Index is down by 0.41°C compared to 2010-19 baseline. Unlike the trend noted at the India level, 2016 was not the hottest Hyderabad pre-monsoon before this year; 2019 pre-monsoon season have been hotter (See *Graph 1: Pre-monsoon seasonal temperature anomalies in Hyderabad (2015-22)*). In fact, the city has recorded consistent below normal pre-monsoon temperatures since 2019.

Graph 1: Pre-monsoon seasonal temperature anomalies in Hyderabad (2015-22)

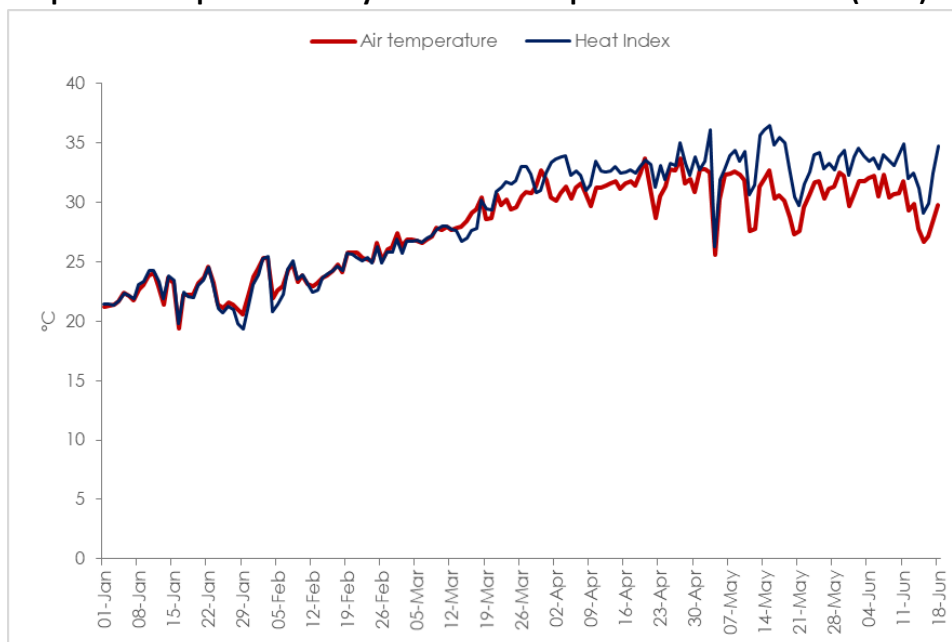


Note: Daily heat index was computed using the U.S. National Oceanic and Atmospheric Administration's (NOAA) formula. Air temperature and land surface temperature anomalies are computed with respect to 1981-2010 baseline. Heat Index anomaly is computed with respect to 2010-19 baseline.

Source: CSE analysis of IMD ground observation data and NASA satellite based remote sensing data

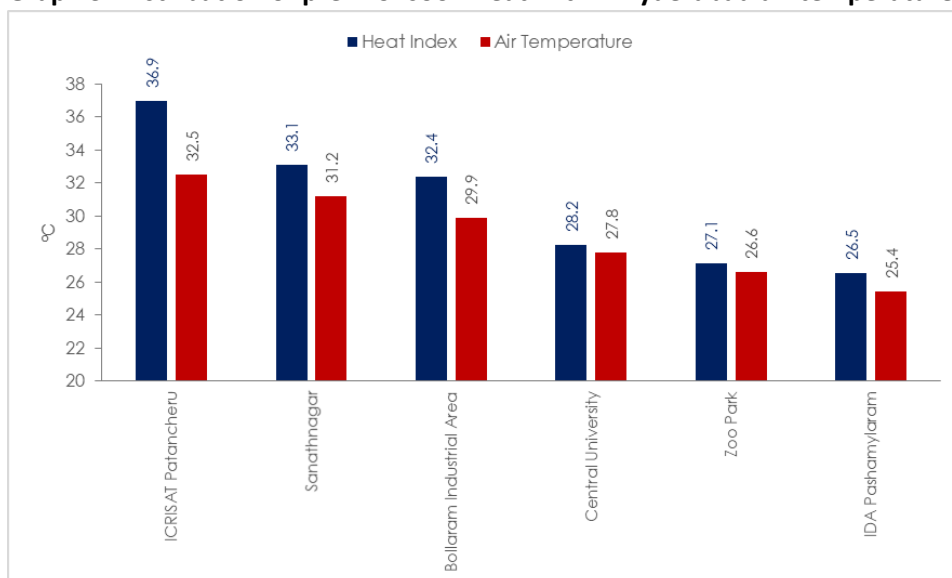
Humidity has not been a major discomfort in Hyderabad this pre-monsoon season: Daily average air temperature in Hyderabad tends to fluctuate between 25°C and 30°C from March. Heat index this year has only been 1-4°C higher than the air temperature. Since IMD doesn't account for humidity in its consideration for heatwaves, dangers of humid heat that is known to be more lethal to humans don't get reported. The daily average heat index in Hyderabad didn't cross the danger mark of 41°C this pre-monsoon (See *Graph 2: Buildup of heat in Hyderabad air temperature vs heat index (2022)*).

Patancheru and Sanathnagra surroundings were on average hottest neighborhoods based on air temperature and heat index: There is variation of over 7.1°C in the observed seasonal air temperature among neighborhoods that have official air quality monitoring. Patancheru recorded highest seasonal air temperature average of 32.5°C in the city while Pashamlaram with 25.4°C was the coolest. From heat index perspective as well Patancheru with an average seasonal heat index of 36.9°C has been the hottest part of the city. Pashamlaram had lowest average seasonal heat index in the city (See *Graph 3: Distribution of pre-monsoon heat within Hyderabad air temperature vs heat index*)

Graph 2: Buildup of heat in Hyderabad air temperature vs heat index (2022)

Note: Daily heat index was computed using the U.S. National Oceanic and Atmospheric Administration's (NOAA) formula.

Source: CSE analysis of IMD ground observation data

Graph 3: Distribution of pre-monsoon heat within Hyderabad air temperature vs heat index

Note: Daily heat index was computed using the U.S. National Oceanic and Atmospheric Administration's (NOAA) formula.

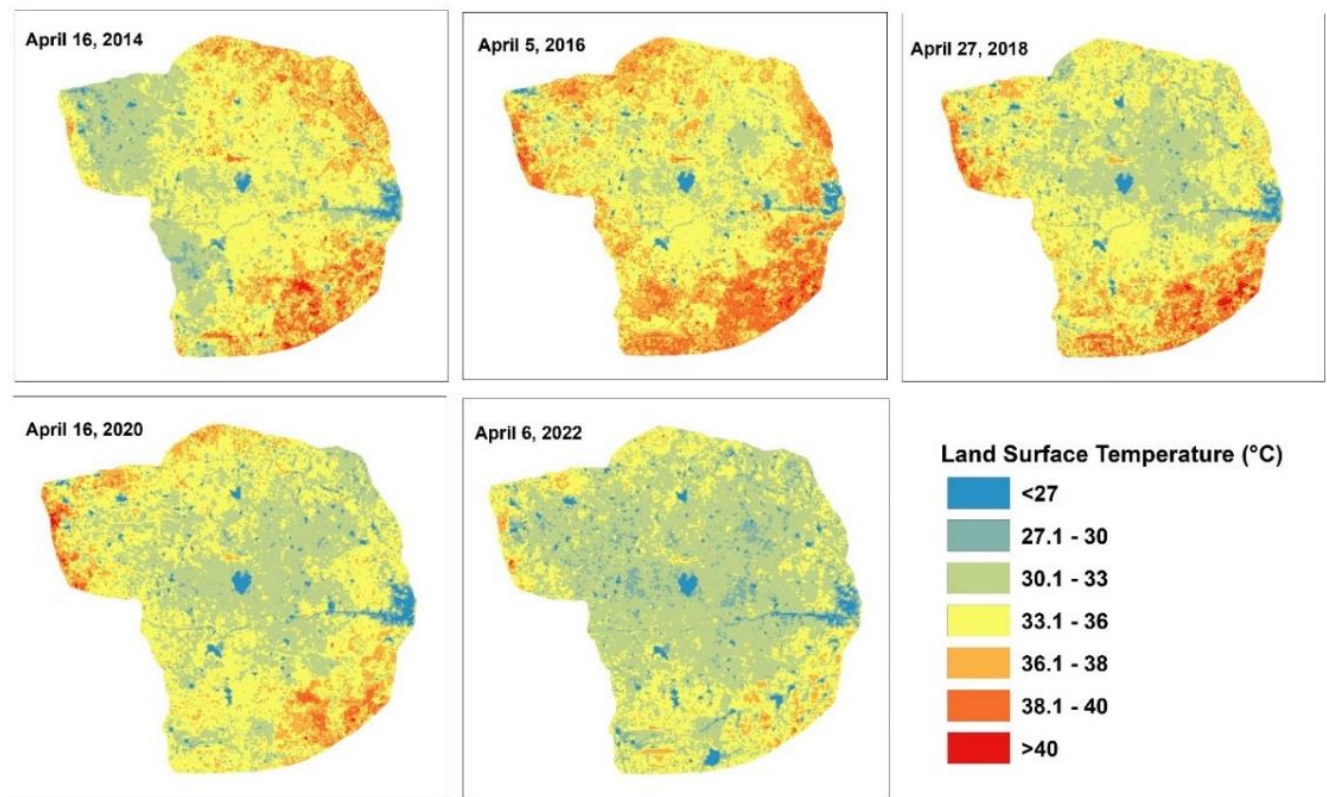
Source: CSE analysis of temperature and humidity data from CAAQMS network of CPCB

Findings-Heat patterns on hot days

Land surface temperature (LST) variation on hot days over years: Bright red tone in the map represents region with high temperature and as the tone shifts towards blue, the temperature reduces. 16 April 2014 had the highest LST with temperatures reaching 43.2 °C, followed by 27 April 2018 (42.5 °C), 5 April 2016 (41.9 °C), 16 April 2020 (41.5 °C), and 6 April 2022 (40.8 °C) (See *Figure 1: Variation in land surface temperature over Hyderabad for 2014, 2016, 2018, 2020 and 2022*). In 2016 April, LST in the southern Hyderabad ranged between 38 – 40 °C, maximum values recorded during the study period.

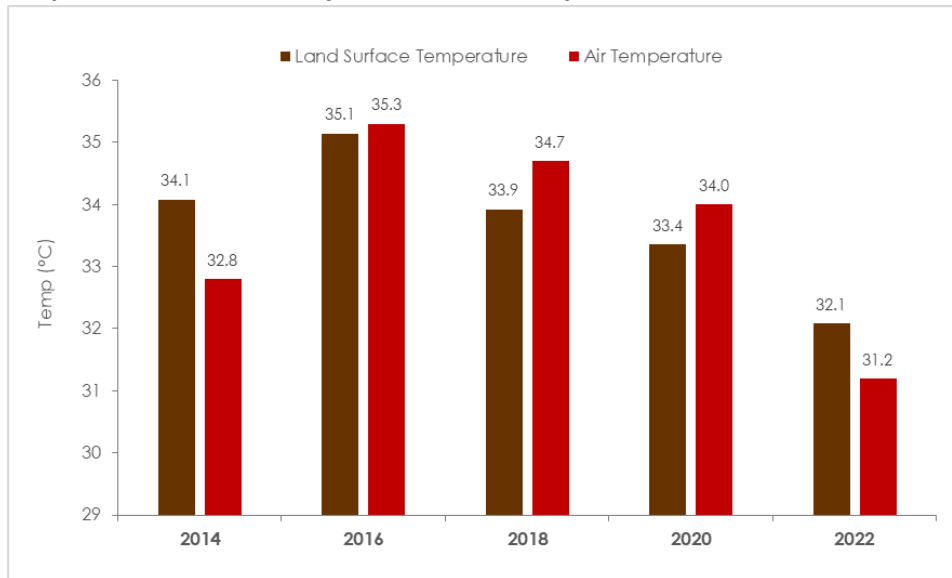
The southwestern part of the city had the highest LST rising above 37 °C, while the lakes in the city had the lowest temperature below 27 °C. LST rose in the north-east part of the city in April 2016 and 2018, but fell gradually in April 2022, with some areas still recording ground temperatures between 36°C and 38°C.

Figure 1: Variation in land surface temperature over Hyderabad for 2014, 2016, 2018, 2020 and 2022



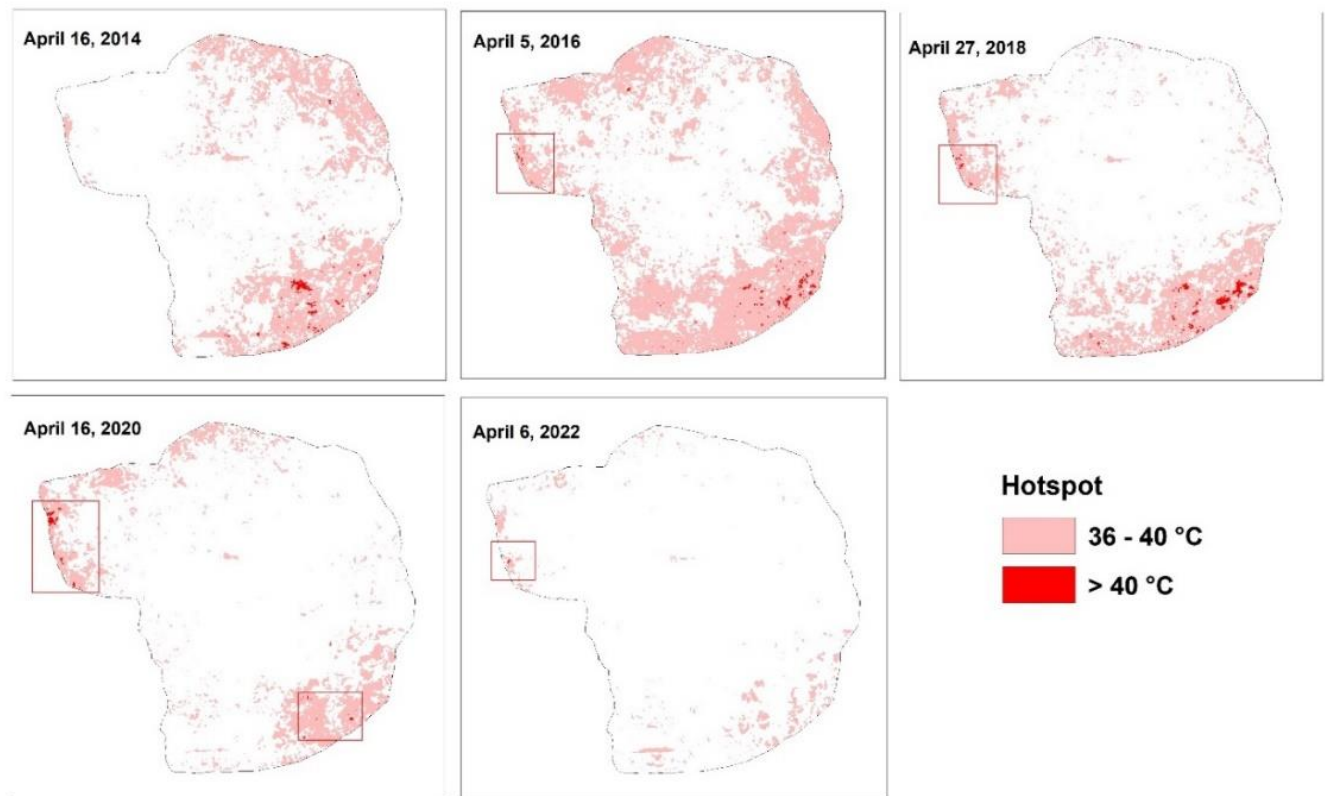
Source: CSE analysis of Landsat 8 satellite image from USGS Earth Explorer website

Decreasing Land Surface Temperature on hot days over years: The average LST in Hyderabad on April 6, 2022 was 32.1°C. Compared to April 5, 2016 the average LST has decreased by 3°C (see *Graph 4: LST Trend over Hyderabad on hot days in 2014, 2016, 2018, 2020 and 2022*). The daily average air temperature has also been lower by 3.9°C on April 6, 2022 compared to April 5, 2016. The average LST was hotter than the daily average air temperature recorded at city's primary weather station at Begumpet. It used to be relatively lower in 2016, 2018 and 2020.

Graph 4: LST Trend over Hyderabad on hot days in 2014, 2016, 2018, 2020 and 2022

Note: Average land surface temperature is based on mean of all values recoded over the city and ambient temperature is based on mean of daily values recorded at 2 stations in the city.

Source: CSE analysis of Landsat 8 land surface temperature and IMD weather data from Begumpet Meteorological Station

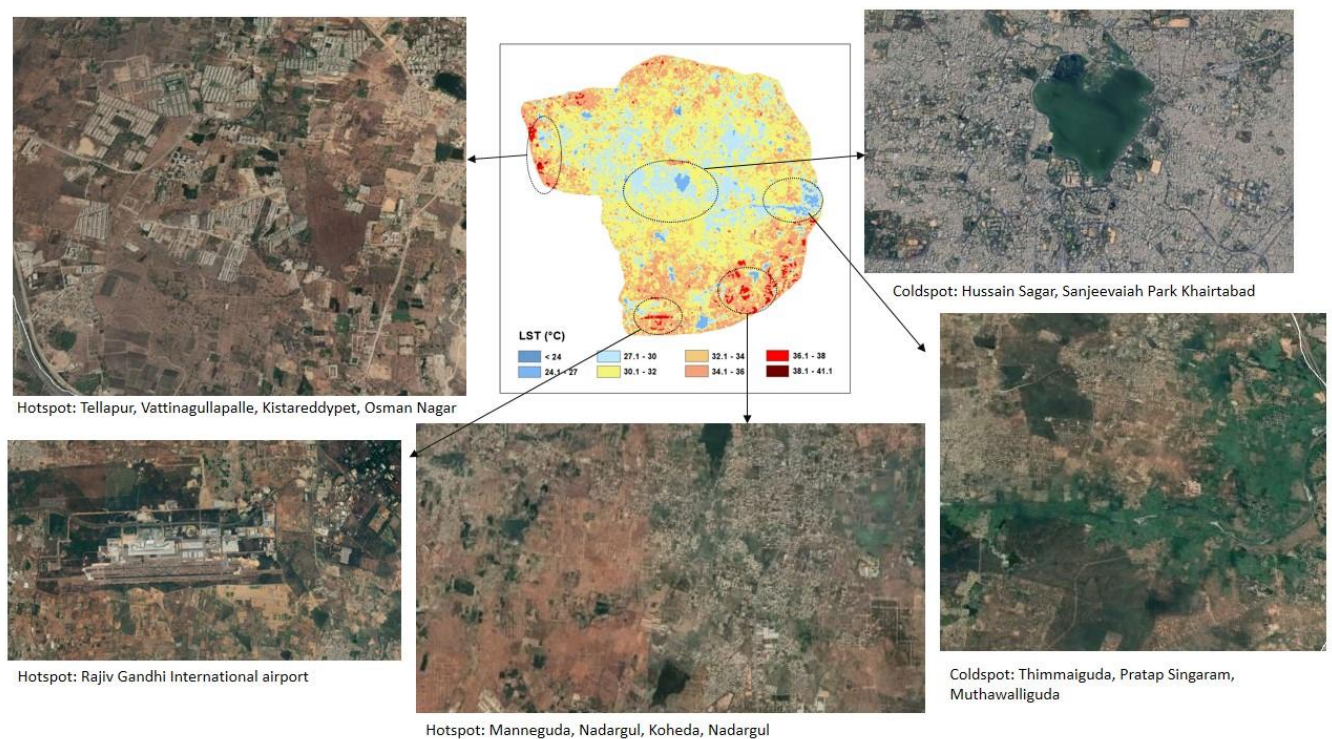
Figure 2: Hotspots identification over Hyderabad on hot days in 2014, 2016, 2018, 2020 and 2022

Source: CSE analysis of Landsat 8 satellite image from USGS Earth Explorer website

Identification of heat hotspots over Hyderabad: April 27, 2018 showed the most number of hotspot with LST exceeding 40°C followed by April 5, 2016 (see *Figure 2: Hotspots identified over Hyderabad on hot days in 2014, 2016, 2018, 2020 and 2022*). The least number of hotspot were observed this year (April 6, 2022). Rajiv Gandhi International Airport, Nadargul, and Turkayamjal are other regions within the city that have consistently recorded high LST.

Denuded and densely built areas are the heat hotspots: Hotspot areas were observed in south western region around Rajiv Gandhi International Airport, Nadargul, and Turkayamjal. Few hotspots are located in the north eastern part of the city as well, namely Jawahar Nagar and Bollaram Industrial area. Coldspots, areas with minimum LST, are observed along water bodies such as Husan Sagar Lake. Thimmaiguda is another coldspot in the city (See *Figure 3: Hotspots and Coldspots over Hyderabad*).

Figure 3: Hotspots and Coldspots over Hyderabad



Source: CSE analysis of Landsat 8 satellite image from USGS Earth Explorer website