Healthy Urban Environments (HUE) Initiative
Arizona State University

Project Update: Fourth Year, Second Quarter, 2022
Date of Report: October 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: October 31, 2022

The Healthy Urban Environments initiative continued to focus on implementation of solutions and institutionalization of approaches for improving local thermal comfort and improving air quality, which in turn support continued economic advancement in the Phoenix region. Highlights of this quarterly report:

1. A new Science and Technology Center on Extreme Environments supported by the State of Arizona New Economy Initiative.

2. An update on the HUE partnership with the City of Phoenix and the Phoenix Zoo to reduce urban heat island effects in parking lots.

3. A collaboration between ASU's Sustainable Cities Network (SCN) and WERK | urban design that addresses the use of greywater and organic mulch for heat mitigation heat perception attenuation in a mixed-use urban infill development of apartment homes and commercial spaces being built in downtown Phoenix.

4. An update on the HUE Heat Solutions Visualization tool powered by ASU's Decision Theater, an interface that helps local municipalities visualize and prioritize locations for heat-related solutions, such as schools, parking lots, and mobile home communities.

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 31, 2022 Status:

To continue the impactful solutions-focused research, deployment and engagement strategies launched under the Healthy Urban Environments initiative as direct financial support from the Maricopa County Industrial Development Authority sunsets, ASU will be launching a new Science and Technology Center on Extreme Environments in early 2023. The Extreme Environments STC will be supported by the State of Arizona New Economy Initiative and link industrial and municipal partners and the ASU community to design, create, validate and translate technologies that mitigate extreme environmental conditions and make these solutions accessible to the broader community. HUE Co-Director Prof Matt Fraser will serve as Co-Director of the new Extreme Environments STC.

Arizona's arid and hot climate coupled with dense population centers that result in extreme air pollution issues provides opportunities to develop new solutions facing the fastest growing regions across the globe. Specific challenges include:

Heat/Materials: Extreme heat is becoming common in many parts of the nation, and the current built infrastructure (buildings, roads etc.) in many parts of the nation is incapable of handling it. In the event of fast-rising temperatures, buildings demand higher energy to cool, thus incurring more cost and straining the grid, while infrastructure fails prematurely, necessitating costly and time-consuming repairs. To improve resilience to extreme heat events, mitigation strategies are needed – such as efficient and sustainable building construction and repair/retrofit materials and methods, cool roofs, building insulation materials with low carbon footprint and high efficiency, cool pavements, and infrastructure materials less prone to thermal cracking and failure. Smart materials and building components, including multifunctional materials, coatings and paints, additives, and self-regulating panels offer new opportunities for thermal management under extreme heat. Development and demonstration of net-zero buildings (both energy and carbon) is a national priority, and in the extreme climate of Arizona, innovative methods and materials to mitigate heat, and at the same time harnessing it for beneficial uses, is an urgent need.

Air: In Phoenix, interactions between urban land uses, local environmental conditions, and desert ecosystems result in unique challenges to air quality planning. Specifically, arid soil conditions generate elevated rates of dust entrainment; high temperatures and solar radiation stress vegetation resulting in greater emissions of biogenic hydrocarbons; transportation systems are dominated by personalized transportation powered by internal combustion emitting large amounts of combustion-generated pollutants. Air pollutants of concern include criteria pollutants known to impact human health (such as particulate matter), criteria pollutant precursors (such as nitrogen oxides and volatile organic compounds), and climate warming long lived greenhouse gases (such as carbon dioxide and methane). Opportunities to design, develop and implement air pollution control technologies and strategies that leverage environmental conditions to mitigate airborne particulate matter or ozone precursors in the Phoenix metropolitan area are of particular need.

Water: Water "quantity" and "quality" needs exist. New water sources are needed for people, plants and industrial manufacturing. These will require accessing impaired water sources (e.g., brackish or contaminated groundwater, wastewater, atmospheric air). Of particular need are new technologies to manage brines produced by industrial and reuse technologies; maximizing water recovery, resource recovery, and reduction of wastestreams to dispose. Sensing and treatment of chemical and microbial pollutants at relatively low concentrations (e.g, parts per trillion of PFAS) or within plumbing systems (e.g., legionella pneumophila) are of particularly high need. Systems that utilize large amounts of water (producing liquid wastestreams or water vapor) offer opportunities for recovery and beneficial reuse. Many Fortune 500 companies have set ambitious "water" conservation and energy goals, approaching "net zero water" by 2050 in some cases which will require not only water conservation but intensive water recovery, reuse and recycling. Agriculture (recreation and crops) utilize large volumes of water, and needs to monitor and optimize water use are needed.

The first funding announcement was released in early November 2022 with anticipation of projects launching in early 2023. The Extreme Environments STC will release new funding opportunities every six months that seek to leverage New Economy Initiative funds by requiring co-funding from the industrial or municipal stakeholder.

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 31, 2022 Status:
Parking lots in Arizona are a significant source of heat exposure to people between late spring and early fall and an important target for urban heat island mitigation measures. As an example, the Phoenix Zoo parking lot consists of asphalt that can reach a surface temperature of up to 160°F and is crossed by 1.5 million people each year, including adults and vulnerable youth who are closer to the hot pavement.

In 2019, the City of Phoenix approved funds for the improvement and expansion of the parking lot on the condition that the project is designed to be sustainable. The City asked ASU to participate in an advisory capacity to suggest sustainability strategies, specifically regarding storm water runoff and heat.

ASU's suggestions divided the parking lot project into two sections. The first involved the creation of a new parking area in the open desert south of the path connecting the Zoo and nearby Papago Park. The expanded parking area includes sustainable features:

1. A modified wash/swale to direct stormwater through retention areas to reduce runoff, allow infiltration to recharge aquifers, and provide a water source for vegetation along the swale.
2. Curb cuts, allowing stormwater to flow into planter areas.
3. A stormwater catchment basin.
4. Native and drought-resistant plantings throughout the site.

The second section focused on the rehabilitation of the existing lot to the west of the Zoo and included:

1. Tree planting along two pedestrian routes to the Zoo entrance to provide shading upon maturation.
2. Existing pavement around new trees replaced with porous pavers, increasing the potential amount of water to each tree, improving their chances for survival, as well as reducing stormwater runoff.
3. The Salt River Project placed an array of solar collectors in the parking lot to provide a power source for 20 electric vehicle charging stations as well as to shade a large area of the lot.

HUE sponsored the collaborative design process between the Zoo, the City of Phoenix, and ASU. This process resulted in shade structures being built over areas students typically walk or wait for buses along with multiple strategic spots adjacent to the Zoo entrance. Most notably, this collaboration installed a large shade structure near the new parking lot where students can cool off after crossing from the Zoo exit before boarding their school buses. The Phoenix Zoo project recently completed the post-installation study of the heat mitigation approaches suggested by the ASU study.

Plaque honoring HUE and others that supported the new shade structures.

Pre-installation (June 2020) as well as post-installation (June 2022) assessments of the City of Phoenix's 2019 heat mitigation strategies were conducted utilizing ASU's human-biometeorological 'MaRTy' (short for 'Mean Radiant Temperature') cart to quantify the heatscape experienced by students along this route.


Collecting pathway heat data with MaRTy.

HUE also worked with Zoo staff to assess heat landscapes within the Children's Zoo itself. Two ASU landscape architecture classes assessed existing conditions among exhibits and pathways of the Children's Zoo, developing projects the Zoo could implement to reduce young visitors' exposure to heat. These projects range from simple shade structures utilizing traditional materials to organic, growing structures, to active cooling places using living materials, all the way to complex, mechanized structures which slowly move during the day intercepting sunrays.

Four-panel infographic of the Zoo project.

A four-panel infographic has been designed to present the results of the three project phases to the public.

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 31, 2022:

ECO PHX is a mixed-use urban infill development of 70 apartment homes and six commercial spaces being built in downtown Phoenix, Arizona. This new development proposes to use alternative materials and innovative landscape design solutions. Among those design solutions are two innovations not commonly seen in high density development projects. The first of these is the use of greywater, generated from residential shower use, as a supplemental irrigation water source. The second of these is the use of organic mulch, such as shredded wood, in lieu of the very commonly used decomposed granite (D.G.) as a site ground covering. For this project, the team will research if the use of these two innovations/materials has a measurable qualitative impact on ECO PHX prospective residents' decision to move to the development and/or to continue living there.

The use of greywater as a supplemental irrigation source in built landscapes is uncommon. To facilitate its use in a public, commercial development such as ECO PHX, the design team invested significant time coordinating with the City of Phoenix development review staff to gain their support in this uncommon application. Organic Mulch will be used as a ground cover on ECO PHX. The material is hypothesized to provide many co-benefits related to air quality and heat, particularly in a desert environment, such as the reduction in use of leaf blowers, the capture and sequestration of settled dust, and the reduction of imported fines, and attenuation of surface and ambient temperatures.

To quantify the impact of this novel approach for urban landscaping, HUE funded a partnership between ASU's Sustainable Cities Network (SCN) and WERK | urban design to quantify the impact of using greywater and organic mulch for heat mitigation heat perception attenuation by studying a mixed-use urban infill development of apartment homes and commercial spaces being built in downtown Phoenix, Arizona. The project team, led by Anne Reichman (SCN Director), is researching two primary questions and hypotheses:

1. Will the abundant use of greywater as irrigation have a measurable impact on the soil?
2. Will the landscape that results from the use of these systems and materials be healthier, and might that have a measurable qualitative impact on prospective residents' decision to move here?

ASU is working with WERK | urban design to collect, test, and analyze ten soil samples to test soil quality and promotion of soil health to mitigate heat and air quality. In addition, a Prospective Resident Opinion Survey will be distributed to assemble data on if these types of features influence perceptions and prospective residents' desire to live in developments with greywater systems.

Final data and findings will be compiled in a report and presentation, with all findings from this project being shared with different sectors (academic, public, private) to further support the use of innovative options to improve local, livability in urban developments.

ASU will work with WERK | urban design to create a variety of graphics and visualizations (see list below), a final report compiling data and summarizing findings, and a final presentation by WERK and the ASU research team.

ECO PHX mixed use development visualization by WERK I design.

Visualization deliverables will include the following:

- 3-D Graphic Visualizations of the project in near and long-term time frames for use by project Owner and publicly as an educational tool
- Drone footage of ECO PHX post installation
- Greywater Use Diagram: a graphic depicting, in general terms, how the water is captured and delivered to the site
- Organic Mulch Diagram: a graphic depicting the reduction in dust and use of local material as supplement
- Prospective Resident Opinion Survey and coordination with researchers on distribution of survey.

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 31, 2022 Status:

HUE has been collaborating with the Decision Theater (DT) at ASU to build an interactive webtool to assist local municipalities, nonprofits, community members, researchers, and other stakeholders in understanding heat, vulnerabilities, and solutions to heat in urban Maricopa County region. This interactive webtool showcases a variety of HUE-funded solutions and research related to extreme heat. In addition, other heat-related solutions and resources from urban Maricopa County are included.
Since the end of September, the webtool has been publicly available at: https://hue.dtn.asu.edu/

Figure 1 shows the "dashboard" side of the webtool. Users can select from a variety of topics (locations) where solutions to extreme heat can be implemented, such as schools, mobile home parks, parking lots, etc. Users can also filter the map by vulnerability variables, such as temperature and socioeconomic status variables, in order to identify high priority areas for implementing solutions to extreme heat.

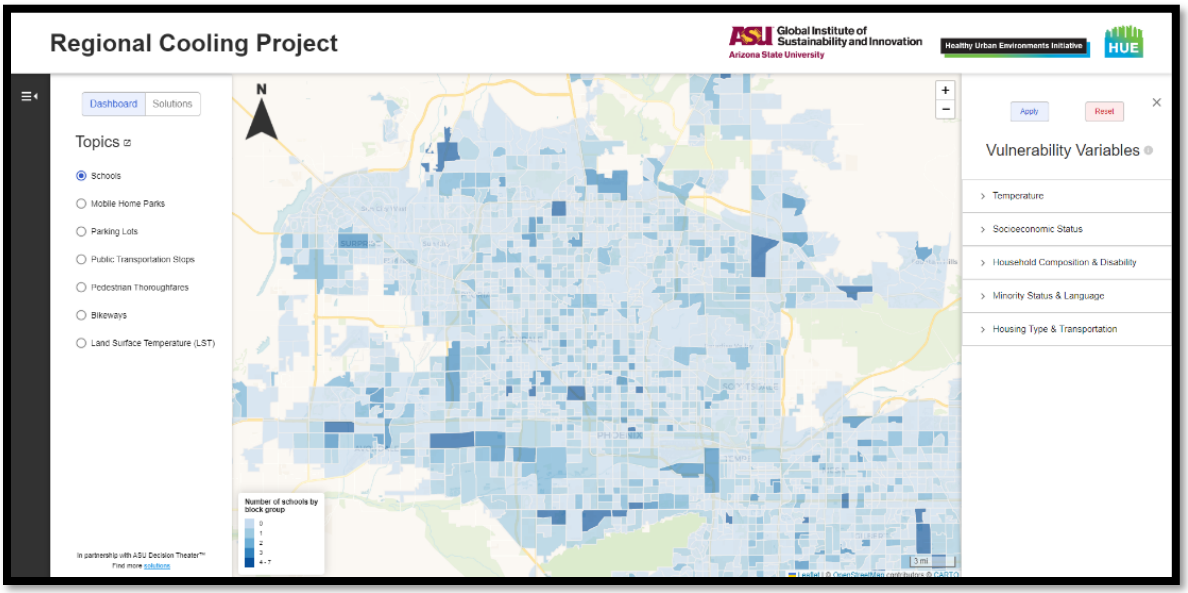

Figure 1. Dashboard of HUE and DT webtool.

Figure 2 shows the “solutions” side of the webtool, where solutions to extreme heat are described, with links to additional information. These solutions are separated by location of implementation, such as schools and parking lots, or included in the category “land surface temperature” for more broad-ranging solutions. As shown in Figure 2, these solutions include HUE-funded projects.

Figure 2. Example of “solutions” webpage for the webtool.

On September 28th, HUE, DT, and a team of researchers from ASU collaborated to launch the webtool at an interactive workshop that brought together stakeholders from a diverse set of institutions working on addressing extreme heat in Maricopa County, such as ASU, local municipalities, and community organizations. An overview of the webtool was presented to the full group, followed by breakout sessions where smaller groups were given the opportunity to interact with the webtool through asking and exploring questions related to extreme heat. Initial feedback from the breakout sessions indicated that the webtool facilitated conversations regarding extreme heat solutions and led to additional questions and data exploration. The webtool will continue to be publicly available at https://hue.dtn.asu.edu/ in order for stakeholders to use information from the tool in their work addressing extreme heat in the region.