Comparison of Temperature Differences Green Spaces and Urban Environments in the El Paso, Tx region

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INTRODUCTION

- Situated in the heart of the Chihuahuan Desert—the largest desert biome in North America—El Paso experiences extreme summer temperatures that can soar to 35-40°C[1].
- Coupled with this natural climatic condition, the city is grappling with an intensifying Urban Heat Island (UHI) effect, a phenomenon whereby heat gets trapped within urban structures like roads, residential areas, and industrial buildings, forming sweltering pockets in the urban core[2].
- Over the span of nearly five decades (1970-2018), El Paso's temperature has rapidly increased by 2.8°C, making it one of the fastest warming cities in the United States[3].
- This increase in temperature is not solely attributed to natural climatic trends, but also to the city's burgeoning population and expanding infrastructure, both of which significantly contribute to the UHI effect.

OBJECTIVE

- This study aims to elucidate the role of expansive green spaces in shaping the thermal dynamics of their adjacent urban environments. Specifically, we strive to:
  - Quantify the temperature disparities between green and urban spaces, providing insight into their unique thermal landscapes.
  - Ascertain the spatial extent of a green space's influence on local temperatures.
  - Evaluate the potential of green spaces in tempering the heat-related impacts of urbanization.

METHODS

Figure 1: Depicts the green space study sites at A) Knapp and B) Lost Dog Conservation Easements, which are managed by the Frontera Land Alliance. Two C) Hobo© weather stations are strategically located within these areas for data collection.

- Network of ground-based weather stations to monitor a comprehensive set of meteorological variables, including wind speed (in kph), temperature (in °C), precipitation (in mm), and relative humidity (%).
- Data logging for temperature was conducted at intervals ranging from 5 to 30 minutes, ensuring a robust dataset to capture nuanced variations between Spring and Summer months.
- The collected data was then subjected to rigorous statistical analysis. Both ANOVA and T.test were employed, harnessing the computational power and versatility of the R programming language.

RESULTS

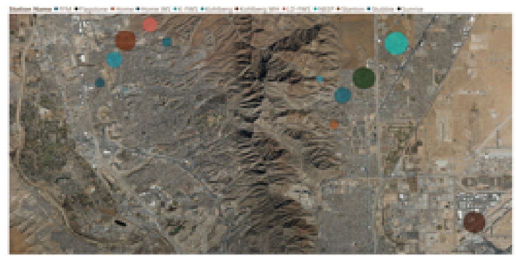

Figure 2: Depicts the spatial distribution of weather stations in proximity to the Knapp and Lost Dog Conservation Easements within the El Paso, TX region. Data collected from https://www.wunderground.com.

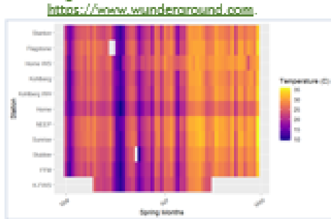

Figure 3: Presents a Heat Map of temperatures recorded from all sites during the Spring months, specifically from April through March.

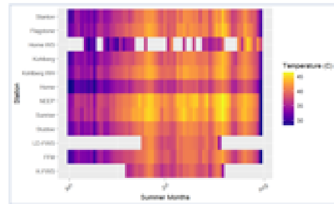

Figure 4: Presents a Heat Map of temperatures recorded from all sites during the Summer months, specifically from June through July.

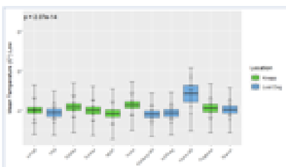

Figure 5: Comparison of low temperatures (°C) among different weather stations for spring (March-April) 2023.

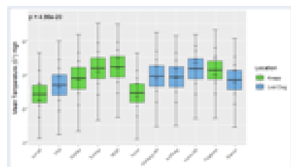

Figure 6: Comparison of high temperatures (°C) among different weather stations for spring (March-April) 2023.

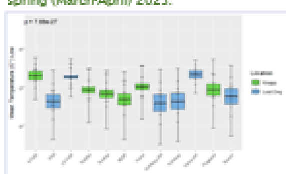

Figure 7: Comparison of low temperatures (°C) among different weather stations for summer (June-July) 2023.

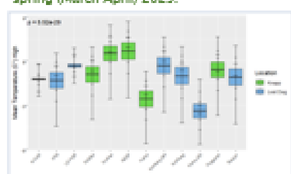

Figure 8: Comparison of high temperatures (°C) among different weather stations for summer (June-July) 2023.

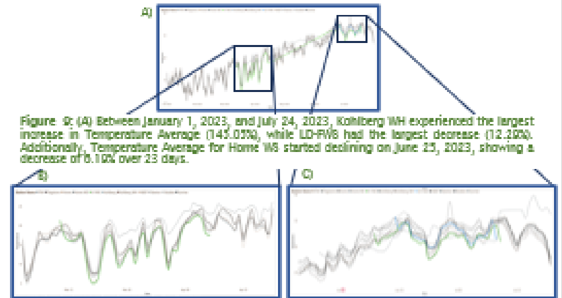

Figure 9: (A) Between January 1, 2023, and July 24, 2023, Kohlberg WH experienced the largest increase in Temperature Average (145.05%), while LD-FWS had the largest decrease (12.29%). Additionally, Temperature Average for Home WS started declining on June 25, 2023, showing a decrease of 6.19% over 23 days.

Figure 9: B) During the period from March 1, 2023, to April 30, 2023, Home WS experienced the highest increase in mean T (°C) (79.33%), while K-FWS had the largest decrease (17.81%). Moreover, the mean T (°C) of K-FWS began to rise on April 3, 2023, showing a 1.48% increase (0.26) within a span of 6 days.

Figure 9: C) Between June 1, 2023, and July 24, 2023, FFM experienced the highest increase in mean T (°C) (25.67%), while LD-FWS had the largest decrease (12.29%). Additionally, the mean T (°C) for K-FWS started trending up on July 14, 2023, with a 5.34% increase (1.73) in just 4 days, following a previous downward trend from June 29, 2023, to July 13, 2023, with a drop of 0.15.

DISCUSSION

- The analysis highlights that high spring temperatures are significantly influenced by green space proximity, weather station, and observation month (ANOVA, $p < 0.001$), with location having no significant impact ($p = 0.172$).
- Low spring temperatures are mainly affected by observation month (ANOVA, $p < 0.001$) and weather station (ANOVA, $p = 0.0112$*), while location and green space distance show no significant effects ($p > 0.1$).
- For high summer temperatures, the month of observation and weather station are primary drivers (ANOVA, $p < 0.001$ and $p = 0.00155$**, respectively), while location has a marginal impact ($p = 0.06025$), and green space distance is non-significant ($p > 0.1$).
- Similarly, low summer temperatures are significantly influenced by observation month (ANOVA, $p = 0.00355$**), with no significant effects from location and green space distance ($p > 0.1$) but a marginal impact from weather stations ($p = 0.12400$). These results underscore the importance of considering multiple factors when analyzing temperature variations across seasons and months[4].

FUTURE DIRECTIONS

- Examining temperature variations and green space distribution in different neighborhoods, a more nuanced understanding of urban microclimates.
- Analyzing seasonal variations and long-term trends will provide a more complete picture of climatic patterns, diurnal and nocturnal patterns.
- Examining their interactions with temperature fluctuations and green spaces will offer valuable insights into the complex dynamics of urban heat island effects and guide urban planning for sustainable and resilient communities.

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