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Short communication

Land use land cover changes and its association with land surface temperature over Palakkad district, Kerala

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Climate change is a major cause of vegetation change. Vegetation responses to climate change vary widely across locations and seasons. Urban and environmental changes in vegetation systems over time provide crucial insights into the impacts of climate change and desertification (Tawfik & Al-Lami, 2025). The Landsat series of satellites offers high-resolution estimations of land surface temperature (LST) that are particularly beneficial for small-scale and local research (Sajan *et al.,* 2023). Land surface temperature (LST) is strongly influenced by land use and land cover changes that modify surface radiative and aerodynamic properties, resulting in higher temperatures over built-up areas compared to vegetated surfaces. Land surface temperature (LST) and its interaction with normalized difference vegetation index (NDVI) is crucial for better understanding of environmental changes in current scenario (Malav *et.al.,* 2024). The NDVI and the Normalized difference built-up index (NDBI) are frequently used to measure vegetation cover and built-up intensity. Previous studies have consistently reported a negative relationship between LST and NDVI and a positive relationship between LST and NDBI, particularly during summer when low soil moisture and high solar radiation enhance surface temperature contrasts (Singh *et al*., 2017; Dutta *et al.,* 2019; Sajan *et al.,* 2023).

Rapid urbanization in Kerala has altered land surface characteristics, increasing summer surface warming, especially in inland districts such as Palakkad influenced by the Palakkad Gap (Cyriac & Firoz, 2022). However, district-level assessments linking summer-season LST with vegetation and built-up characteristics remain limited. The objective of this study was to quantify summer-season (March-May) land surface temperature variability over Palakkad district and examine its association with vegetation cover and built-up intensity using satellite-derived indices.

Palakkad district has a tropical wet and dry climate influenced by the southwest and northeast monsoons. Summer (March–May) is characterised by very high air temperatures, often exceeding 38 °C, low wind speeds, and elevated thermal stress. Its inland location and the Palakkad Gap facilitate the inflow of warm continental air, making the district one of the warmer regions in Kerala and suitable for studying summer heat stress and land–atmosphere interactions. Satellite data and meteorological datasets were accessed through Google Earth Engine and the NASA POWER project. Land surface temperature (LST) was analysed for the summer season (March–May) of 2014 and 2024, representing peak thermal conditions over Palakkad district. Landsat 8 imagery was processed using the Google Earth Engine (GEE) platform, with LST derived from thermal Band 10. Only cloud-free images (<10% cloud cover) were selected to ensure data quality.

Landsat 8 OLI/TIRS surface reflectance and thermal datasets were processed using Google Earth Engine (GEE) and only cloud-free images (<10% cloud cover) during the summer season (March–May) were selected. Land surface temperature (LST) was retrieved from Landsat 8 thermal Band 10 using the generalized single-channel algorithm with emissivity correction proposed by Jiménez-Muñoz and Sobrino (2003). Median LST values were computed for each summer season to minimize the influence of extreme pixels. Vegetation and built-up characteristics were quantified using the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Built-up Index (NDBI), derived from Landsat 8 Operational Land Imager (OLI) data following Shah et al. (2022).

NDVI was calculated using the following equation:

$$NDVI = (NIR - Red) / (NIR + Red)$$

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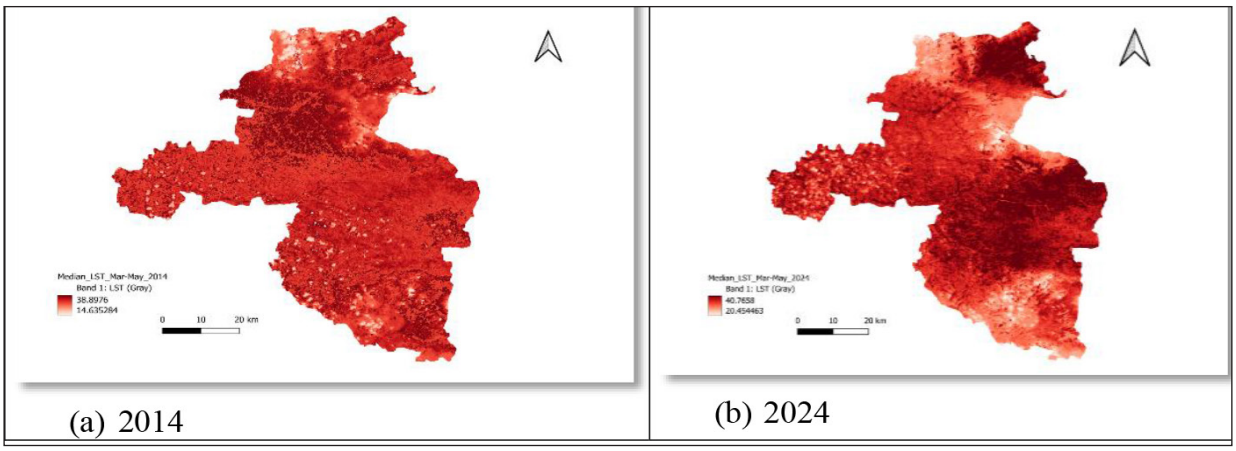

Fig. 1: Spatial variation of median LST over Palakkad during summer-season (March-May) of 2014 and 2024

where NIR represents the near-infrared band (Band 5) and Red represents the red band (Band 4) of Landsat 8.

NDBI was calculated using the following equation:

$$NDBI = (SWIR - NIR) / (SWIR + NIR)$$

where SWIR corresponds to the short-wave infrared band (Band 6) and NIR corresponds to Band 5 of Landsat 8.

The vegetation classes determined from the NDVI represented composite summer land cover conditions, such as plantations, natural vegetation, fallow areas, and sparse cropping. Pearson correlation analysis was performed on a pixel-by-pixel basis between LST and NDVI, and between LST and NDBI, for each respective year (2014 and 2024) using summer-season composite images.The correlation was performed using python. The land surface temperature (LST) was analysed using median values to minimise the influence of extreme pixels. The summer median LST over Palakkad district increased from 38.8 °C in 2014 to 40.53 °C in 2024 (Fig. 1) indicating an overall intensification of surface thermal conditions during the peak summer season.

Table 1: Variation in area under different land surface characteristics over Palakkad

Indices	Category	2014	2024
NDVI	Low vegetation (< 0.2)	13.59	21.77
	Moderate vegetation (0.2 – 0.5)	43.27	39.23
	Dense vegetation (> 0.5)	0.00	0.00
NDBI	Build-up area (> 0)	12.30	21.39

From Table 1, it could be interpreted that low to moderate vegetation clearly dominated the summer land cover of Palakkad district for both years. The proportion of area under low vegetation increased from 13.59% in 2014 to 21.77% in 2024, while that under moderate vegetation decreased from 43.27 to 39.23% over the same time period. Dense vegetation compaction was still low during the summer, in both years. The built-up area expanded significantly from 12.30% in 2014 to 21.39% in 2024, reflecting strengthened urban surface modification impact on the summer LST variation.

The LST was negatively correlated with the NDVI while it was positively correlated to NDBI in both years. The strength of the negative relationship increased from −0.18 in 2014 to −0.57 in 2024, while the positive correlation between LST - NDBI increased from 0.53 to 0.66 over the same period (Table 2), clearly indicate the influence of vegetation reduction and built-up intensity on summer surface thermal conditions Similar results have been reported by Sajan *et al.,* (2023).

Table 2: Correlation between of LST with NDVI, and NDBI

Year	NDVI	NDBI
2014	−0.18	0.53
2024	−0.57	0.66

The analysis revealed that summer land surface temperature variability over Palakkad district was strongly associated with variations in vegetation cover and built-up intensity, highlighting the role of land surface characteristics in controlling surface thermal conditions during peak summer. The findings offered useful insight into summer surface warming patterns derived from satellite observations.

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