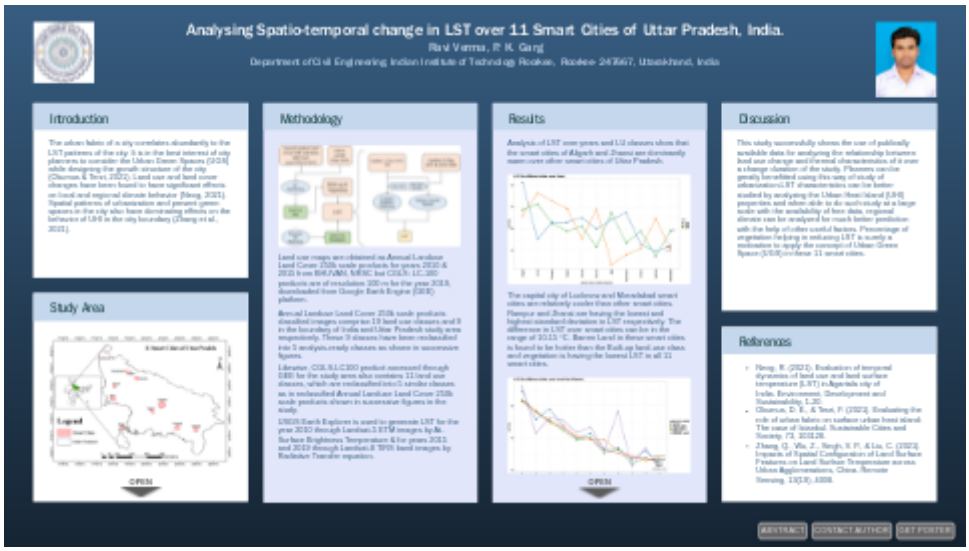
Analysing Spatio-temporal change in LST over 11 Smart Cities of Uttar Pradesh, India.



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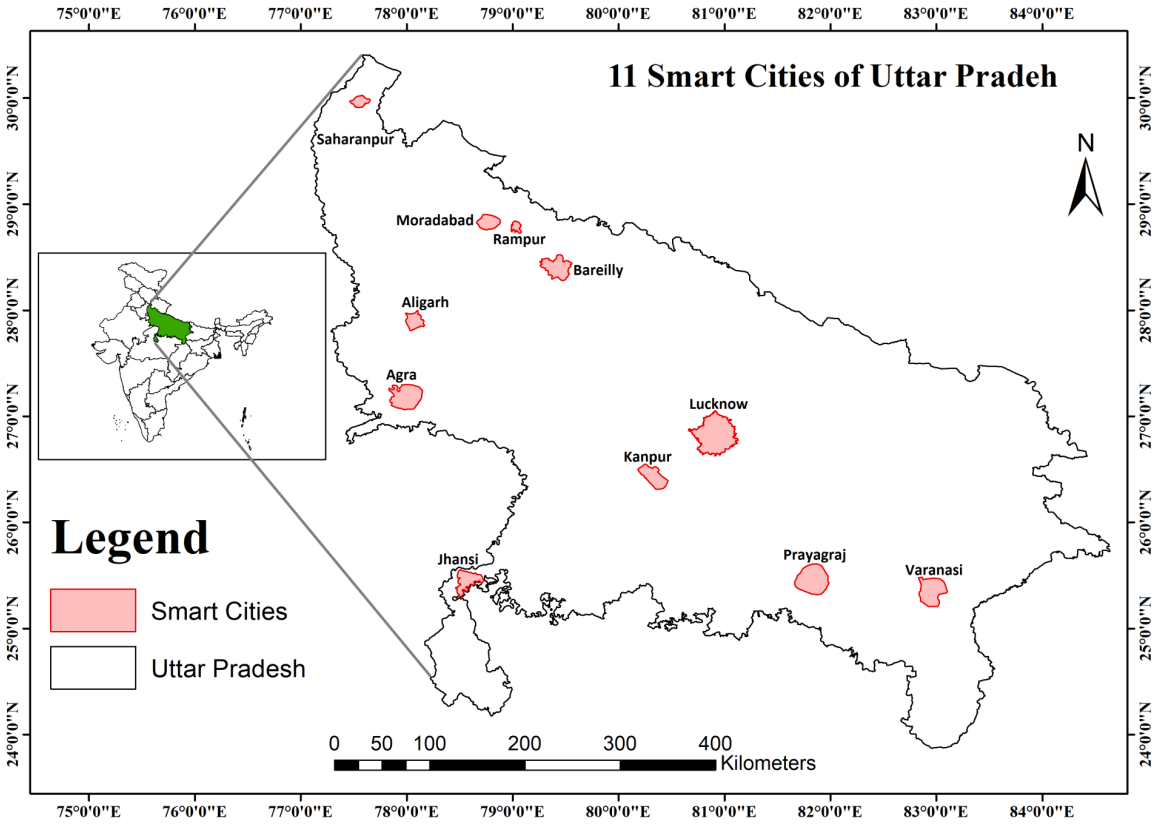
PRESENTED AT:

INTRODUCTION

The urban fabric of a city correlates abundantly to the LST patterns of the city. It is in the best interest of city planners to consider the Urban Green Spaces (UGS) while designing the growth structure of the city (Okumus & Terzi, 2021). Land use and land cover changes have been found to have significant effects on local and regional climate behavior (Neog, 2021). Spatial patterns of urbanization and present green spaces in the city also have dominating effects on the behavior of UHI in the city boundary (Zhang et al., 2021).

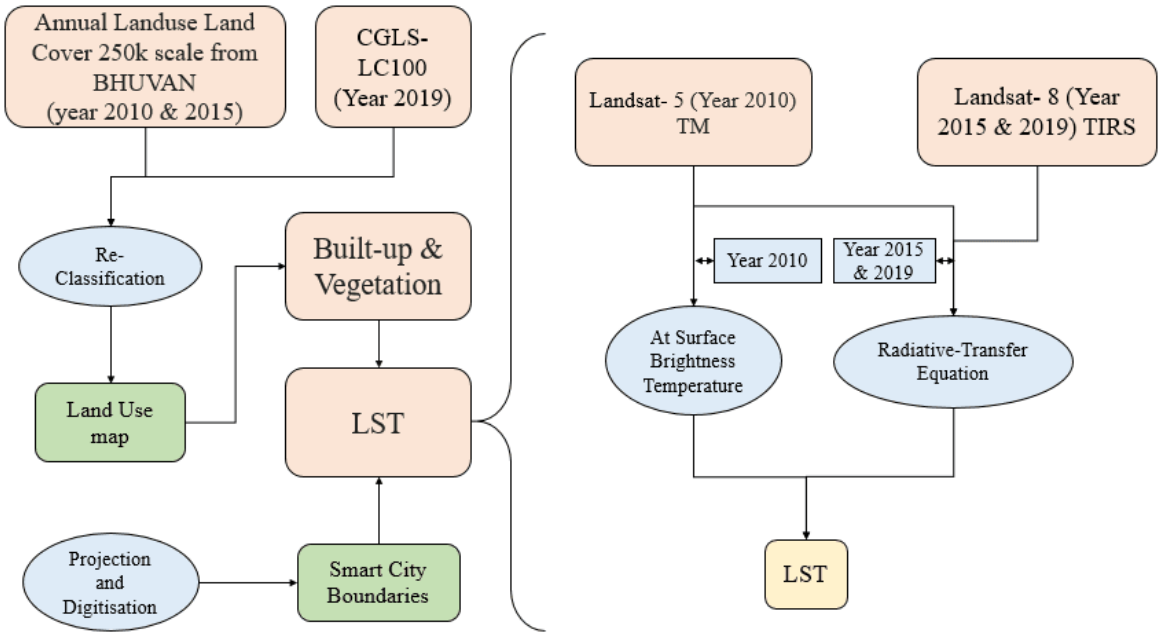
STUDY AREA



Cities considered in the study area are 11 of the 100 smart cities declared in the “SMART city Mission” by the Government of India in the year 2014 for a better standard of living for its citizens. Uttar Pradesh, being one of the largest states of the country got its 11 cities nominated in different phases of the mission, to be developed as smart cities. Cities of "Agra", "Aligarh", "Bareilly", "Jhansi", "Kanpur", "Lucknow", "Moradabad", "Prayagraj", "Rampur", "Saharanpur" and "Varanasi" are shown in Figure 1.

The study area is a fragment of fertile Ganga-Yamuna Plane (Doab region). These cities acquire a total of area approximately 5074.27 km^2. Cities in themselves comprise rivers, canals passing through the center of it, and also reserved forests are situated in it. Rampur is the smallest in the area (77.44 km^2) and the capital of Uttar Pradesh state, Lucknow is the largest (1232.45 km^2). In total, these cities acquire 5074.27 km^2.

METHODOLOGY



Land use maps are obtained as Annual Landuse Land Cover 250k scale products for years 2010 & 2015 from BHUVAN, NRSC but CGLS: LC-100 products are of resolution 100 m for the year 2019, downloaded from Google Earth Engine (GEE) platform.

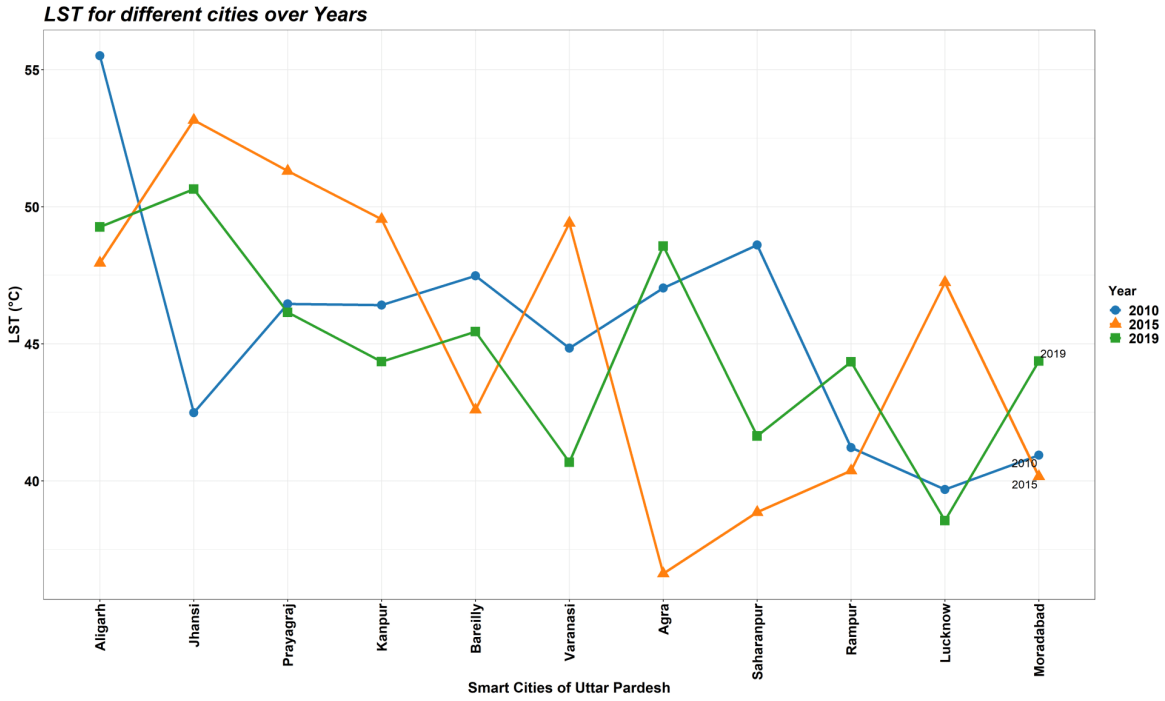
Annual Landuse Land Cover 250k scale products classified images comprise 19 land use classes and 9 in the boundary of India and Uttar Pradesh study area respectively. These 9 classes have been reclassified into 5 analysis-ready classes as shown in successive figures.

Likewise, CGLS-LC100 product accessed through GEE for the study area also contains 11 land use classes, which are reclassified into 5 similar classes as in reclassified Annual Landuse Land Cover 250k scale products shown in successive figures in the study.

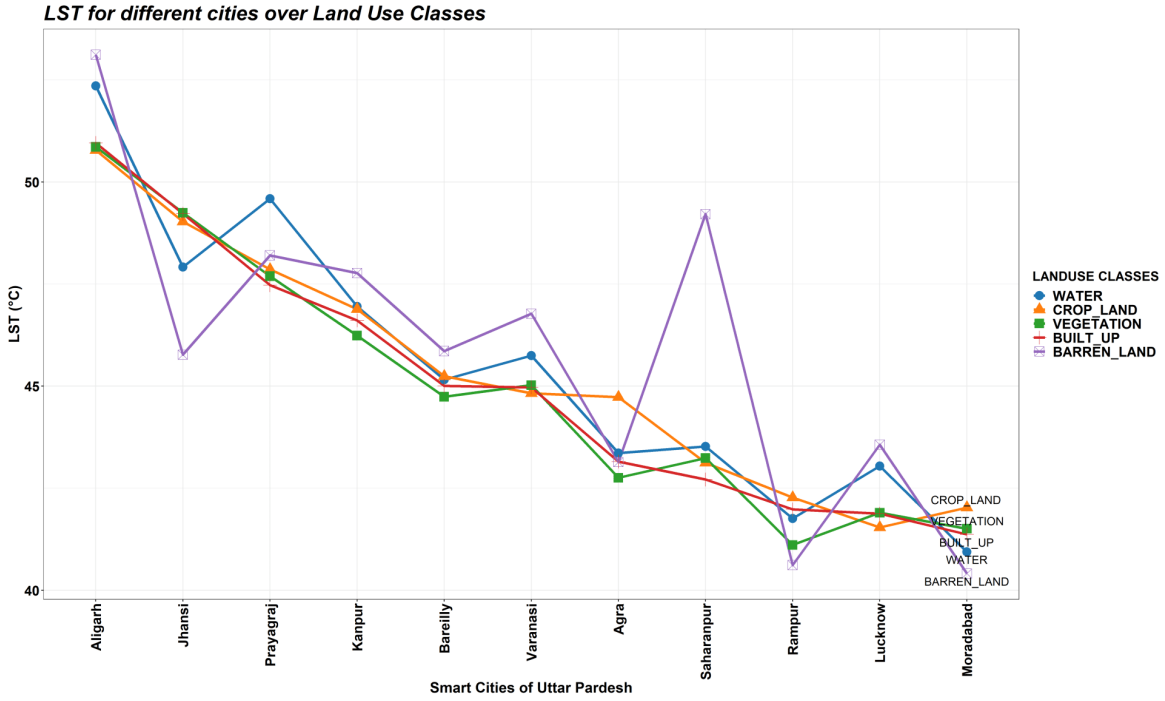
USGS Earth Explorer is used to generate LST for the year 2010 through Landsat-5 ETM images by At-Surface Brightness Temperature & for years 2015 and 2019 through Landsat-8 TIRS band images by Radiative Transfer equation.

RESULTS

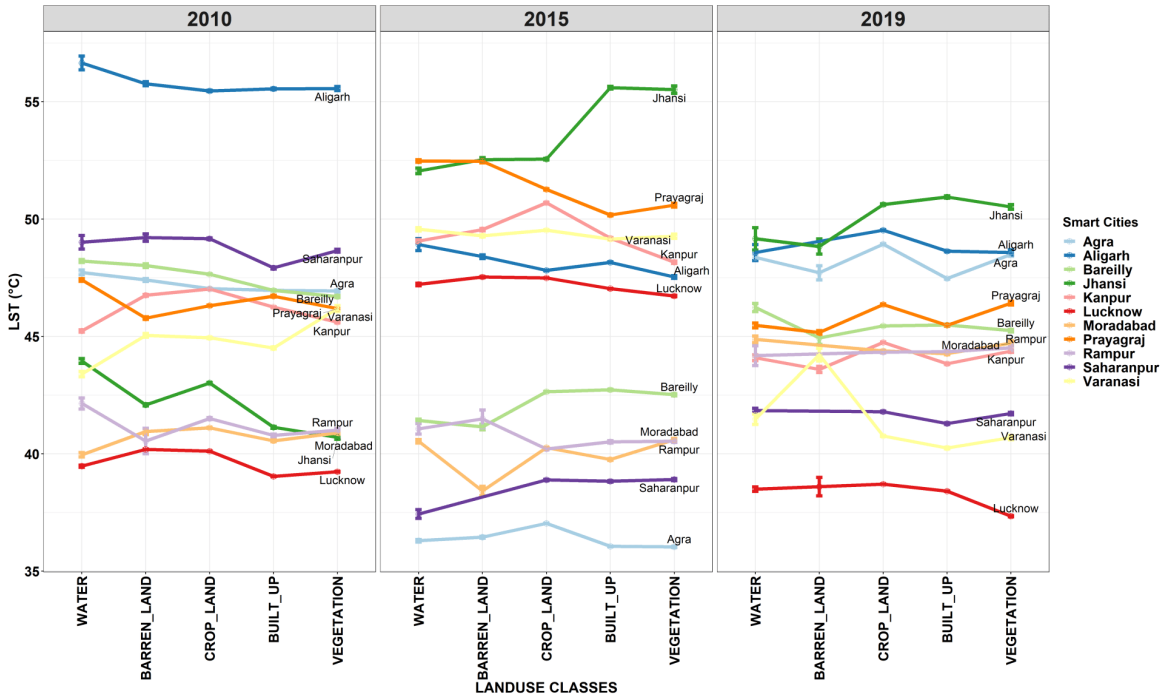
Analysis of LST over years and LU classes show that the smart cities of Aligarh and Jhansi are dominantly warm over other smart cities of Uttar Pradesh.



The capital city of Lucknow and Moradabad smart cities are relatively cooler than other smart cities. Rampur and Jhansi are having the lowest and highest standard deviation in LST respectively. The difference in LST over smart cities can be in the range of 10-15 °C. Barren Land in these smart cities is found to be hotter than the Built-up land-use class and vegetation is having the lowest LST in all 11 smart cities.



The range between LST values in different years over different LU classes varies between 28-35 °C. In the Year 2019 LST statistics seem to be cooled down after the year 2015 being worst in terms of LST range, maximum value, and standard deviation of 6.12 °C.


2010
2015
2019
LST (°C)
55
50
45
40
35
WATER
BARREN_LAND
CROP_LAND
BUILT_UP
VEGETATION
LANDUSE CLASSES
Aligarh
Saharanpur
Agra
Bareilly
Prayagraj
Varanasi
Kanpur
Rampur
Moradabad
Jhansi
Lucknow
Smart Cities
Agra
Aligarh
Bareilly
Jhansi
Kanpur
Lucknow
Moradabad
Prayagraj
Rampur
Saharanpur
Varanasi

DISCUSSION

This study successfully shows the use of publically available data for analyzing the relationship between land use change and thermal characteristics of it over a change duration of the study. Planners can be greatly benefitted using this way of study of urbanization.LST characteristics can be better studied by analyzing the Urban Heat Island (UHI) properties and when able to do such study at a large scale with the availability of free data, regional climate can be analyzed for much better prediction with the help of other useful factors. Percentage of vegetation helping in reducing LST is surely a motivation to apply the concept of Urban Green Space (UGS) in these 11 smart cities.

REFERENCES

- Neog, R. (2021). Evaluation of temporal dynamics of land use and land surface temperature (LST) in Agartala city of India. Environment, Development and Sustainability, 1-20.
- Okumus, D. E., & Terzi, F. (2021). Evaluating the role of urban fabric on surface urban heat island: The case of Istanbul. Sustainable Cities and Society, 73, 103128.
- Zhang, Q., Wu, Z., Singh, V. P., & Liu, C. (2021). Impacts of Spatial Configuration of Land Surface Features on Land Surface Temperature across Urban Agglomerations, China. Remote Sensing, 13(19), 4008.

ABSTRACT

Multiplicity of open source remote sensing date platforms help in bringing various opportunities. Spatio-temporal analysis of a region can help in analysing changes in regional climate over different constituent land use/land cover (LU/LC). This study derives a pattern of Land Surface Temperature (LST) over a period of 10 years in 11 smart cities of Uttar Pradesh using open source data and software programs only. Smart cities namely Agra, Aligarh, Bareilly, Jhansi, Kanpur, Lucknow, Moradabad, Prayagraj, Rampur, Saharanpur and Varanasi are studied for LST in year 2010, 2015 and 2019 by using data from BHUVAN, NRSC and Copernicus Global Land Service: Land Cover (CGLS: LC-100) products. Boundary of the smart cities are digitized form maps of various local authorities. Land use maps are obtained as Annual Landuse Land Cover 250k scale products for year 2010 & 2015 from BHUVAN, NRSC but CGLS: LC-100 products are of resolution 100 m for year 2019. Both the Land use products are having 12 classes in region of smart cities which are reclassified into 5 LU classes of Built-up, Vegetation, Crop land, Barren land and Water. USGS Earth Explore is used to generate LST for year 2010 through Landsat-5 ETM images by At-Surface Brightness Temperature & for year 2015 and 2019 through Landsat-8 TIRS band images by Radiative Transfer equation. Analysis of LST over years and LU classes show that smart cities of Aligarh and Jhansi are dominantly warm over other smart cities of Uttar Pradesh. Capital city of Lucknow and Moradabad smart city are relatively cooler than other smart cities. Rampur and Jhansi are having the lowest and highest standard deviation in LST respectively. Difference in LST over smart cities can be in range of 10-15 °C. Barren Land in these smart cities is found to be hotter than Built-up land use class and vegetation is having lowest LST in all 11 smart cities. Range between LST values in different years over different LU classes vary between 28-35 °C. In Year 2019 LST statistics seem to be cooled down after year 2015 being worst in terms of LST range, maximum value and standard deviation of 6.12 °C. Percentage of vegetation helping in reducing LST is surely a motivation to apply concept of Urban Green Space (UGS) in these 11 smart cities.

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