Materials Matter: A Case-Study of the UHIE on Albuquerque's Surface Materials

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Introduction and Motivation

The Urban Heat Island Effect (UHIE) is currently affecting many large cities around the world. The UHIE has been described as an increase in urban area temperatures that is compared to the rural surrounding areas (Phelan et al. 2015). Albuquerque, New Mexico is a city experiencing the UHIE. In 2021, CAPA Strategies thermally mapped the city as part of a heat mapping campaign (CAPA Strategies, LLC 2021). This campaign identified localized "hot spots" within the city-scale geospatial domain. To explore these "hot spots", we performed a case-study focused on understanding the UHIE at the neighborhood scale.

Methodology

Our survey site is located on the west side of Albuquerque. This site was selected based on CAPA's results, which showed a notable "hot spot" in this region.

The mobile transect method, walking a 2.53 mile-long closed-loop path, was used to assess air temperature (T_{Air}) and surface temperatures ($T_{Surface}$).



- 13 weeks: May 19, 2024 through July 24, 2024
  - Every Wednesday and Sunday
- 3 times a day:
  - Morning: 8am to 9am
  - Afternoon: 2pm to 3pm
  - Evening: 7pm to 8pm
- Data collected using Kestrel-3000 and ThermoWorks IR sensor
- Common materials found:
  - Sand
  - Asphalt
  - Concrete
  - North/east-facing walls

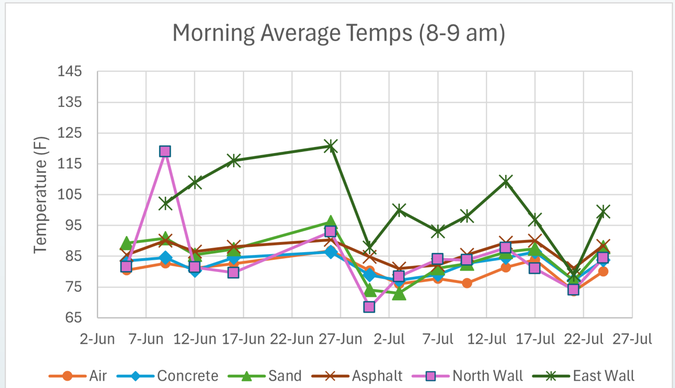
Results and Analyses

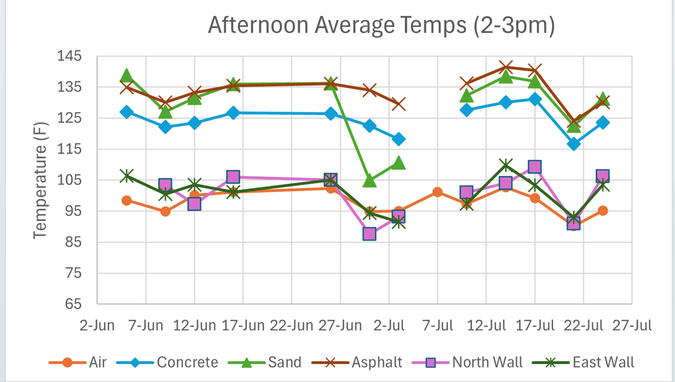
This study's three research questions:

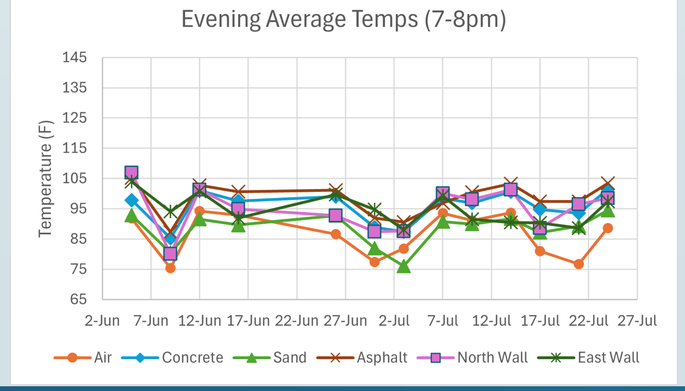
1. Why was the study area considered one of the hottest areas in the city, according to CAPA's study?

2. Was the high temperature of the study site correlated to the amount and/or type of materials found at this site?

3. Are there differences in the $T_{Surface}$ for the materials measured along the transect and do these temperatures change as part of their geospatial location?







Morning 7am to 8am
- Avg. morning T_{Air} = 80.4 °F
- Concrete lowest average $T_{Surface}$ above T_{Air}
  - 1.9 °F
  - High thermal mass
- East-facing walls highest average $T_{Surface}$ above T_{Air}
  - 21.4 °F
  - Exposure to sun and angle of incidence

Afternoon 2pm to 3pm
- Avg. afternoon T_{Air} = 97.9 °F
- North/east-facing walls lowest average $T_{Surfaces}$ above T_{Air}
  - 2.4 °F and 2.8 °F, respectively
  - Releasing stored energy
- Asphalt and sand highest average $T_{Surfaces}$
  - *Asphalt*: 35.8 °F, due to low albedo paired with high solar radiation
  - *Sand*: 31.0 °F, due to high albedo paired with high solar radiation

Evening 7pm to 8pm
- Avg. evening T_{Air} = 86.5 °F
- Asphalt highest average $T_{Surface}$ above T_{Air}
  - 11.8 °F
- Sand lowest average $T_{Surface}$ above T_{Air}
  - 1.80 °F due to low specific heat

Conclusions

- $T_{Surface}$ are higher than T_{Air} because materials absorb more solar radiation than transparent air
- Differences in $T_{Surface}$ are due to differences in albedo
  - Also angle of incidence and/or time exposed to the sun
- Monsoon season showed lower air and surface temperatures
- Large amounts of asphalt and sand found along the transect may help to explain why this area was found to be one of the hottest regions in Albuquerque, according to the CAPA Strategies data



References

CAPA Strategies, 2021: Albuquerque NM Heat Watch Report.

Phelan, P.E., et al., 2015: Urban Heat Island: Mechanisms, Implications, and Possible Remedies. Annual Review of Environment and Resources., 40, 285-307.0

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