Healthy Urban Environments (HUE) Initiative
Arizona State University

Project Update: Fourth Year, First Quarter, 2022
Date of Report: July 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: July 31, 2022

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:

1. An update on the Crowdsourced Heat & Indoor Air project.

2. A collaboration between ASU and The Sagrado Galleria, which is focusing on a prototype of an art installation that will display air quality data in real-time and will be used as a tool for science engagement and communication.

3. A collaboration between ASU, the City of Phoenix, and the 3M corporation that is building, monitoring, and evaluating the performance of a ramada shade structure to be deployed in a City of Phoenix park.

4. A collaboration between Unlimited Potential, CHISPA, Maricopa County Health Expert, ASU School of Transborder Studies, and the American Lung Association to engage, educate, and empower community members and help them understand the interconnection of asthmas, pollution, and climate-change.

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.

July 31, 2022 Status:

HUE's Crowdsourced Heat & Indoor Air project aims at investigating the exposure to both heat and air pollution (fine particulates) and the difference between indoor and outdoor exposure. The goal is to have students as "citizens" and provide them with low-cost air pollution and temperature sensors to make the measurements in their homes and in their daily life (carrying the sensors). After some unexpected delays in acquiring the appropriate sensors, subjects are now being recruited and data collection will begin soon.

The team is also working with a high school chemistry teacher on the development of a teaching module to enhance the citizen (student) understanding and awareness of air and heat issues. This work is ongoing, and results/outputs will be provided in HUE's final Quarterly Report.

The research team has developed a sampling protocol to quantify the difference in exposure to air pollutants during indoor and outdoor activities. This sampling protocol was reviewed and approved by ASU's Internal Review Board. Personal air sampling devices have been calibrated and data storage verified. The student scientists will be recruited in the Fall 2022 semester to participate in isolating indoor air pollution exposure from outdoor air pollution exposure.

In parallel, Jershon Eager, a high school science teacher at Basis Goodyear, has developed a learning module to integrate exposure sampling into the State of Arizona science curriculum for high school students. By ensuring that the learning module is consistent with and advances the required curriculum, this project will ensure wide adoption throughout BASIS Charter Schools and beyond. By demonstrating the learning module in Fall 2022 and incorporating suggestions and revisions, the revised learning module will then be distributed to other schools in the Phoenix metropolitan area.

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.

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Environmental health benefits and impacts are unevenly distributed in Maricopa County. Substantial evidence links low sociodemographic areas within cities with heightened levels of extreme heat and air pollution that are associated with adverse health outcomes (Harlan et al., 2007; Hajat et al., 2015). In the case of Phoenix, the South Phoenix area has and continues to be disproportionately affected by adverse health effects that are the result of historical legacies of systemic injustice and segregationist planning and zoning practices (Bolin et al., 2005; Pope and Wu, 2014; York et al, 2014). Community-level initiatives that seek to further environmental justice in the South of Phoenix suggest that poor air quality is a key point of intervention to galvanize a wider systems change. However, air pollution (similar to other indicators of environmental quality) is difficult to convey, visualize, and talk about with a broader audience who nevertheless continues to live with its negative health impacts. Artistic expressions can render visible the invisible and open up the solution space.

HUE's recent project, *Making Visible the Invisible*, is an art installation that will display air quality data in real-time and will be used as a tool for science engagement and communication. The prototype is being developed by South Phoenix artists and designers, and it will be installed along Central Avenue where it will have good visibility and can be showcased during community events, e.g., the biweekly South Central Mercado. In addition, there will be a series of community engagements centering the art installation to obtain feedback on the pilot itself as well as to bring the conversation on air quality and health equity to public spaces in the community.

The project is a collaboration with The Sagrado Galleria, which is a celebrated artistic and cultural landmark whose mission goes beyond promoting the arts. The Sagrado Galleria has been a pedagogical partner in the InnovationSpace course at ASU – a year-long problem-based learning course dealing with the challenge of trauma-informed design for schools in the Roosevelt School District.

The Sagrado Galleria also functions as a meeting point for artists in the community, some of whom are helping to design and develop the structure. The gallery is also a sought-after partner in local development projects who look to center the voices of

long-time community residents.

As a demonstration project, the installation seeks to show the value of art as a medium for scientific communication and a catalyst for broader engagement. The insights that we will obtain through the targeted community engagements will inform the design of future environmental art installations around South Phoenix and beyond. As an education project, we believe that this installation has the potential for two-way learning, where researchers may better understand community concerns in relation to air pollution, and where residents may become more aware of its impacts and, further, see themselves as agents of change in designing solutions. Last, because the art installation will have its own air quality sensor for PM1, PM 2.5, and PM 10, and nitrogen dioxide, it will feed data and be part of the network of sensors that ASU has deployed in South Phoenix with Dr. Jennifer Vanos.

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.

July 31, 2022 Status:

In hot desert climates such as Phoenix, shade structures can provide much needed shelter from the summer sun and can also contribute to the thermal environment of the surroundings. Optimal design of shade structures, however, first requires a basic understanding of the processes affecting individuals using the shelter and the interactions between the shelter structure and the surroundings.

With respect to an individual, thermal comfort depends upon the following factors: ambient air temperature and humidity, wind speed, magnitude of incident shortwave radiation from the sun, and magnitude of longwave radiative exchange with the surroundings. While a traditional shade structure can greatly reduce shortwave radiative loads on individuals, it has little effect on air temperature, humidity, and windspeeds. However, the radiative and thermal properties of the shade structure roof surfaces can significantly impact the shelter surface temperatures, and hence, the longwave radiation, transmitted to the users of the shelter.

Just as low shelter surface temperatures benefit individuals using them, cooler surface temperatures also result in less sensible heat flux into the urban airshed and can therefore have benefits at the local and even neighborhood scales.

HUE's *Cool Ramadas* project is partnering with the City of Phoenix and 3M

corporation to explore the various benefits and impacts of a shade structure roof. Specifically, the City of Phoenix Parks Department has agreed to provide a suitable plot of land on which to locate a specially designed and instrumented park ramada shelter. The 3M corporation has agreed to provide radiative cooling film (including installation) at no cost to the project. They are also currently considering a pending proposal that would provide 3M funds to enhance the proposed effort and enable us to gather and analyze data over a longer period of study1. ASU researchers (led by PI Sailor) are overseeing the project, including sensor installation at the project site, and monitoring and analyzing the resulting data.

The selected site for the cool ramada is the RJ dog park (big dog area) within Pecos Park in southern Phoenix (Figure 1).

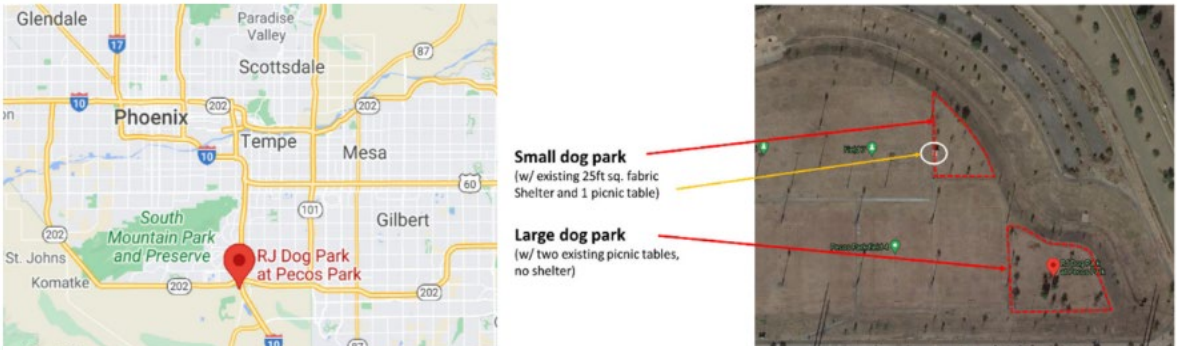

Figure 1. Map location of Pecos Park (left) and general layout of RJ dog park within Pecos Park.

The ideal location within the site should not interfere with the functions of the park and should not be too close to tall structures or trees. A location was identified in the southeast section of the park (Figure 2) that fits these requirements. A single 30 ft long by 26 ft deep ramada shade structure with a monoslope standing seam roof is proposed.

Figure 2. Nominal location of the proposed ramada structure within RJ dog park.

Miracle Playgrounds, a structure installer with whom the City of Phoenix has contracted for prior shelters, carries Poligon company ramada products. We have selected a monoslope design ramada to ease the installation process for the 3M film product. An initial set of design documents has been

produced by Poligon engineers to assist with the design process (Figure 3).

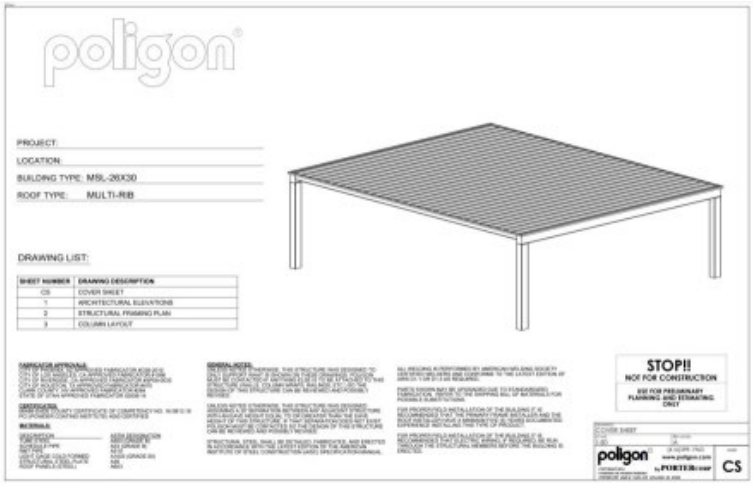

Figure 3. Nominal design of the monoslope ramada shade structure with no overhang. The sloped surface will face south to minimize potential of roof-reflected radiation reaching individuals on the ground.

The goal is to install the shelter at the site in summer 2022 and then monitor the structure thermal performance at least through December 2022, but preferably (with additional support from 3M) through June 2023.

The basic shelter design principle to be exploited in this project is to ensure that the shelter top surface is highly reflective to shortwave solar energy and also highly emissive to longwave radiation, particularly in the infrared atmospheric window (8-13 um), thus radiating thermal energy out to space. At the same time, it is desirable to minimize net longwave radiation emitted (and reflected) from the roof bottom surface down to the users of the shelter.

Two technologies are being explored to alter the radiative properties of a traditional shelter roof. These are a passive radiative cooling film with extremely high solar reflectance and thermal emittance for the top surface and a low-emissivity paint on coating for the underside surface.

To test the use of radiative film technology on the shelter top surface and a low-emissivity coating on the underside surface, four sequential short measurement phases are planned. The first phase, shortly after the shelter is complete, includes monitoring of the roof surface temperatures and fluxes as delivered, with an “evergreen” roof color. The second phase would involve measurements of the effects of application of the 3M film to half of the roof surface (15 ft by 26 ft). The third phase would involve finishing the roof surface film coating so the entire (30 ft by 26 ft) surface is covered with 3M product. The fourth phase would then involve the application of a low-emissivity coating to the underside surface of the ramada roof surface. After these phases are complete, the final step will be to make the underside surface uniform in color. We will use measurements from phase 4 to determine whether the addition of the low-emissivity coating improves or worsens the thermal

performance of the structure. We will then recoat the underside surface with the preferred coating—either a conventional paint or low-emissivity coating.

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.

July 31, 2022:

Metropolitan Phoenix ranks in the top five US cities for asthma-related deaths with approximately 8% of the population living with the disease. In its 2019 State of the Air report, the American Lung Association ranked Phoenix 13th out of 217 cities across the country for highest daily particle pollution and seventh for high ozone days out of 228 metropolitan areas.

In south Phoenix, community health is impacted by poor air quality and complex factors related to racial and ethnic disparities.

1. According to the Office of Minority Health, in 2018, 2.3 million Hispanics reported they currently have asthma and Hispanics are twice as likely to visit the emergency department for asthma, as compared to non-Hispanic whites.
2. ASU School of Sustainability reports 16% of children in south Phoenix under 19 years old had been diagnosed by a doctor as having asthma; this is twice the national average.
3. Researchers at ASU investigated how environmental factors and access to health care affected different socioeconomic groups across Maricopa County. The study found poor housing and limited access to health care are the two biggest factors that put families in south Phoenix at risk for asthma. “Substandard housing co-located with outdoor environmental hazards in south and central Phoenix, creating an environmental double jeopardy for children with asthma,” the report said.
4. African American children have the highest prevalence of asthma. African Americans in the U.S. die from asthma at a higher rate than people of other races or ethnicities. African Americans are three times more likely to die from asthma, especially African American women, than any other group.
5. According to Christopher Tessum, a research scientist at the University of Washington, “Blacks and Hispanics on average bear a ‘pollution burden’ of 56% and 63% excess exposure, respectively, relative to the exposure caused by their consumption.

The HUE project, *Unlimited Potential*, was established to engage, educate, and empower community members and help them understand the interconnection of asthma, pollution, and climate-change.

With over 35 years of grassroots work, Unlimited Potential is deeply rooted in the community and poised to ensure project success. They have extensive knowledge, proven strategies, access to under-resourced populations, and demonstrate robust cultural competency. Their experiences help us build on the natural leadership of community members, cultivate a critical consciousness, and engage neighborhood residents in promoting health and educational equity. They provide equitable opportunities grounded in acceptance and respect, promoting healthy families and communities. Through a holistic lens, Unlimited Potential focuses on the person's physical, emotional, social, spiritual, and intellectual well-being while helping them understand holistic health is an approach to life.

Unlimited Potential works with a variety of sectors, including Health Education (with 150 active community health workers (CHWs)), Million Hearts Initiative (Maricopa County), Fresh Connections (no cost organic produce), Health Start (AZDHS), Spaces of Opportunity (Founding member), West River Mesa Heat Action Project (with ASU), Adult Education (ESL, conversational, technology, and GED), and the City of Tempe (Energy Equity and Climate Justice), and more.

Anticipated outcomes include:

1. Develop a best-practice and comprehensive training curriculum for the community at large.
2. Increase the understanding of community health workers regarding the relationship between climate, pollution, and asthma.
3. Provide two-hour train-the-trainer workshops to community health workers.
4. Integrate the impact of climate, pollution, and asthma into all health workshops and outreach provided by Unlimited Potential.
5. Elevate community members' understanding of climate, pollution, and the intersection with health.
6. Provide one-hour workshops to 1,200 community members of whom 95% will report a heightened awareness of asthma, climate, pollution, and the intersection of health.
7. Develop and distribute outreach materials at Spaces of Opportunity, Roosevelt Elementary School District, Brooks Academy Community School, and all Unlimited Potential projects reaching a minimum of 10,000 community members.
8. Encourage community members to engage with the City of Phoenix Climate Action plan.