Healthy Urban Environments (HUE) Initiative
Arizona State University

Project Update: Third Year, Second Quarter, 2021
Date of Report: October 29, 2021

Project Overview

As outlined in the Healthy Urban Environments (HUE) Initiative proposal, ASU has launched HUE as a solutions-focused research, policy and technology incubator to rapidly develop, test and deploy heat-mitigation and air-quality improvement strategies and technologies. This will be accomplished through four project components: 1) research, solutions and innovation incubator; 2) communication, networking and solutions hub; 3) implementation and evaluation of new insight in real-world contexts; and 4) public, workforce and management education and capacity building. The schedule for delivery of each component as proposed is shown below; we will report on progress for each of these components separately in the following pages.

Project Summary: October 29, 2021

During the second quarter, the Healthy Urban Environments initiative continued to focus on implementation of solutions and institutionalization of approaches for improving local thermal comfort and reducing air pollution exposure, which in turn support continued economic advancement in the Phoenix region. Highlights from this quarterly report include:

- Providing preliminary data regarding the impact on lowering ambient temperatures and offsetting the urban heat island effect using reflective coating pavement.
- Discussing how HUE created an innovative and affordable solution to reduce cooling centers gaps in Tempe by partnering with the city's human services department and collaborating to create a mobile cooling center to provide heat relief to the homeless community and other groups.
- Celebrating the appointment of HUE's partner, Dr. Dave Hondula, as the director of the City of Phoenix Office of Heat Response and Mitigation.
- Reporting on Dr. Guardaro's testimony at the United States House Science Subcommittee on Environment.

1. Research, Solutions and Innovation Incubator

Overview:
ASU will develop a research, solutions and innovation incubator to test novel heat and air pollution mitigation technologies; deploy field demonstration projects to quantify the heat and air quality mitigation effectiveness; and modeling projects to simulate the impact of heat and air quality mitigation approaches.

October 29, 2021 Status:

HUE has been collaborating with the Maricopa County Facilities Management Department (MCFMD) to evaluate the impact of reflective pavements on lowering ambient temperatures and offsetting the urban heat island effect. Working with MCFMD, HUE researchers have collected primary data on the impact of a reflective coating designed to reflect some of the incoming solar radiation at the new Maricopa County parking lot in downtown Phoenix. This primary data show that the parking lot treatment reduces absorbed solar radiation by about 50% by increasing the fraction of reflected radiation from 0.15 to 0.30 as shown in Figure 1a. We also measure emitted surface radiation which is reduced approximately 10% (Figure 1b) and indicates that peak surface temperature is cooled by 8 °C at the daily solar maximum. However, despite an approximate decrease of 25% in heat exchange at the treated site (Figure 1c), we found no differences in air temperature above the treated and untreated portion of the parking lot (Figure 1d).

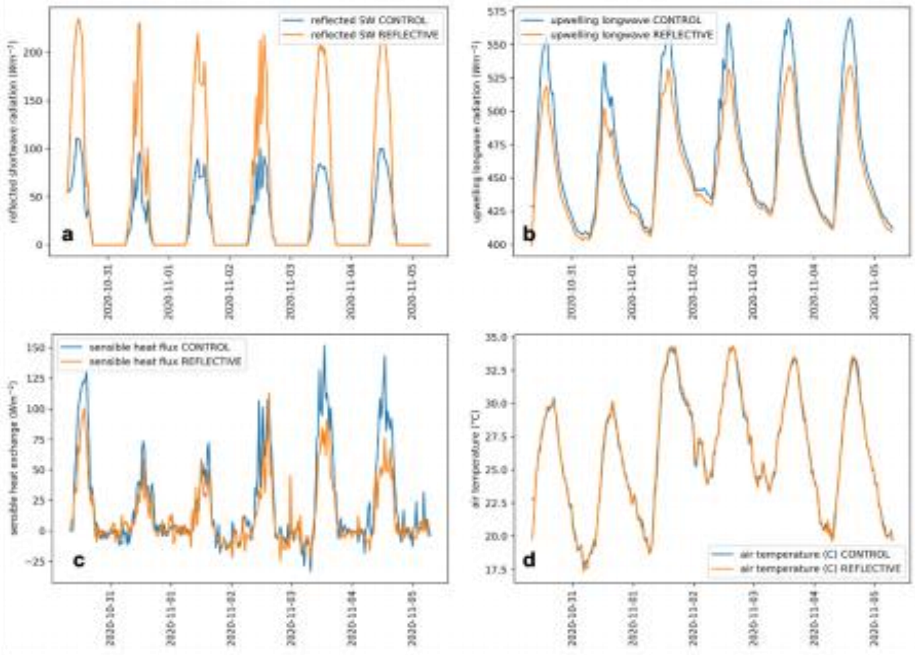

Figure 1: Results from primary data collection on the Maricopa County reflective parking lot (western half) versus the untreated control lot (eastern half) in downtown Phoenix: (a) reflected shortwave radiation, (b) upwelling longwave radiation, (c) sensible heat flux, and (d) air temperature

Our data show that the treated parking lot has a larger fraction of solar radiation reflected which results in a lower surface temperature compared to the untreated lot. However, the ambient air temperature measured 10 feet above the surface is no different between the reflective lot versus the untreated lot. One possible explanation for this result is that the area treated - one parking lot in central Phoenix - is too small to impact ambient air temperature as atmospheric mixing and convective heat transfer offsets any localized change in the urban heating balance in a single location.

To investigate if a more widespread deployment of reflective pavements could lower air temperatures in Phoenix based on the primary data collected, we need to rely on urban climate models. We chose the Weather Research and Forecasting (WRF) model developed by the National Center for Atmospheric Research in Boulder CO as best suited to evaluate what impact different heat mitigation approaches would have on our local air temperature. WRF uses fundamental data to simulate air temperatures under different scenarios and can be used to estimate what impact more widespread use of reflective pavements would have on local air temperatures. For comparison, we also simulated the impact of other heat mitigation approaches such as widespread use of highly reflective rooftops and alternative construction practices to use timber construction in building roofs and walls. This modeling work was funded by The Global Kaiteki Center at Arizona State University by Prof. David Sailor in close collaboration with the HUE team.

The three scenarios considered to estimate what regional impact in air temperature could be achieved in Phoenix included increasing building rooftop reflectivity from 0.20 to 0.96; replacing traditional construction materials with wood in building walls and roofs; and increasing reflectivity of paved surfaces from 0.10 to 0.35. For each of these three scenarios, WRF was run for downtown Phoenix for a base case and three heat mitigation cases. For each heat mitigation approach, half of the built infrastructure (rooftop reflectance, timber construction practices, and reflective pavements) was modified in the model relative to the base case. The level of change in the thermal properties under the heat mitigation cases was based on reviewing a range of primary data sources such as the HUE MCFMD parking lot project as well as the City of Phoenix Cool Pavement program (https://www.phoenix.gov/streets/coolpavement). The specifics of the physical properties modeled for downtown Phoenix using WRF are summarized in Table 1.

Table 1. Average properties across downtown Phoenix for cases involving modifications of half of all surfaces (e.g., 50% of rooftops or paved surfaces)

	Base	**Reflective Rooftops**	**Wood Building**	**Reflective Pavement**
Roof reflectivity (%)	20	58	20	20
Wall Conductivity (W/m-K)	0.67	0.67	0.39	0.67
Roof Conductivity (W/m-K)	0.67	0.67	0.39	0.67
Wall Thermal Storage (MJ/m^3K)	1	1	0.85	1
Roof Thermal Storage (MJ/m^3K)	1	1	0.85	1
Pavement Reflectivity (%)	10	10	10	22.5

Figure 2 shows the change in air temperature compared to the base case predicted using the WRF model for the implementation of different strategies in Phoenix, AZ. The reflective rooftop mitigation strategy shows significant cooling during the daytime, and moderate cooling during the night. However, simulations show that addition of cool pavements did not result in significant cooling for downtown Phoenix. While this is consistent with the observations at the MCFMD parking lot, it may be the result of the region selected for modeling as the building heights modeled in downtown Phoenix result in significant shading of paved surfaces throughout the day which then limits the potential benefit of reflective pavements as opposed to reflective roofing. To further investigate this, work will continue and develop mathematical models representing suburban locations where reflective pavements may have a greater impact on lowering air temperatures to see if reflective pavements are better suited to offset urban heating in those locations.

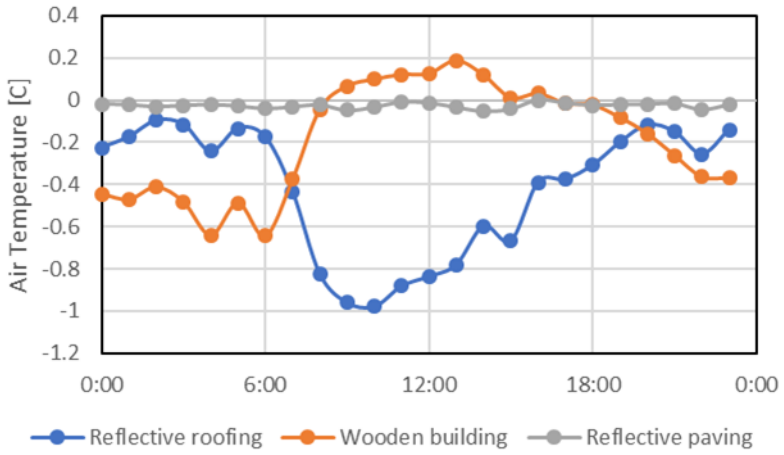

Figure 2. Modeled change in air temperature while implementing different cooling strategies in downtown Phoenix predicted by the WRF Model. Negative values indicate urban cooling and positive indicates warming.

2. Communication, Networking and Solutions Hub

Overview:

Arizona State University (ASU) will convene workshops to share mitigation approaches, initiate new inquiries to expand on urban heat and air quality improvement strategies, and provide summative reports on relevant community strategies for interventions for urban heat and air quality.

October 29, 2021 Status:

As temperatures from climate change and the urban heat island continue to rise in Maricopa County, the most vulnerable - those who suffer the most - are people who don't have the means to cool themselves or their homes. People who are unsheltered and spend most hours outdoors are at greater risk; as homelessness increases, the threat from heat increases as well. According to the Heat-Associated Deaths in

Maricopa County, AZ Final Report for 2020, 323 heat-associated deaths were recorded in 2020. This is an alarming 62.3% increase from 2019 (199 heat-associated deaths), and 15 times higher than 2001, the year the County started the heat surveillance. The report also illustrates an increasing disparity of injuries that lead to deaths in outdoor settings. In 2020, 85% of heat-associated deaths occurred outdoors compared to 76% in 2019. Furthermore, 61% of the outdoors deaths in 2020 occurred in urban areas/parks.

Cooling centers are one solution helping to reduce heat-related illnesses and deaths. Typically established by municipalities, nonprofits and community-based organizations, cooling centers provide air-conditioned relief during the day, and many provide water and other amenities. They are often located where municipalities have existing facilities, like libraries and office lobbies, or wherever local organizations are willing to host them. Although a crucial and effective resource to keep people safe from the heat, analysis of data from the Heat Relief Network shows problems both with the total number and specific locations of cooling centers throughout Maricopa County to meet the need.

Using trailers as mobile cooling centers may provide an affordable and effective solution. Properly retrofitted trailers, including systems to minimize air quality impacts, could increase the number of cooling centers open to residents. The mobility would provide flexibility to respond to changing needs and as experience dictates. HUE is testing this innovative solution with a pilot project.

This pilot results from a successful partnership between HUE, the City of Tempe, and a philanthropic organization. Each organization uniquely contributed to this effort. Jenny Norton and the Ramzey Foundation purchased the trailer (the trailer was named Jenny's Trailer to honor Jenny Norton). HUE coordinated the project, worked with internal and external teams and sponsored the solar panels and trailer exterior. The City of Tempe, the Human Services Department in particular, supported the project with homelessness expert knowledge and experience. The department will operate the trailer in parks and selected neighborhoods throughout the city.

HUE's priority was to create a mobile cooling center that serves the people where they are and considers that people experiencing homelessness may have mobility issues and other physical and social barriers that prevent them from accessing municipal services. Figure 3 illustrates the inside of the trailer, which looks and feels like a comfortable and inviting space. The trailer also provides opportunities to enjoy additional benefits by sitting outside of the trailer under an awning in the shade.

Figure 3. Jenny's Trailer interior

Figure 4. Solar panels on top of the roof

Another priority was to create a mobile cooling trailer that does not impact the air quality. Therefore, the cooling center design eliminated the use of a polluting generator and substituted with a greener solution. Solar panels were installed to support the large battery mounted in the trailer by Sun Valley Solar Solutions. Rewiring of the trailer with the new system allows the use of clean energy for the air conditioning, lights, refrigerator, expanding the pop out, and awning operations. Figure 4 illustrates the solar panels on top of the trailer's roof. When batteries are fully charged the trailer can operate for five to six hours supported by the solar panels on a sunny day.

Currently, the trailer offers air conditioning, Wi-Fi, cold water, and resources. The municipal team operating the trailer, HOPE (Homeless Outreach Prevention Effort), will provide social, housing, and work-related resources. Their goal is to visit with repeat clients and help end homelessness in Tempe. The City plans to operate the trailer year-round and use it around neighborhoods and communities that experience power outages.

This project has been supported by the Office of the Mayor of Tempe and has received significant coverage in the local media, including:

KJZZ, September 15th, 2021. Tempe Opens First Mobile Cooling Center (https://kjzz.org/content/1716985/tempe-opens-first-mobile-cooling-center)

KTAR News, September 7th, 2021. Tempe's New Mobile Cooling Center to Serve Those Experiencing Homelessness (https://ktar.com/story/4671052/tempes-new-mobile-cooling-center-to-serve-those-experiencing-homelessness/)

Wrangler News, September 28, 2021. Even as Summer Heat Wanes, Jenny's Trailer Still a Connection to Tempe Housing and Social Services (https://www.wranglernews.com/2021/09/28/even-as-summer-heat-wanes-jennys-trailer-a-connection-to-tempe-housing-social-services/)

The State Press, Tempe, October 6th, 2021, ASU Program Collaborate in Effort to Aid People Without Housing (https://www.statepress.com/article/2021/10/community-heat-relief-tempe-for-homeless-populations)

3. Implementation and Evaluation of New Insights in Real World Context

Overview:
ASU will test new solutions developed as part of HUE; conduct surveys and in-depth interviews with community members; and enable Technology Transfer and Intellectual Property licensing on all projects sponsored by HUE.

October 29, 2021 Status:

Implementation of solutions to heat in a real-world context often occurs at the municipality level. For this reason, many of the HUE pilot projects have partnered with local municipalities in Maricopa County, such as Phoenix, Tempe, and Chandler, to implement and evaluate the effectiveness of various solutions to mitigate extreme heat. However, impacts of and solutions to extreme heat are related to multiple departments within each municipality, such as transportation, parks and recreation, and human

services. With such broad-ranging impacts of extreme heat, the formation of municipal roles to specifically address and manage heat will be critical for aligning responses to extreme heat within municipalities.

As HUE works to implement and institutionalize heat solutions across Maricopa County, we are excited that Dr. David Hondula has been appointed as the inaugural director of the recently formed Office of Heat Response and Mitigation for the City of Phoenix. This position is the first publicly funded position of its kind in the nation and represents a major step forward in advancing efforts to mitigate heat in the Phoenix metropolitan region. HUE is excited to work with the new office to demonstrate proven heat mitigation approaches as well as work with Dr. Hondula to advocate for other municipalities, both in the region and nationally, to increase their efforts in combating heat and protecting their residents.

Dr. Hondula has been a leader or team member for multiple projects that have received HUE funding, including “Building a Targeted Real-Time Warning System to Prevent Indoor Heat Deaths,” “City of Phoenix Cool Pavement Pilot Program”, “Developing and Testing HeatReady Standards for Cities,” “HeatReady Schools,” “Measuring the Urban Canopy and Cool Corridors,” and the “Phoenix Zoo Parking Project.” His work has developed critical insights into multiple solutions for mitigating heat in Maricopa County and beyond. Through his new role, we are excited about the possibility of Dr. Hondula further transforming these insights from HUE projects into real-world solutions.

More information about Dr. Hondula’s appointment can be found in a recent article from the Arizona Republic: “Phoenix names a heat officer, with a goal of easing the risk of rising temperatures.” (https://www.azcentral.com/story/news/local/arizona-environment/2021/10/07/phoenix-hires-heat-officer-cool-city-ever-warming-future/6029086001/)

4. Public, Workforce, and Management Education and Capacity Building

Overview:
ASU will enable capacity through development and implementation of workshops aimed at stakeholders and community members; create online modules to be integrated into existing ASU outreach programs; and develop material for new workforce training programs.

October 29, 2021 Status:

As part of HUE’s commitment and mission to enable capacity through development and implementation of workshops aimed at stakeholders and community members, Dr. Melissa Guardaro, an Assistant Research Professor with HUE, testified about the urgency of addressing extreme heat before the United States House Science Subcommittee on

the Environment. In the congressional hearing “Silent Killer: The Rising Problem of Extreme Heat in the US” on July 21, 2021, Dr. Guardaro testified about the urgency of addressing extreme heat in different timescales - policies and programs that constrain a warming future and urgent action to protect people during extreme heat periods.

This hearing reflects a growing concern by Federal agencies to address the intersectional issue of urban heat. The House Science committee oversees the EPA and NOAA/National Weather Service. Dr. Guardaro also stressed the imperative of creating a NOAA/NWS Extreme Heat Center to coordinate national efforts and respond to the impacts of extreme heat.

The Healthy Urban Environments Initiative was mentioned in both the oral and written testimonies. HUE supported projects, such as the Arizona Heat Preparedness and Resilience Workgroup, Heat Ready Cities, Heat Ready Schools and Heat Ready Neighborhoods were highlighted, suggesting that these could be scaled up in other cities/regions. The written and oral testimonies can be accessed through https://science.house.gov/hearings/silent-killer-the-rising-problem-of-extreme-heat-in-the-us