# UNDERSTANDING THE ECOLOGICAL DESIGN BENEFITS AND LIMITATIONS OF ROOFTOP GREEN SPACES TO REDUCE HEAT EXPOSURE FOR VULNERABLE RESIDENTS

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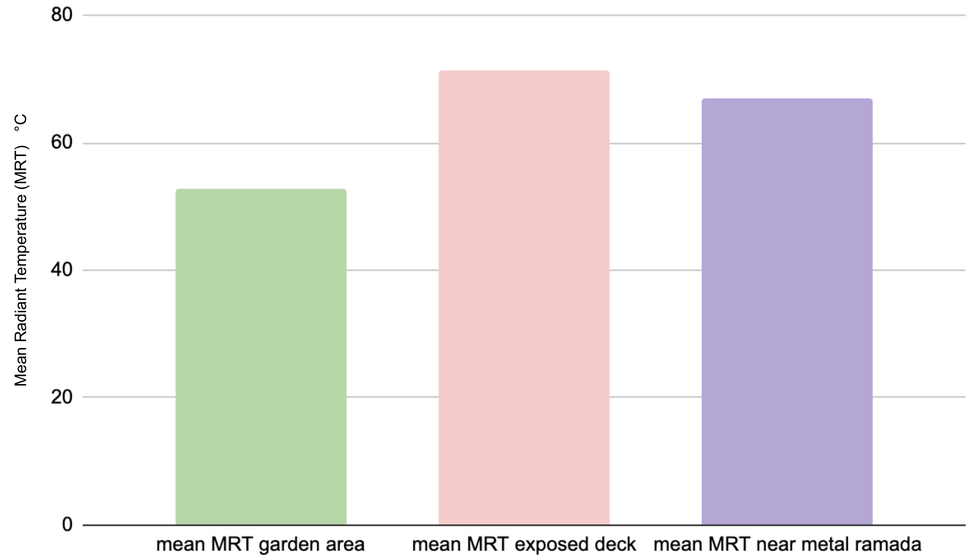
## Abstract

In rapidly growing central Arizona cities like Phoenix and Tempe, the built environment is evolving with a focus on integrating landscaped rooftop spaces into denser, more vertical urban developments. This trend surpasses traditional green roofs, offering usable outdoor areas. Rooftop green spaces, particularly in multifamily housing, are prevalent in modern urban planning. However, research on these spaces is scarce. This study aims to establish an evidence-based understanding of rooftop green spaces as nature-based design solutions for compact cities. Focusing on a Tempe a high-rise residential community designed for older adults, the research investigates how rooftop green spaces impact the health and well-being of residents, especially considering the heightened health risks for older populations exposed to high temperatures. The study explores the influence of shade and vegetation on mean radiant temperatures (MRT) and residents' thermal perception. Factors such as irrigation and evapotranspiration will be examined for their role in reducing MRT. Through collaboration with Mirabella residents, the study seeks to uncover the benefits and limitations of rooftop community gardens, providing valuable insights for designers aiming to create effective and health-conscious urban spaces.

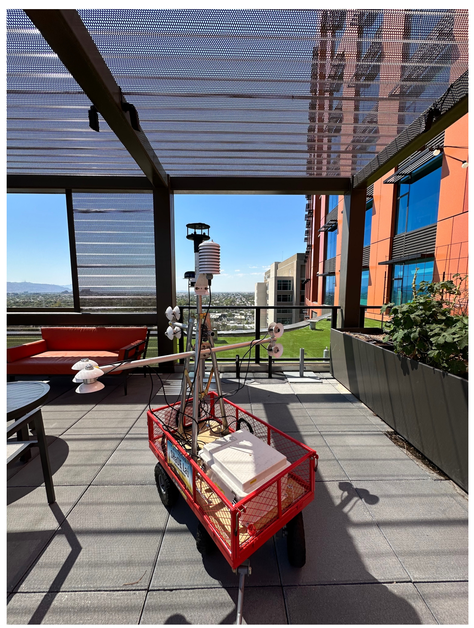
## Methods

Both objective and subjective methodologies are used in this ongoing research. Our objective measures include observing relevant meteorological data including air temperature, surface temperatures, humidity, wind speed and calculating mean radiant temperature (MRT). We will use stationary and mobile weather instruments. MaRTy mobile biometeorological cart will take transects to observe different portions of the rooftop amenity spaces of the older adult residential community. We will also adapt a method called a “heat walk” (Dzyuban et al., 2022) to pair MaRTy with a resident focus group to evaluate the rooftop spaces. A heat walk is a participatory action research data collection event where a community walks with MaRTy while answering focus group questions to identify and reveal new information about hot spots and cool places in their community - in this case a “heat rooftop walk”.

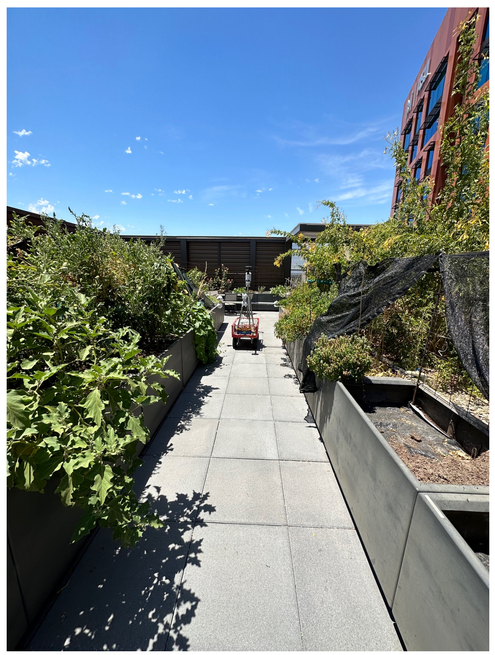
In the next phase, we will co-research the experience with a focus group. The focus group will be open to the entire residential community. We will co-create a series of community events with a predetermined walk route to meet MaRTy and walk with MaRTy while asking the focus groups questions and create dialog around perceptions of cooling and other ecosystem benefits from their rooftop green space. The featured event is a community walk on a predetermined route that will expose participants to a variety of microclimate conditions, rooftop landscape design features, tree cover, and other rooftop hardscape infrastructure features. During the heat rooftop walk, participants will complete a novel Rooftop Heat Assessment Guide at designated check points. The Guide asks residents to report their perceptions about segments of the Heat Walk, including shade cover, pleasantness, thermal comfort, and safety.




**Preliminary MRT results from July 15, 2023 MaRTy Transects**



MaRTy in the Tempe Rooftop Common Space



Rooftop Community Garden Planters

## Expected Outcomes

This work will help inform designers of rooftop green spaces in urban compact neighborhoods, where vulnerable populations are most likely to be exposed to dangerous levels of heat. The residents will benefit directly from more informed understanding of their rooftop heatscape for future cooling design applications. It has broad application outside of the Sonoran Desert. It will advance the collective knowledge about rooftop green spaces, and the potential cooling benefits and limitations they may have for novel urban spaces. Most importantly, this study advances a proof of concept on innovative methods to examine these novel landscapes. These privatized spaces are increasing in numbers and results could have important implications for ecosystem service benefits from these spaces including who benefits and who is excluded.

## References

Dzyuban, Y., Hondula, D. M., Coseo, P. J., & Redman, C. L. (2022). Public transit infrastructure and heat perceptions in hot and dry climates. *International journal of biometeorology*, *66*(2), 345-356.

Middel, A., & Krayenhoff, E. S. (2019). Micrometeorological determinants of pedestrian thermal exposure during record-breaking heat in Tempe, Arizona: Introducing the MaRTy observational platform. *Science of the total environment*, *687*, 137-151.