Analyzing transit-based heat exposure and behaviors to enhance urban climate adaptation and mitigation strategies in the southwest USA

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Introduction
Public transportation systems represent an intersecting point between urban climate change adaptation and mitigation strategies. Increasing the use of public transit systems can help cities meet a wide range of sustainability and health goals including reductions in greenhouse gas emissions. Simultaneously, public transit use typically necessitates exposure to outdoor weather. In extreme climates, uncomfortable or dangerous weather conditions may suppress public transportation system without sufficient infrastructure to moderate exposure. We will present results from an ongoing research project in the hot desert city of Phoenix, Arizona, that aims to understand and improve public transit riders' experiences and resilience to heat. Researchers used environmental measurements and surveys to assess environments, conditions, and the behaviors and perceptions of public transit riders. Survey data revealed key behaviors and perceptions that should influence transit stop design strategies: stops that are perceived more beautiful and pleasant are also rated as more thermally comfortable; riders identified infrastructure elements and coping behaviors that make them feel cooler. Findings also showed that current infrastructure standards and material choices for bus stops are not ideal for providing thermal comfort and can contribute to hotter microclimates. As cities in warming climates shift toward increasing the use of public transit, continued attention to the experiences and preferences of transit riders—especially during the summer months—will improve the likelihood that they can meet or exceed public transportation and sustainability goals.

Background
Currently, low-income and marginalized communities use public transit and engage in non-motorized transit activities more often than other users (Karner et al., 2015). For instance, in South Mountain Village, more than half of residents do not own a car and use public transit as their primary transit mode. Such neighborhoods are also the most vulnerable to heat related morbidity and mortality (Karner et al., 2015). For vulnerable populations that do not have access to AC, exposure to heat due to transit related activities can be a critical component that adds to total exposure (Karner et al., 2015).

Riders' heat exposure is characterized by two factors: a walk time to the stop and the wait time at the stop. Riders identified infrastructure elements and coping behaviors that make them feel cooler. Findings also showed that current infrastructure standards and material choices for bus stops are not ideal for providing thermal comfort and can contribute to hotter microclimates. As cities in warming climates shift toward increasing the use of public transit, continued attention to the experiences and preferences of transit riders—especially during the summer months—will improve the likelihood that they can meet or exceed public transportation and sustainability goals.

Research Questions
- Is bus stop infrastructure effective in influencing environmental variables that affect thermal comfort?
- How is thermal sensation vote influenced by the perception of stop aesthetics?
- What infrastructure and natural elements are perceived to have cooling benefits?

Methods

Measurements
- Air T
- Globe T
- Surface T
- Humidity
- Wind

Surveys
- Access and wait time
- Coping strategies
- Stop perception
- Thermal sensation
- Demographic

Study sites
6 bus stops were selected based on the infrastructure characteristics and daily ridership. Standard and Advertising bus stop types are prevalent in Phoenix. Several stops were upgraded and include art features, vegetated awnings and trees. All stops in this study are located along the Baseline Rd. and face north.

Results

Thermal sensation votes

How do you feel at this stop?

Predictor: Do you think this bus stop is...

Dependent: Thermal sensation vote

N=84

Relationship between aesthetic preferences and stop perception

Predictor: What is your perception of this stop?

Dependent: Thermal sensation vote

N=84

Average public transit rider exposure in Phoenix Metro Area

Average summer surface temperatures for prevailing material types

Grey and green infrastructure elements are perceived as beneficial for cooling

Adaptive model of thermal comfort

physiological

psychological

behavioral/physical

Nikolopoulou & Steemers found that microclimate properties of the environment accounted for 50% of the variation, authors attribute the rest to the psychological factors discussed above (Nikolopoulou & Steemers, 2003).

This in study we examine both environmental variables that affect physiological thermal comfort and psychological perceptions of heat.

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In conclusion, current bus stop infrastructure in Phoenix does not provide thermally comfortable conditions for bus riders. Majority feels hot. However, design matters for reducing actual temperatures and influencing psychological thermal comfort. Stops with artistic features provided higher temperature range and were more effective for cooling. Moreover, people who felt that stop is beautiful or pleasant felt more thermally comfortable. Investing in improving psychological thermal comfort can be a cost effective strategy to make people feel more comfortable.

Climate change models suggest that more cities will face climate challenges similar to Phoenix. Thus, we need to rethink how to integrate cooling functions into infrastructure systems in addition to their primary purpose.

References