Healthy Urban Environments (HUE) Initiative
Arizona State University

Project Update: Third Year, Third Quarter, 2022
Date of Report: January 31, 2022

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: January 31, 2022

During the third 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 of this quarterly report:

- A research project that examined the impacts of extreme heat on a commonly proposed strategy for reducing urban air pollution: transitioning from single-occupancy vehicle (SOV) travel to alternative transportation (AT) modes, such as walking, biking, and using public transportation.

- A collaboration between HUE and Decision Theater to build an interface that will help local municipalities visualize and prioritize locations for heat-related solutions, such as schools, parking lots, and mobile home communities.

- A design project for a pedestrian and bicycle thoroughfare using landscape design that mitigates heat, in Wall St, Chandler. The pilot will encourage alternative forms of transportation for improving air quality and will also address landscaping practices and design choices for reducing air pollution emissions and providing thermal comfort.

- A new partnership between Local First Arizona and ASU to focus on technology development and the outcome is a decision-making tool that allows community and

data inputs and demonstration of design performance outputs.

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.

January 31, 2022 Status:

HUE postdoc Rachel Braun and director Matthew Fraser recently completed a research project that was submitted for publication in the academic journal *Weather, Climate, and Society*. Dr. Braun also presented the research as a poster at the recent *Urban Climate Research Center* poster event at ASU and won first place in the postdoctoral poster contest.

The project focused on issues at the intersection of extreme heat and air pollution in Maricopa County. In particular, this research examined the impacts of extreme heat on a commonly proposed strategy for reducing urban air pollution: transitioning from single-occupancy vehicle (SOV) travel to alternative transportation (AT) modes, such as walking, biking, and using public transportation.

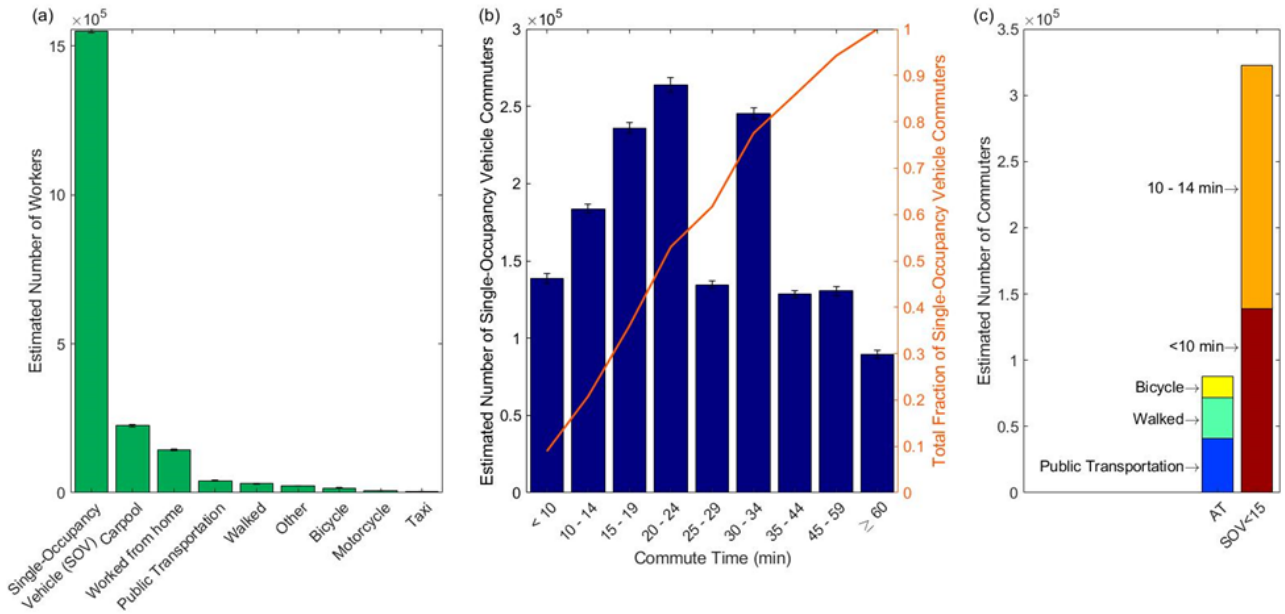

Figure 1. Current status of commuting in Maricopa County, including (a) methods of commuting for all workers in the county, (b) commute times for SOV commuters in the county, and (c) description of prime candidates for AT commuting.

While many studies have addressed the benefits of switching from SOV to AT, fewer studies have examined the potential for negative outcomes due to increased exposure to heat when using AT modes. Three questions were addressed in the final report.

1. What communities within Maricopa County have the most favorable opportunity for switching to AT to combat O_3 pollution?

We theorized that the commuters with the highest chance of switching to AT would be those with the shortest commutes (<10 min) who drove alone to work via car, truck, or van. These commuters, subsequently referred to as SOV commuters with commute times of less than 10 minutes (SOV<10), were combined with the number of current AT users to find a total number of prime candidates for AT. Given that some fraction of these prime candidates already commute via AT, an AT utilization rate was defined as the ratio of current AT commuters to prime candidates for AT commuting in each ZIP code. Figure 2 shows the AT Opportunity Index that was developed based on the current AT utilization rate in each ZIP Code and the total number of current SOV<10 commuters. ZIP Codes surrounding the ASU Tempe Campus have both the highest rates of AT utilization and largest numbers of SOV<10 commuters, indicating that this region may present a good opportunity for increasing AT commuting.

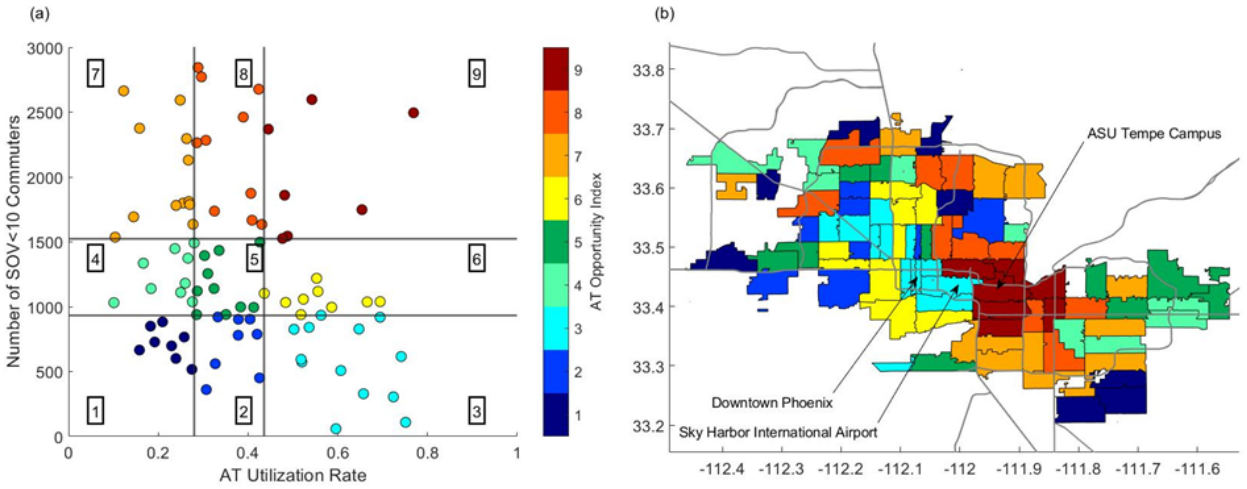

Figure 2. In panel (a), the categories for the AT opportunity index are defined by terciles for both the number of SOV<10 commuters and AT utilization rate by ZIP Code. The

regional map in panel (b) shows ZIP Codes by AT opportunity index with major roadways displayed as grey lines. The approximate locations of a few important areas are shown, including downtown Phoenix, Phoenix Sky Harbor International Airport, and the Arizona State University (ASU) Tempe campus.

2. What does the relationship between regional weather conditions and air quality warnings imply for increased adoption of AT?

Table 1 summarizes various characteristics for days with O_3 warnings in Maricopa County by month for 2017-2020. For the purposes of Table 1, both high pollution advisories and health watches are included in the category "O_3 warning." Along with the number of days with O_3 warnings and the concurrence of these days with excessive heat warnings issued by the National Weather Service, the typical daily range in temperature and temperatures during "peak" commuting times for days with O_3 warnings are provided.

Table 1. Number of warnings and weather conditions of days with O_3 warnings divided by month for 2017-2020. The last column shows the total number of warnings and the average conditions of days with warnings for all months in 2017-2020.

MONTH	4	5	6	7	8	9	10-3	All
Total Number of Days with O_3 Warning (High Pollution Advisory or Health Watch)	25	35	53	54	62	16	6	251
Total Number of Days with O_3 Warning + Excessive Heat Warning	3	4	21	12	23	2	0	65
Average of Morning Commute (6-9 AM) Average Temperature (°C) for Days with O_3 Warning	21.4	24.9	29.4	32.2	31.8	30.5	18.3	29.0

Average of Evening Commute (3-6 PM) Average Temperature (°C) for Days with O_3 Warning	33.7	36.4	41.1	41.5	41.1	40.7	30.6	39.5
Average of Daily Minimum Temperature (°C) for Days with O_3 Warning	18.4	21.6	26.5	30.2	29.9	28.8	16.2	26.5
Average of Daily Maximum Temperature (°C) for Days with O_3 Warning	34.8	37.5	41.8	42.6	42.1	41.8	31.5	40.5

To summarize a few items of interest from this analysis:

- 97.7% of days with an O_3 warning occurred in April – September
- The average daily maximum temperature on days with an O_3 warning was 40.5°C (104.9°F).
- 25.9% of days with an O_3 warning also had an excessive heat warning

3. What are the current and potential heat burdens for AT users, especially during O_3 warnings?

Commuting times and methods from the American Community Survey and average walking/waiting times for public transit from Fraser and Chester (2017) were used to estimate one-way daily commuting hours of AT exposure in each ZIP Code. These AT exposure times were then combined with land surface temperature (LST) data to produce the Degree Hours Above Minimum LST (DHAM) based on the average LST in each ZIP Code on a day with an O_3 warning during a typical morning commute time (May 6, 2020 at 8:15 am local time). Finally, a scenario was created with variable rates of AT adoption based on the AT Opportunity Index to show potential exposures times and DHAM for new AT commuters. The results of this analysis are shown in Figure 3.

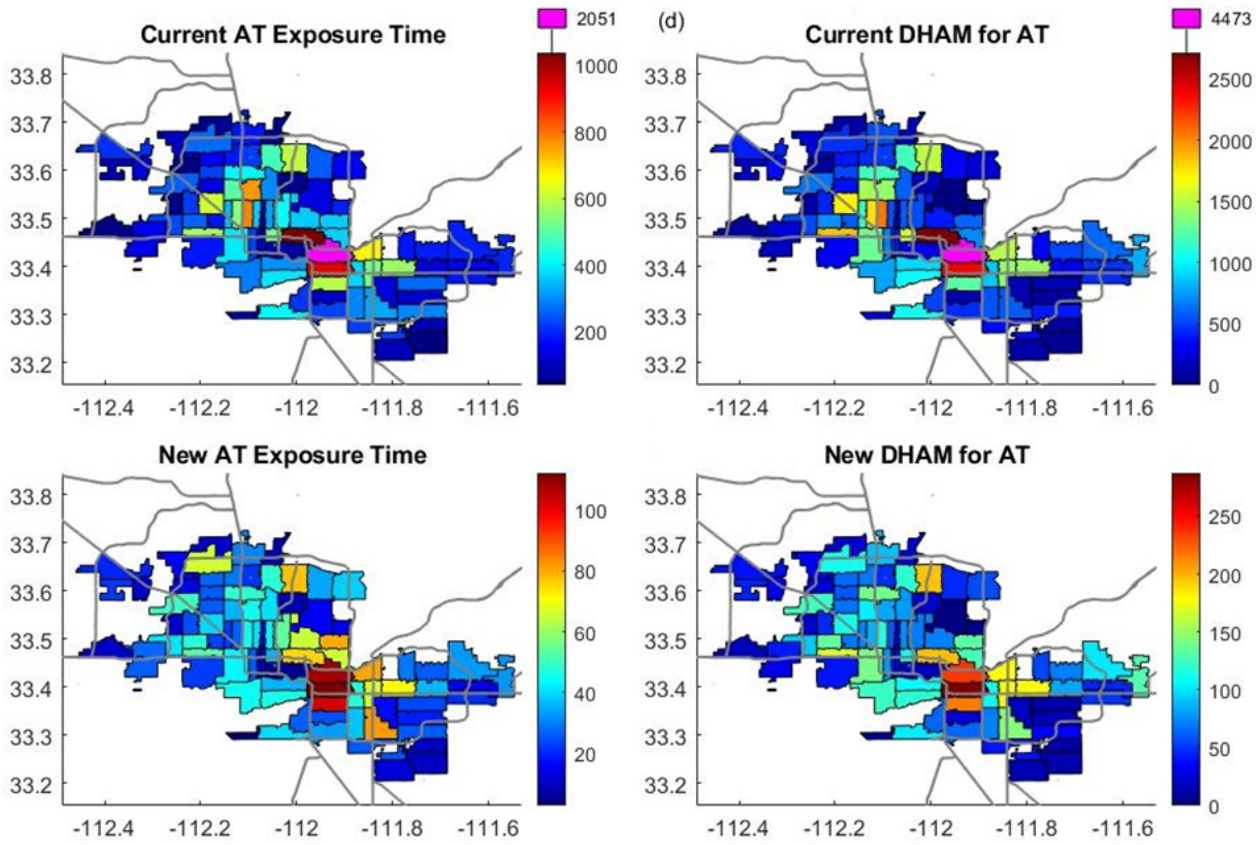

Figure 3. Current and future hours of AT exposure for one-way commuting each day, as well as Degree Hours Above Minimum LST (DHAM) for current and future scenarios.

Overall, the results of this work indicate that associations between O_3 pollution and high temperatures could result in negative health outcomes due to exposure to heat for individuals who currently utilize AT or switch transit modes from SOV to AT. For addressing these issues in Maricopa County, a dual approach that considers both heat and air quality should be pursued for developing solutions to mitigate both hazards.

4. 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.

January 31, 2022 Status:

HUE is beginning a collaboration with the Decision Theater (DT) at ASU (https://dt.asu.edu/). DT works with different groups to build impactful problem-solving interfaces that integrate information from many sources to help decision-makers visualize and determine solutions. As part of this collaboration, HUE hopes to bring together insights from many different HUE pilot projects that have dealt with research and solutions related to extreme heat in Maricopa County. In particular, the collaboration plans to build an interface that will help local municipalities visualize and prioritize locations for heat-related solutions, such as schools, parking lots, and mobile home communities. The insights developed from the HUE pilot projects will be included in the DT project, and we hope that this interface will fill a need for many local municipalities working to address extreme heat in their communities. In particular, we hope to include outcomes from the following pilot projects, divided by location category, in the final DT interface:

Schools:

- Playspace Redesign to Improve Children's Environment and Health: A Pilot Project in South Phoenix
- Revitalizing and Reimagining Outdoor Play and Learning Environments
- HeatReady Schools

Parking Lots:

- Design, Development and Testing of Innovative Paving Materials for Urban Cooling
- Reflective Parking Lots
- Design, Development, Testing and Modeling of Innovative Building Materials for Urban Cooling
- Phoenix Cool Pavement Project
- Phoenix Zoo Parking Project

Mobile Home Communities:

- Increasing Heat Awareness in Manufactured and RV Homes-2020
- Building a Targeted Real-Time Warning System to Prevent Indoor Heat Deaths

Pedestrian Areas:

- Heat and Health Maps for Decision Making in Tempe
- Measuring the Urban Canopy and Cool Corridors
- Online Decision-Making Tool for Active Shade Management
- Waking Up Wall St: Creating a Cool Pedestrian Thoroughfare in Downtown Chandler, AZ
- The Right Shade in the Right Place: Thermal Assessment of Natural and Engineered Shade in Tempe

Other:

- Developing and Testing HeatReady Standards for Cities

This project will be highly collaborative, with inputs from multiple HUE researchers, the City of Tempe, and potentially other cities in Maricopa County as well. While this project is still in the early stages of development, the final interface will be available online, and provide a useful and educational tool for the public, municipalities, and others interested in addressing extreme heat in our community.

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.

January 31, 2022 Status:

Figure 4 South-North View of Wall Street in Chandler

The idea of activating alleyways has been embraced as an urbanist strategy across the globe to reclaim public space for cities and to create more interconnected pedestrian networks. During the COVID-19 pandemic, alleyways were lifelines for restaurants looking to create additional outdoor seating that allowed for safe social-distancing. As alleyways transform from dark, underutilized spaces frequented mostly by service trucks to vibrant arteries within cities that safely connect people and places, they help to create

more livable communities.

A majority of the robust alleyway activation projects are found in markets that do not face the same heat-related challenges that projects in metropolitan Phoenix faces, limiting applicability.

The Wake Up Wall Street project aims to identify concepts that can be applied throughout metropolitan Phoenix, where there are many other alleys that could be used as year-round pedestrian corridors. Also, it aims to, with the help of multiple stakeholders as well as community members: explore, demonstrate, jump-start, and showcase the implementation of a comprehensive alleyway activation approach that is unique to Maricopa County's hot, desert environment.

By supporting the design process for a pedestrian and bicycle thoroughfare using landscape design that mitigates heat, Waking Up Wall St. will encourage alternative forms of transportation for improving air quality. This project will also address landscaping practices and design choices for reducing air pollution emissions and providing thermal comfort. Figure 4 demonstrates the bare Wall Street landscaping and the need for shade.

During FY 2023-24, the City of Chandler will largely pedestrianize Wall St, an alley in Downtown Chandler. Wall St. connects to the Frye Rd. protected bicycle lane project and provides a first/last mile connection to the Valley Metro bus. Additionally, the City plans to create an actionable Pedestrian and Wayfinding Plan for Downtown Chandler aimed at integrating wayfinding design and improving the pedestrian experience, including Wall St. This package of projects is an effort to create a safer walking and biking environment for the city, resulting in less dependence on the motor vehicle, improved air quality, and improved quality of life for residents and visitors.

Figure 5. Cars and Pedestrians Currently Share Wall Street

The Wall St. alleyway currently serves as the primary access to a large brewpub and provides rear access to several businesses and residences. The City also expects that several vacant parcels will be developed for commercial purposes in the coming years, likely with significant access via Wall St. The alleyway boasts a fair amount of pedestrian and bicyclist traffic due to the ease of access it to multiple downtown destinations. Unfortunately, Wall St. currently lacks both shade and adequate nighttime lighting, and conflicts regularly arise between vehicles and pedestrians, making the alley a relatively unsafe and unpleasant place to walk as illustrated by figure 5.

The project anticipates the following solutions outcomes:

1) a safe, comfortable, and cooler pedestrianized alleyway that can be used year-round,
2) data and best practices that can be applied to other alleys in Downtown Chandler and beyond,
3) recommendations that can be filtered into future pedestrian and specific area plans for the City of Chandler and
4) a more livable, walkable, and equitable City overall.

Waking Up Wall St. builds on what Chandler is already planning for Wall St. including to 1) allow for testing of a variety of pedestrian street design environments,
2) foster positive relationships with community members while gathering critical public feedback and data based on testing, and
3) raise awareness about pedestrian/bike infrastructure and safety in Chandler.
Specifically, the project's main activity is to design, purchase, and install temporary materials to transform Wall St. into a heat-mitigating pedestrian and bicycle zone for a short period of time. The demonstration week will include a dedicated street fair opportunity to capture actual use of the alleyway across multiple days and times as well as feedback from a variety of stakeholders that will inform and improve final design. Supplemental quantitative (thermal comfort, pedestrian and bicycle counts) and qualitative (focus groups, surveys) data collection methods will also take place around the same time frame to gather additional community feedback, including from hard-to-reach populations, about Wall St. and related active transportation projects. Partnership with local, community-based organizations will be critical for engagement.

The City recently completed 15% design plans, funded by a MAG Active Transportation grant, and will soon begin 100% design plans for the project. The City will facilitate coordination between the design team for the project and the proposal team, which will ensure that data and feedback gathered during the demonstration period will be incorporated into the Wall St. design, delivering a better project for the community.

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.

January 31, 2022 Status:

Built environments are designed through deliberate decision-making processes that are influenced by complex factors including desirable outcomes for achieving sustainability, resilience, and justice goals. In the Phoenix metro area, creating an outdoor space and landscapes that can mitigate urban heat and provide healthy environments for all is critical for every property and site users. It is a win-win investment for business operations to protect environments, promote social responsibility, and please customers as well as workers.

In the building and real estate industry, several existing and widely adopted rating systems exist. The most popular ones in the US are LEED (Leadership in Energy and Environmental Design) and SITES (Sustainable Sites Initiatives) that certified green buildings and sustainable landscape designs. LEED and SITES have transferable points both dedicated to achieving 'heat island reduction' goal through addressing hard and impervious surfaces on site: 1) install high-albedo and vegetated roof surfaces, 2) provide shade or porous paving onto over half of the hardscape areas. The rating systems are designed to be generalizable and applicable to all regions of the world. They are principle-based rather than evidence-based design. In other words, LEED honors one point for replacing 50% of hardscape area to shaded area (either tree or structural shade), but we do not know to what degree those shade provide the measurable effects for heat reduction or thermal comfort.

Empirical research provides evidence for understanding how the designed projects are performing after occupancy, however, there is a lack of decision-making tool in environmental design for the general public and stakeholders to understand how design elements are interlinked and their choices of implementing certain strategies can affect other parts of the system. For example, non-native trees such as pines provide the most heat mitigation benefits yet consume more water (Middel et al. 2021) and may be a nuisance for maintenance in the community thus may not be the most sustainable and equitable solution considering all factors the interlinked social-ecological-technological systems.
Local First Arizona SCALE UP (Sustainable Communities Accessing Lending and Expertise Upon Performance) engages with local businesses entities to develop visions

and actionable projects that address sustainable development goals. This project aims to fill the gap in the co-design process engaging communities and stakeholders to develop strategies together by providing a comprehensive environmental design decision-making tools that aim to address urban heat and thermal comforts in the built environments that achieve sustainability, resilience, and justice goals considering local-specific climate and context.

This project focuses primarily on technology development and the outcome is a decision-making tool that allows community and data inputs and demonstration of design performance outputs. This project recognizes the critical importance of meaningful engagement with stakeholders to co-design this decision-making tool to better address the needs in local communities to address justice goals. Sustainability goals measured by social, ecological, and economic landscape performance outcomes as well as resilience goals measured by heat hazard mitigation and adaptation outcomes will be identified through a series of stakeholder workshops integrated with SCALE UP program with two cohorts. The project team intends to work with the two cohorts to identify indicators of measures for developing the tool and for testing the tool as a pilot study. The final product will be a prototype of stakeholder-driven environmental design performance decision-making tool.