

## Executive Summary

Satellite observations are extensively used to monitor land surface temperature (LST) changes owing to their global coverage. However, satellite observations are unable to capture small variations of LST because of their coarser spatial resolution. This can cause inaccurate estimation of urban heat islands, the difference in LST between urban and rural areas, and micro-urban heat islands (MUHIs) within heterogeneous land uses in a metroplex. This study used a thermal camera onboard a drone to detect MUHIs in two seasons in a diverse location in the Dallas-Fort Worth Metroplex having two residential neighborhoods, one industrial area, and a natural park. The hotspots of severe LST leading to intense MUHI were identified in the study area. Such studies can aid urban planning and design to reduce thermal discomfort and protect urban dwellers from the negative impacts of MUHIs on their health during heat waves.

## Background

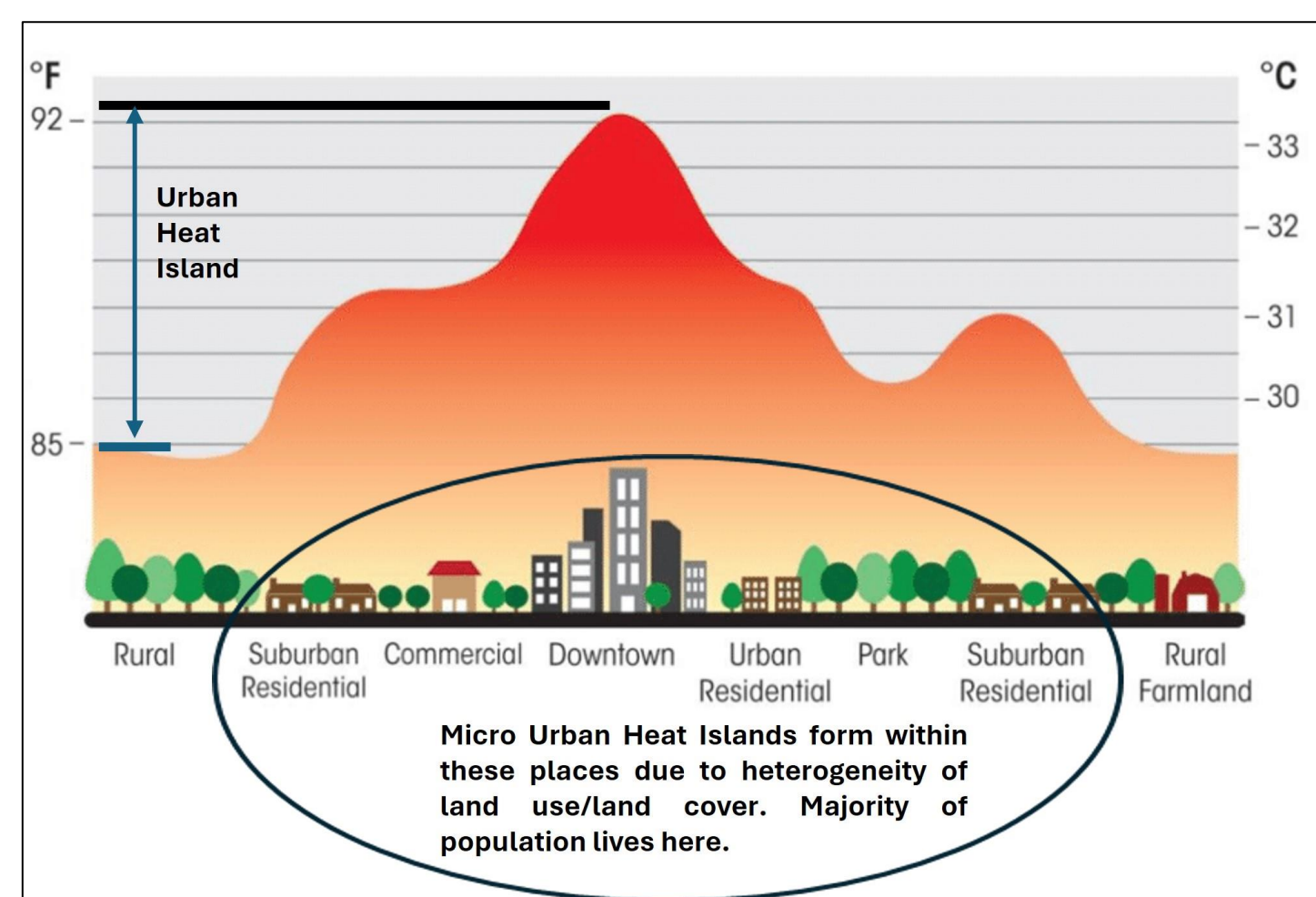


Figure 1. Difference between Urban Heat Island (UHI) and Micro Urban Heat Island (MUHI)



Figure 2. Study Area

## Methodology

Table 1. Drone flight schedule

Start time	Fall	Summer
9:30	10/5/2022	6/17/2023
10:00	10/6/2022	6/19/2023
12:00	10/1/2022	6/24/2023
15:30	10/2/2022	7/9/2023
16:20	10/19/2022	6/8/2023
17:30	10/17/2022	6/16/2023

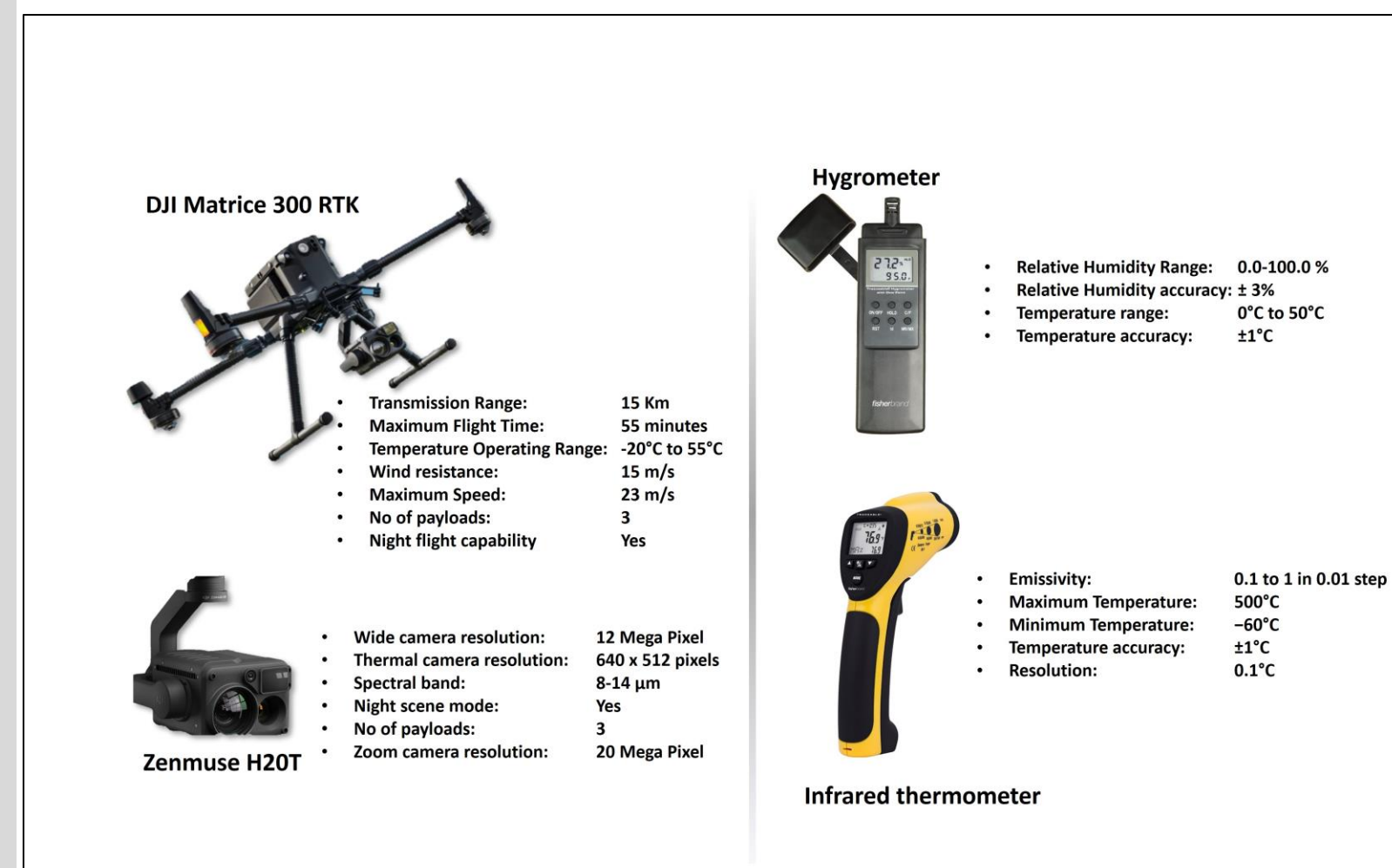


Figure 3. Specifications of drone, thermal camera, hygrometer and infrared thermometer

- Six flights were conducted in each season at different times of the day.
- The drone-derived LST was compared with Landsat data.
- MUHI is the difference in LST of two land uses reporting minimum and maximum mean LST.
- The mean LST of Park Area was subtracted from every location of other land uses to estimate spatial variation of MUHI.
- Negative MUHI:  $<0^{\circ}\text{C}$ , Low:  $0\text{-}5^{\circ}\text{C}$ , Medium:  $5\text{-}10^{\circ}\text{C}$ , High:  $10\text{-}15^{\circ}\text{C}$  and Very High:  $>15^{\circ}\text{C}$ .
- Land uses are: Residential High Cost (RHC), Residential Low Cost (RHC), Industrial Area (IA) and Park Area (PA).

## Results

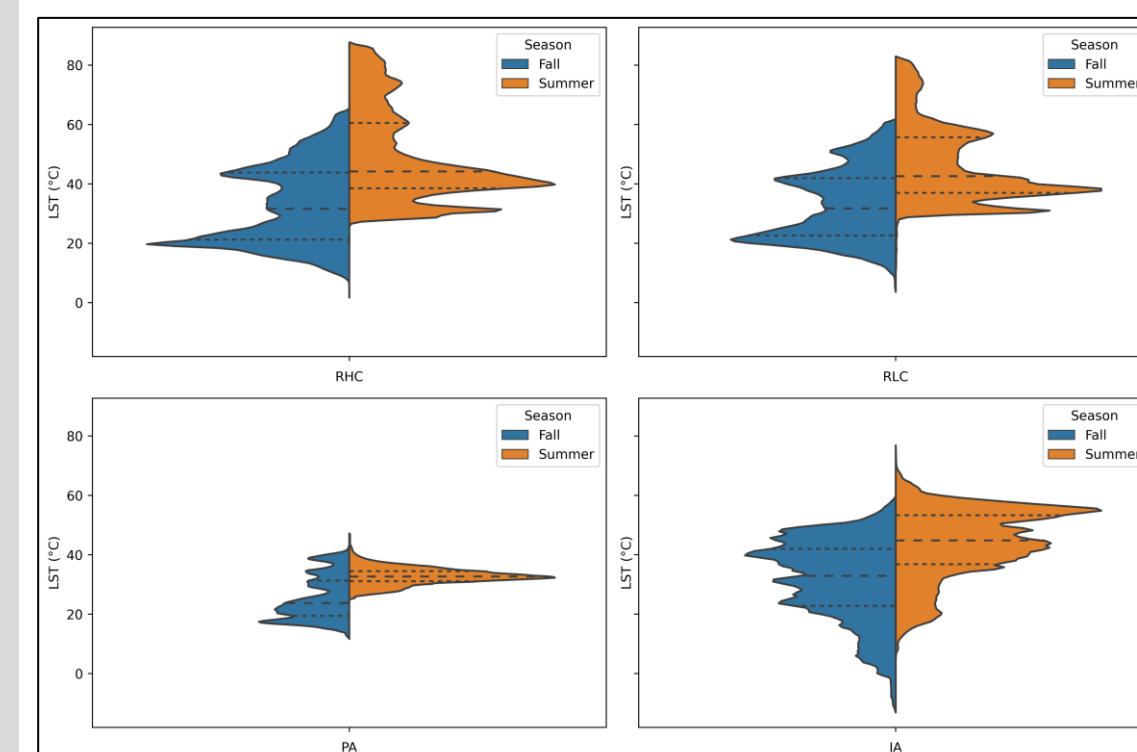


Figure 4. Distribution of LST in all land uses for both seasons

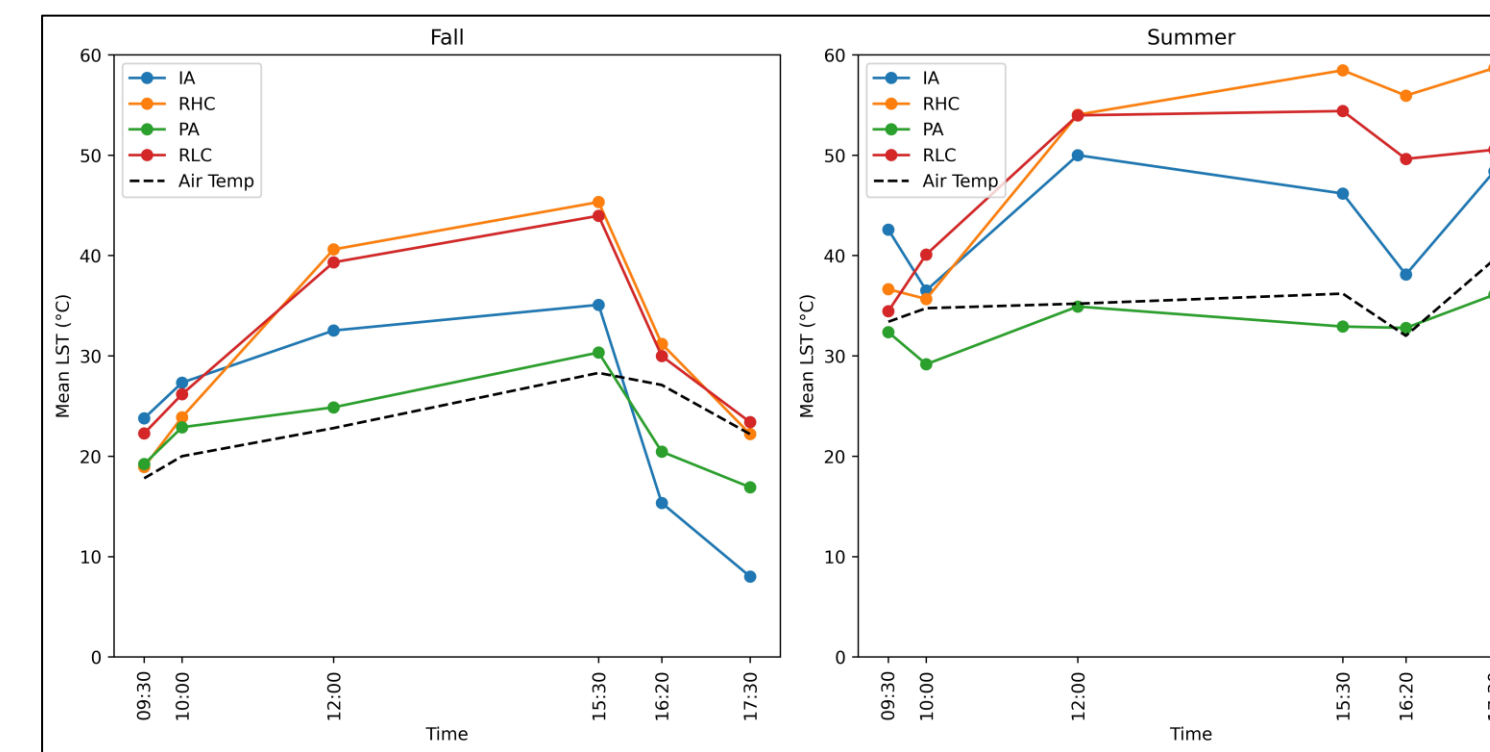


Figure 5. Variation of mean LST for all land uses in both seasons for different times of the day

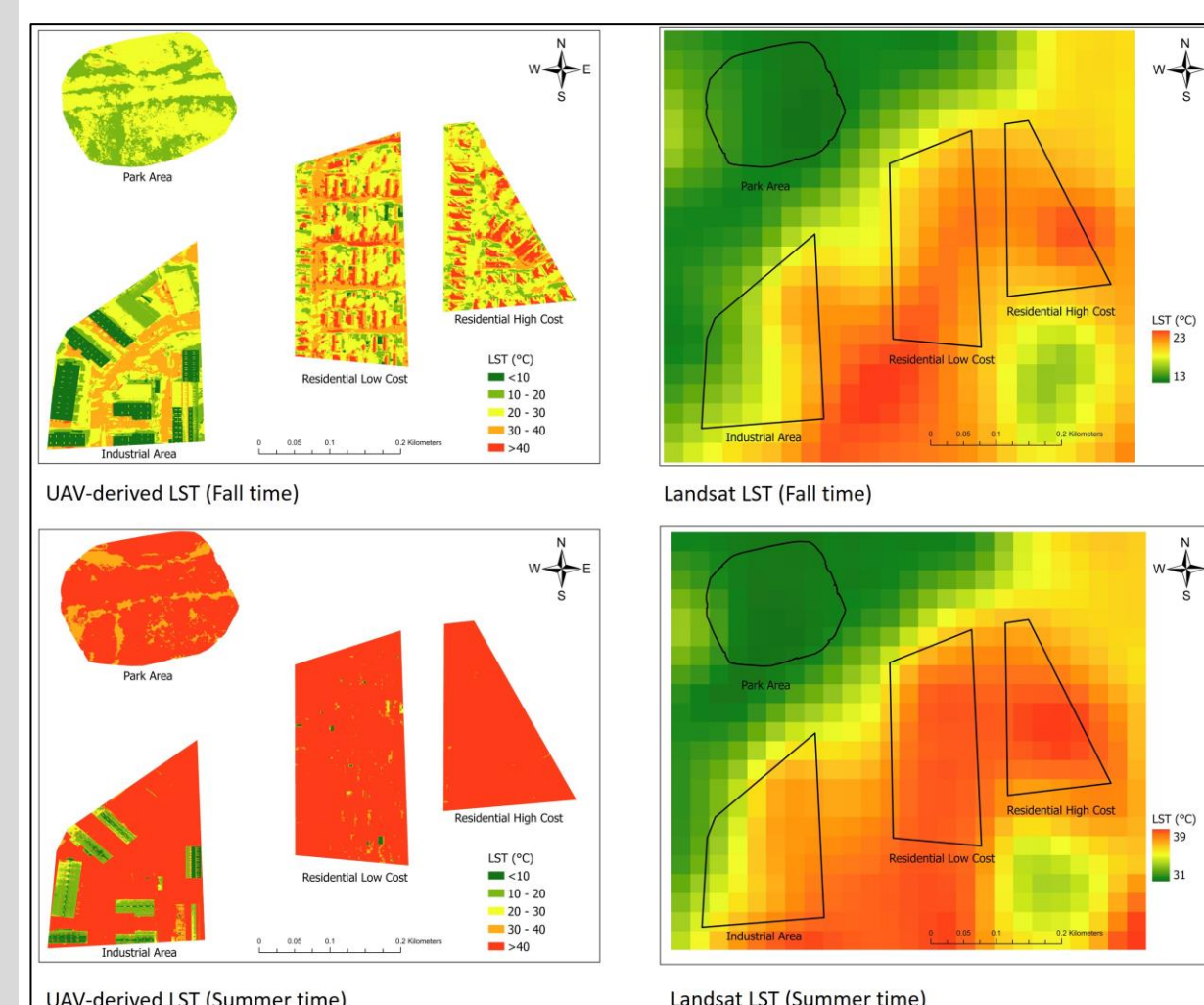


Figure 6. Spatial variation of LST obtained from drone and Landsat from two flights in different seasons

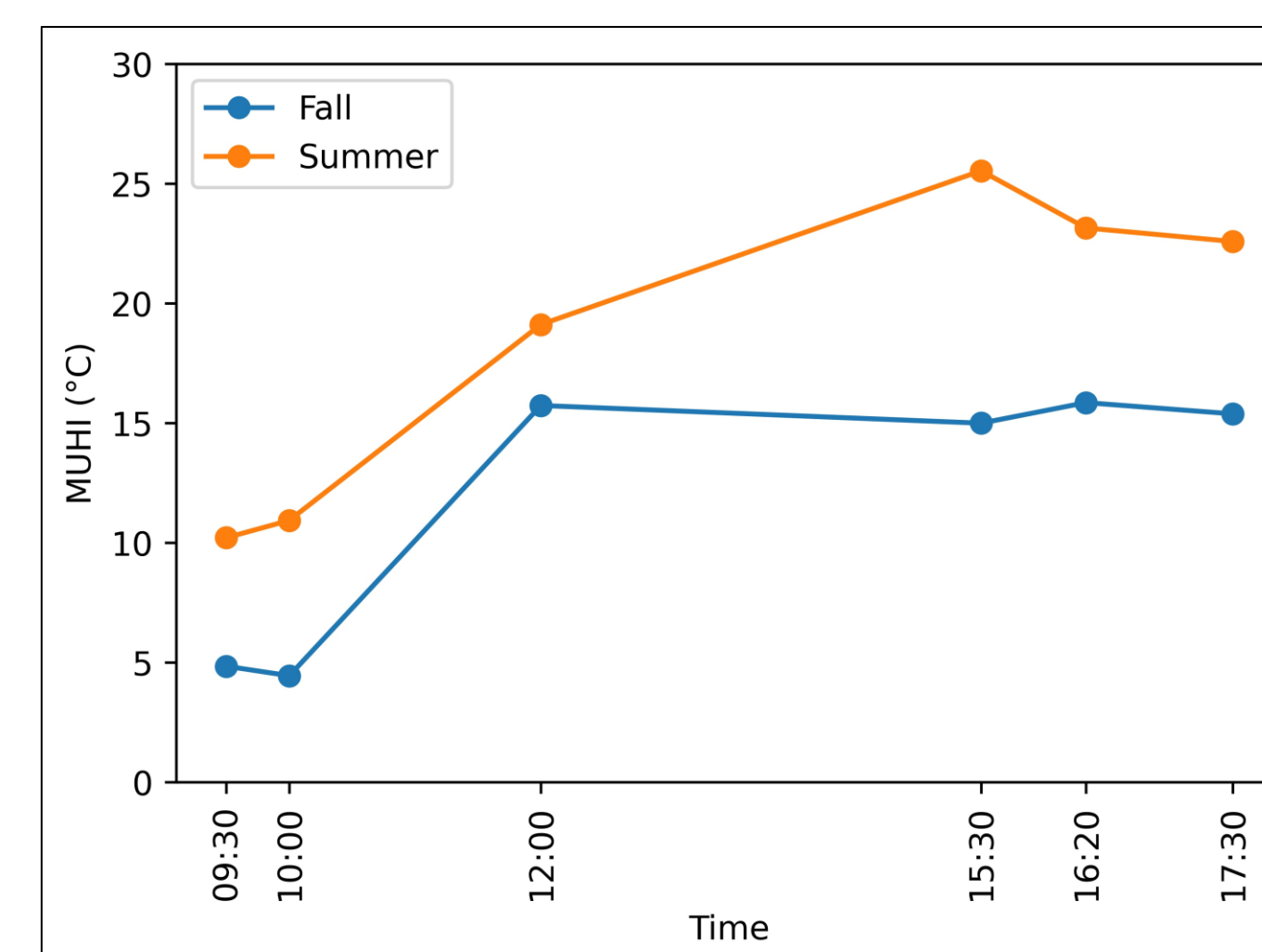


Figure 7. MUHI variation obtained from the drone in both seasons

## Results

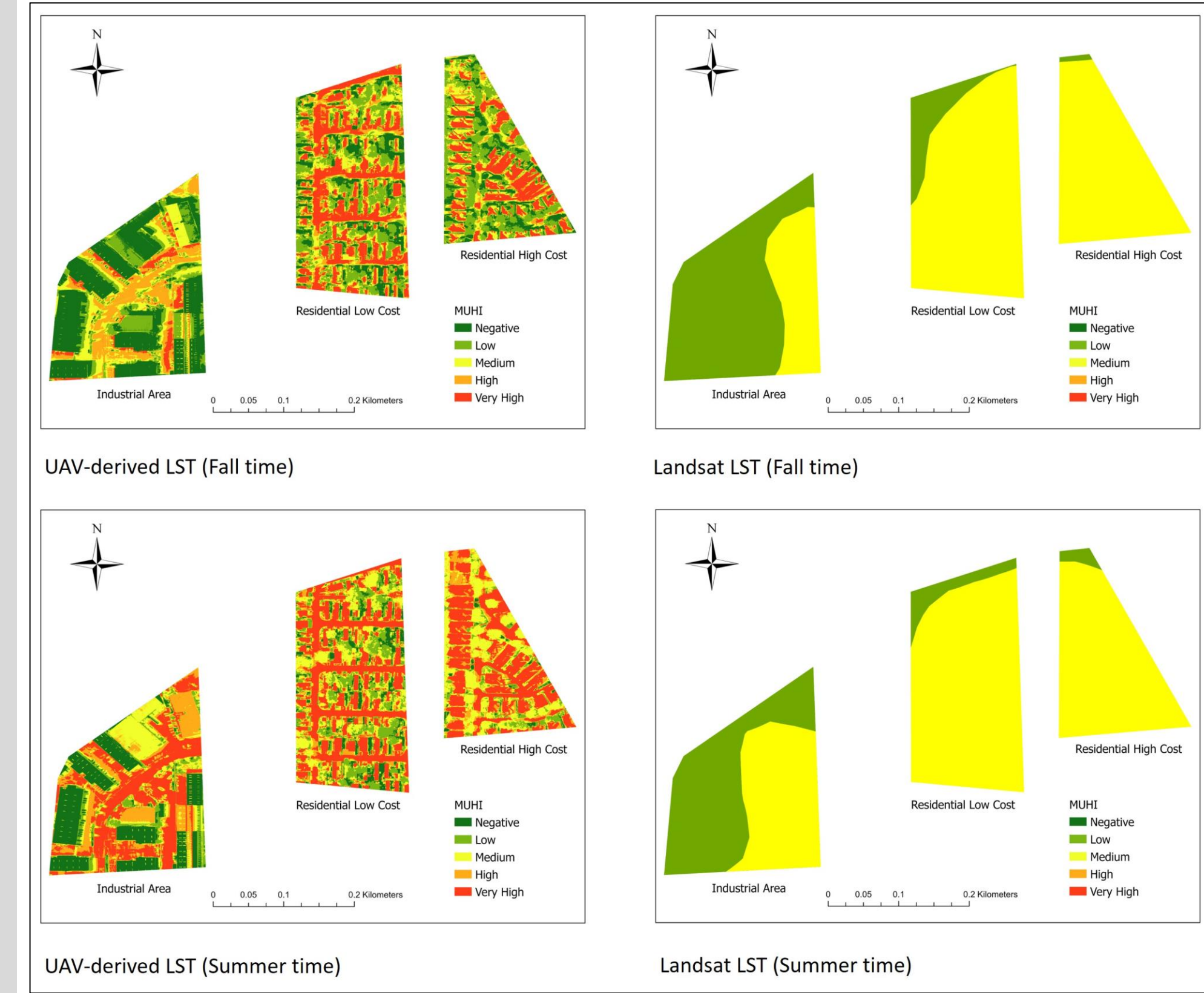


Figure 8. Spatial variation of MUHI from drone and Landsat data

- Drone reported MUHI variation in all categories.
- Landsat could only report MUHI in low and Medium category in both seasons.
- Drone not only captured areas of Very High MUHI but also reported places with negative MUHI.

## Conclusions

- Residential High Cost reported maximum mean LST in both seasons from noon onwards mainly due to dark colored roofs reaching up to  $86^{\circ}\text{C}$  (high absorption and emissivity).
- Spatial configuration (wider pavements), material type (insulation panels, concrete) and material color (light colored roofs) lead to lower LSTs.
- Drone reported a maximum MUHI of  $25.54^{\circ}\text{C}$  around 15:30 in summer (June-July) and  $15.85^{\circ}\text{C}$  around 16:20 in fall (October), respectively.
- Drone captured minute variation of MUHI's in both seasons which was significantly overlooked by the Landsat data.
- Other studies [1-4] using drones did not estimate the spatial variation of MUHI which has been conducted in this study. Also, satellite-derived MUHI is unable to capture small-scale variation which the drone could estimate [5,6].

## References

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2. Dimitrov, Stelian, Anton Popov, and Martin Iliev. "An application of the LCZ approach in surface urban heat island mapping in Sofia, Bulgaria." Atmosphere 12.11 (2021): 1370.
3. Song, Bonggeun, and Kyunghun Park. "Verification of accuracy of unmanned aerial vehicle (UAV) land surface temperature images using in-situ data." Remote Sensing 12.2 (2020): 288.
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