Healthy Urban Environments (HUE) Initiative
Arizona State University

Project Update: Second Year, First Quarter, 2020
Date of Report: July 30, 2020

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.

HUE Work Plan - Gantt Chart	Project Year	1				2				3			
	Calendar Year	2019		2020				2021				2022	
	Project Quarters	1	2	3	4	1	2	3	4	1	2	3	4
Communication, networking and solutions hub													
Convene ASU heat and air quality researchers		■											
Create Network of Concerned Parties and Advisory Council			■										
Aggregate relevant plans from local and external entities		■	■										
Research, solutions and innovation incubator													
Laboratory Investigations - Year 1			■	■	■								
Laboratory Investigations - Year 2						■	■	■					
Laboratory Investigations - Year 3									■	■	■		
Pilot Field Experiments					■		■		■			■	
Model Proposed Interventions						■		■		■		■	
Behavioral Research on Perceptions of Heat and Air Quality						■	■	■	■				
Implementation and Evaluation													
Scale-up of Proposed Interventions										■	■	■	■
Evaluate Changes of Perceptions										■	■		
Public, workforce, and management education + capacity building													
Workforce, Public, and Management Educational Programs					■	■							
Share Solutions for Relevant Stakeholders						■	■	■	■	■	■		
Offer Training for New Jobs								■	■	■	■	■	■

Figure 1. Gantt Chart for ASU Healthy Urban Environments project deliverables.

1. Research, Solutions and Innovation Incubator

Overview:

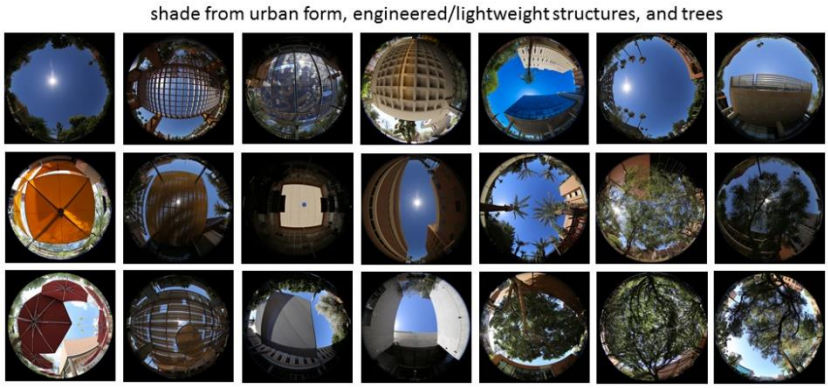
ASU will develop a research, solutions and innovation incubator to test novel heat and air pollution mitigation technologies; deploy field demonstration projects to quantify the heat and air quality mitigation effectiveness; and modeling projects to simulate the impact of heat and air quality mitigation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

July 30, 2020 Status:

Central to HUE serving as a Research, Solutions and Innovation Incubator, individual projects supported by HUE explore technologies, demonstrations and deployments to mitigate urban heat and air quality. Most of the projects had to delay or detour their activities and adjust to COVID circumstances. Some of the projects had to completely stop their work, stay indoors, and keep social distancing. Other projects had to modify their implementation procedures. Considering the difficulties and limitations our projects continue to progress and move forward. Below are descriptions of the projects and their current progress status:

The Right Shade in the Right Place: Thermal assessment of natural and engineered shade in Tempe

Understanding the thermal performance of natural and engineered shade types is critical to supporting effective deployment of shade for improved human thermal comfort in cities. The heat mitigation services provided by shade must be understood in their urban context (e.g. underlying surface materials, surrounding urban form) and function of space (e.g. right-of-way, playground) to find the best shade strategy for a given location.



To assess shade performance, we conducted hourly shade measurements in Tempe with the mobile human-biometeorological station MaRTy over a three-year period on hot summer days from 8:00 AM to 9:00 PM. We sampled sun-exposed reference locations and various shade types classified by urban form (e.g., awnings, overhangs), engineered shade (e.g., shade sails, umbrellas), and tree species over multiple ground surfaces (grass, gravel, concrete). We investigated shade performance using four thermal metrics: the difference between a shaded and sun-exposed location in mean radiant temperature, incoming solar radiation, surface temperature, and air temperature. We investigated average shade performance during the day, at peak incoming solar, peak air temperature, and investigated the daytime heat mitigation vs. nighttime heat retention tradeoff. 159 unique locations were sampled, yielding 1988 valid data points across dates and times. Results are currently being analyzed and will be available later this summer. Findings will inform the City of Tempe's active shade management practices and policies.

Quantifying Dust Control by a Novel Enzymatic Treatment

The objective of our work is to quantify the benefit for a novel enzymatic soil stabilization process developed by ASU researchers in the Center for Bioinspired and Biomimetic Geotechnics (CBBG). By leveraging CBBG field demonstrations, we will quantify the air quality benefit for treating uncovered soil with a novel enzyme induced calcium precipitation (EICP) treatment. Two field deployments are planned: an initial scoping study in Fall/Winter 2019 and an extended deployment in Summer 2020. The initial field deployment utilized particle mass measurements of localized PM concentration over a field treated with different EICP solutions versus a control plot for a 2 week period. This initial scoping study was used to optimize instrumentation and make recommendations for field studies during the full deployment in Summer 2020. Based on the initial deployment, no statistically significant difference was observed in local PM levels over a treated field versus the control field. However, there were no observations during high wind events (wind greater than 25 mph) during which the treatment is expected to be most beneficial. As a result, the next deployment will be conducted during high-wind summer monsoon conditions. Also, localized wind sensing and chemical composition monitoring will be deployed during the extended Summer 2020 program. Also, the field plan calls for larger plots to be treated during the second deployment pending availability of the space to prevent cross-over between study sites.

Photocatalysts on solar panels for NOx control

The objective of our work is the development of bifunctional solar cells, able to provide electrical energy while also reducing atmospheric NOx concentration. The NOx abatement would be achieved through photocatalysis on TiO2 nanoparticles, coated onto or embedded into the surface of the solar cells. The photocatalysis would only impact a small fraction of the solar spectrum, typically not efficiency transformed into energy anyway and hence not significantly negatively impacting energy generation while allowing for the oxidation of NOx into HNO3/NO3-. An experimental setup was developed to test this concept allowing irradiation with different light sources the use of a controlled atmosphere and continuous inline NOx measurements. Initial proof of concept demonstrations are very promising, showing a significant NO decrease although some NO is being transformed into NO2. Ongoing research is focusing on achieving complete oxidation and testing a variety of catalysts under a broader range of experimental conditions (contact time, humidity, temperature).

HeatReady Standards

Extreme heat is a pressing challenge for many cities, posing risks to health, quality of life, and economic vitality. ASU researchers are collaborating with local municipal leaders and national heat-health experts to develop a set of guidelines called "HeatReady Standards" that cities can use to structure and evaluate their response strategies for this growing hazard. Cities that earn HeatReady recognition will demonstrate increasing capabilities to identify, prepare for, mitigate, track, and respond to urban heat dangers. To date, ASU researchers have engaged more than 50 heat experts to bring the HeatReady program this effort to life. In 2020, the project team developed and implemented a pilot version of Tier 1 HeatReady Standards. Cities that achieve Tier 1 HeatReady certification will have demonstrated the necessary foundations to begin addressing heat and its impacts in a comprehensive manner. As such, the Tier 1 application questions are intended to assess a city's preparedness to take action. Several cities are pilot-testing the Tier 1 application in summer 2020, with results expected later in the calendar year.

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.

July 30, 2020 Status:

During this last quarter we successfully convened our grantees in two different opportunities. The first convening took place on June 17th, and focused on the progress of HUE's first cohort- the 2019 grantees. Prior to the convening we surveyed our grantees where we learned that HUE has been a beneficial engine to all our grantees to promote extreme heat and air quality projects. In a virtual meeting the 2019 cohort presented their projects to 26 participants. Presentations were followed by a vivid discussion including questions from the 2020 cohort as well as from the HUE team.

The second convening took place on July 29th, focusing on the 2020 cohort who are just starting their projects in light of COVID. We presurveyed the 2020 cohort and asked for ways HUE can support the grantees and have a bigger impact on the community. We heard about the projects' progress as well as the challenges and adjustments each project had to endure. We also discussed the following topics:

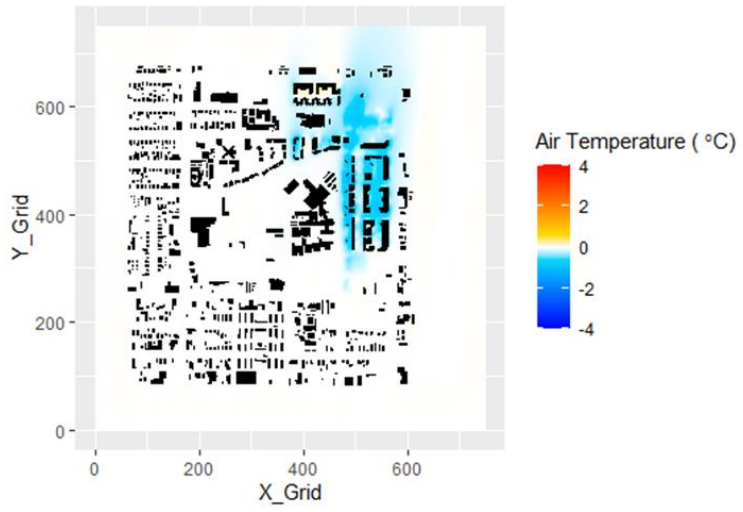
- Possibilities of scaling up projects to broaden the impact on the community
- Enhancing community engagement moving forward
- Project opportunities that will lead to the creation of new jobs or new aspects of current jobs, expanding aspects of jobs to incorporate heat or air quality.

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 30, 2020 Status:
The coronavirus pandemic has challenged the implementation and evaluation of all our projects. It forced our researchers and stakeholders to delay their projects, or when social distancing requirements were possible to come up with creative ways to move forward with implementing their revised plans. Two projects that successfully implemented their plans are the *Neighborhood-scale comparison of heat mitigation strategies in Phoenix,* and the second project *Paideia Elementary School Playspace Re-naturalization: A Pilot Project in South Phoenix to Enhance Children's Environment, Health, and Well-being.*

Neighborhood-scale comparison of heat mitigation strategies in Phoenix

Neighborhood redevelopment efforts, particularly in affordable housing communities, offer opportunities for cities to address social, economic, and environmental health disparities. The City of Phoenix is in the process of redeveloping the Edison Eastlake community, with one goal being to improve thermal environments for its residents. This project uses microscale atmospheric modeling to quantify the thermal conditions in the neighborhood before redevelopment, validate the model based on observations within the neighborhood, and then use the validated model to explore the thermal environment implications of various redevelopment designs. The value of this project is both in terms of its ability to inform design decisions in this neighborhood, but also to establish a framework for providing design guidance in future redevelopment plans in Phoenix and elsewhere.



Paideia Elementary School Playspace Re-naturalization: A Pilot Project in South Phoenix to Enhance Children's Environment, Health, and Well-being

The goal of the project is to assess the impact of the implementation of a Natural Play and Learning Environment on child health and well-being. The objectives are to: 1) assess differences in playtime exposures to extreme heat, radiation, and air pollution; 2) examine

physical activity throughout the year and lower heat illness; 3) bring nature, green infrastructure, and nature exposure into children's education & play. Efforts have focused on the collection of "pre-intervention" data on environment and space usage to understand these factors before the re-naturalization occurs. Since May 2020, we have been collecting microclimate and air pollution information across the campus. Specially with six Clarity air quality sensors and six Arable microclimate stations around the playground (4 each) and parking lots (2 each). These data are being augmented by MaRTy Transects throughout all playspaces. We also have a

high-end Davis Vantage Pro-2 weather station on the roof. All station data are live, with select sensors 'open' for use by the students and public. We have also performed human subjects research to gather pre-intervention data on scholar space use and physical activity (using heart rate monitors) and personal UV radiation exposure. Further, we have worked with kindergarten students to generate "photo stories" and "artistic renderings" about their favorite or optimal playspace attributes, which are being analyzed. In the fall of 2019, Dr. Chingwen Cheng's Design Studio hosted four community workshops to share and gain input from students, teachers, and parents on the new playspace designs. Finally, we are working to analyze school-based heat illness and asthma cases with the School Nurse. Thus far, the edible garden area has been built (see photo) by LEHR gardens, a community partner, surrounded by edible trees. This is part of a "Green STEAM" studio project funded by HIDA at ASU and integrated into the curriculum. Currently, the final designs have been completed by Norris Design, and we hope to break ground in September. We are working with Paideia to host a fundraising event for the playspaces on October 28, 2020 at the school.

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 30, 2020 Status:

We are thrilled to announce that Rachel Braun joined the HUE team as a postdoctoral research scholar at the beginning of June. Rachel joined us to advance air quality knowledge after completing her Ph.D. in Chemical Engineering with a minor in Atmospheric Sciences at the University of Arizona in May. During her time in graduate school, Rachel's research focused on clouds and aerosols in marine environments and she also participated in field measurement campaigns in coastal California and Metro Manila, Philippines. Rachel is interested in looking at the intersection of extreme heat and air quality in Maricopa County, and looks forward to applying her knowledge of aerosols in an urban desert environment while learning more about issues related to extreme heat in the region.