



Exploring the Urban Heat Island (UHI)

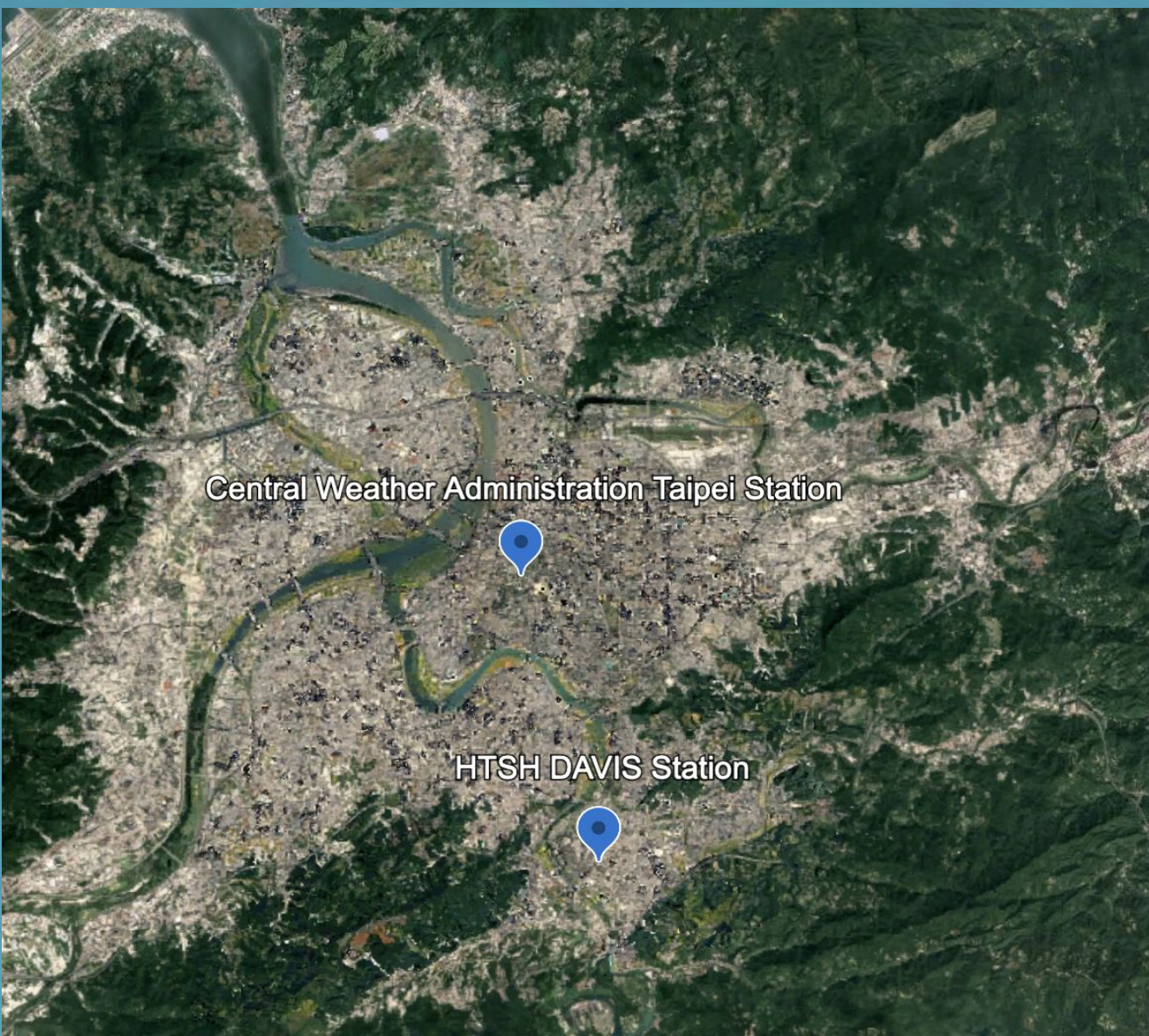
Trend in Taiwan's Capital

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Abstract:

Most studies on the urban heat island (UHI) effect in Taiwan focus on short-term analysis, typically covering a research period of about one month. Additionally, many books and references do not clearly define urban and rural areas. In our study, we first analyzed data for Taipei City from May 2020 to December 2023. We calculated the UHI by subtracting the monthly average temperature of the HTSH DAVIS Station from the monthly average temperature of the Central Weather Administration's Taipei station. We then conducted further analysis using gridded meteorological station data.



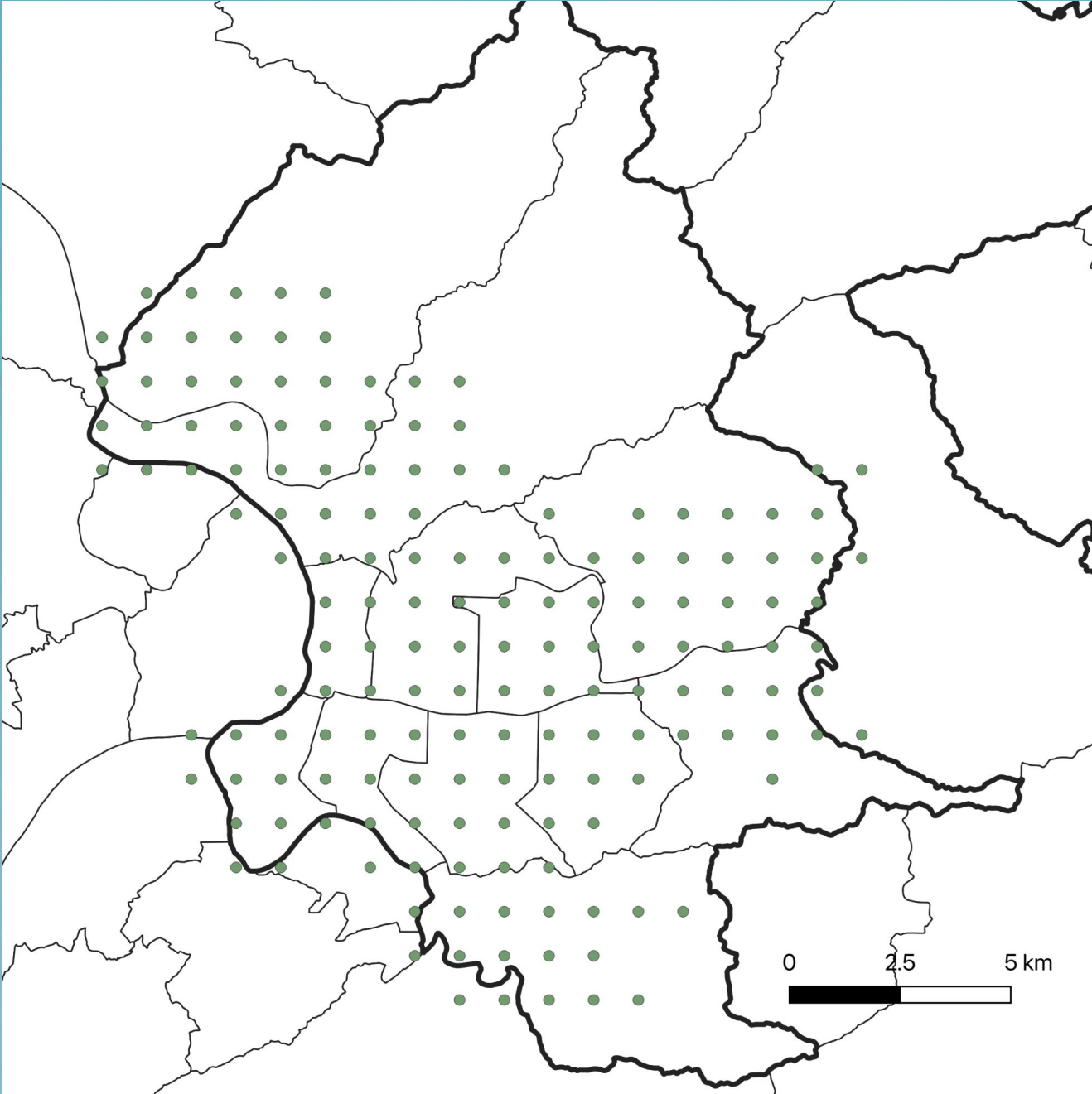
Using gridded data helps compensate for the lack of meteorological stations in certain areas. We adopted the TCCIP second-edition gridded dataset and excluded grid points above 100 meters to avoid altitude effects. Within urban areas, we selected the highest and lowest temperatures below 100 meters to estimate UHI intensity.

Our analysis showed that the UHI from station data (2020–2023) exhibited a decreasing trend, while gridded data (1960–2022) showed an increasing trend. To understand this discrepancy, we explored possible causes. We also hope to increase the number of meteorological stations to ensure the data better reflects daily life conditions.

Research Results:

- The UHI from May 2020 to December 2023 is shown below. The blue line represents the actual UHI, while the orange line illustrates the overall trend. The trendline equation is $y = -0.027 \cdot x + 4.39$, with an R^2 value: 0.118.
- According to the table on the right, the Urban Heat Island (UHI) is higher in summer and weaker in winter. Notably, in July 2020, the UHI reached its highest value of 6.7. Additionally, 2020 had the highest annual average temperature, while 2022 had the lowest annual average temperature.

	Years			
Months	2020	2021	2022	2023
1		3.1	2.8	3.2
2		4.4	2.6	3.3
3		3.6	4.1	4.0
4		3.8	3.3	3.9
5	4.7	4.6	2.9	3.7
6	5.9	4.4	4.8	4.3
7	6.7	4.5	4.8	4.6
8	5.5	4.4	4.4	4.7
9	5.0	4.4	3.5	3.8
10	3.1	2.6	2.3	2.7
11	3.7	2.6	2.6	3.5
12	2.7	2.4	2.4	3.1
Average	4.7	3.7	3.4	3.7



Discussion:

- Next, we analyzed the gridded data. Within this urban area, we selected the highest and lowest temperatures from grid points below 100 meters to estimate UHI intensity.
- The UHI in Taipei City showed an overall upward trend from 1960 to 2022. The remained relatively low between 1986 and 2008, but around 2009, it began to rise more rapidly compared to previous growth rates.
 - Ground stations can directly measure local temperatures, making them suitable for small-scale observations, but they are easily affected by the environment. Temperature readings may vary depending on the station's location (e.g., rooftop, grass, or near a classroom). Gridded data reduces environmental influences, compensates for the lack of stations, and is more suitable for large-scale and long-term studies.
 - The gridded data aligns with our expectations, showing that the UHI effect intensifies with global warming, while the station data exhibits a decreasing trend. Since station data covers only the past three years, it may reflect Taipei's urban development reaching saturation, leading to population migration to Xindian, where increased vehicle emissions contribute to rising temperatures. Additionally, the government's recent promotion of green buildings has reduced heat absorption, helping to cool Taipei.

Conclusion:

- The average rate of change in the UHI based on 2020–2023 surface station data indicates that the urban heat island effect in Taipei City has decreased by approximately 2.7°C per century.
- The average rate of change in the UHI based on 1960–2022 gridded data shows that the urban heat island effect in Taipei City has increased by approximately 1.6°C per century.
- The monthly average temperature at Taipei Station is consistently higher than that at HTSH DAVIS Station.
- We hope to continue collecting temperature data from Hsintien High School to further investigate whether the urban heat island effect is intensifying under global warming.
- We also hope to increase the density of automatic weather stations in the future, allowing for more detailed and practical temperature data analysis relevant to daily life.

