Healthy Urban Environments (HUE) Initiative
Arizona State University

Project Update: Second Year, Second Quarter, 2020
Date of Report: October 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.

October 30, 2020 Status:

The HUE team has recently met with the 2019 projects' leads who are in the process of wrapping up their research and projects. Each project reported on their exciting research, findings, and progress.

HeatReady Cities

Earlier this year the HeatReady project team developed and implemented a pilot version of Tier 1 HeatReady Standards. Cities can use these standards to structure and evaluate their response strategies

for the growing extreme heat hazard. Cities that earn HeatReady recognition will demonstrate increasing capabilities to identify, prepare for, mitigate, track, and respond to urban heat dangers. Cities that achieve Tier 1 HeatReady certification will have demonstrated the necessary foundations to begin addressing heat and its impacts in a comprehensive manner. Following the Tier 1 completion cities will progress to Tier 2 which lays the base for creating a plan to mitigate extreme heat. During this phase cities will demonstrate an active and comprehensive approach to respond to threats associated with heat. The HeatReady team is currently developing Tier 2 that will consist of a combination of a free scorecard and a paid verification. The goal of this tier is to serve as a platform for creating and developing an emergency plan. This tier focus on three elements:

- Adaptation action - help people cope with heat
- Mitigation actions - make the city cooler and more comfortable
- Internal actions - support decision-making by city staff

Right Shade in the Right Place

Understanding the thermal comfort performance of various natural and engineered shade types is critical to supporting effective implementation of shade expansion and thermal comfort goals in cities. Further, the services provided by shade must be understood in their urban context (e.g. materials, location) to isolate the impact of each shade type on thermal comfort.

In this HUE-funded project a mobile biometeorological instrument platform documented the objective thermal comfort and human thermal environment of various shade types as experienced by pedestrians in Tempe, AZ. This pilot field experiment project expanded on existing studies by increasing the sample size and types of shade structures sampled. Preliminary results suggest that engineered shade structures (e.g. shade sails) are a viable alternative to trees for daytime thermal comfort and should be included in shade management practices, while natural shade (e.g. trees) can vary in performance by species.

Further, ASU researchers are partnering with the City of Tempe to support Tempe's Urban Forestry plan by conducting solutions-oriented research with the goal to inform policy. The team has collected an extensive amount of data to be shared with the community and is planning to share their findings in a conference or a workshop later this year.

Playscape Redesign

A common space for children to be impacted by heat and air quality are playgrounds and play spaces at schools and parks. This HUE pilot project is providing novel insights on the impacts of playspace design on children's exposure to heat and air pollution, the impacts of this exposure on health and well-being, and outdoor space usage for learning and physical activity. ASU researchers are collaborating with Paideia Academy, a K-8 public charter school located in south Phoenix, Arizona to collect data and find answers.

The five-acre school property experiences persistent environmental justice issues endemic to the greater South Phoenix area, including flooding, excessive urban heat, and poor air quality. Because South Phoenix is located on an alluvial floodplain of South Mountain, green infrastructure interventions, including the creation of bioswales and bioretention for stormwater along with the use of native vegetation, are critical to mitigate seasonal flooding and improve environmental site conditions. Through community engagement workshops, this project envisions the use of green infrastructure at Paideia to create resilient natural learning and play landscapes that promote health equity. Using Padeia's whole-person education paradigm to guide the goals of the project, the project triggered the conversation on how school landscapes can address the immediate health equity challenges of the site while creating a welcoming and healthful green space amenity for the community.

This project produced the following outputs:

- A planting guide/palette for the school. This guide can be shared with other schools in the area to expand the impact and improve the health of other schools in South Phoenix and other areas with similar conditions.
- MRT (Mean Radiant Temperature) data collection
- Flyover data collection

Neighborhood-Scale Comparison

The Edison Eastlake neighborhood in Phoenix, AZ, is the subject of a substantial public housing redevelopment initiative being led by the City of Phoenix. This redevelopment effort explicitly targets goals that include improved air quality, reduced heat impacts, and soliciting desired design outcomes from community members. This HUE project tested these goals using a combination of in-situ measurements and modeling to explore the air flow and heat transfer dynamics of the neighborhood across both baseline and the new proposed redesigns.

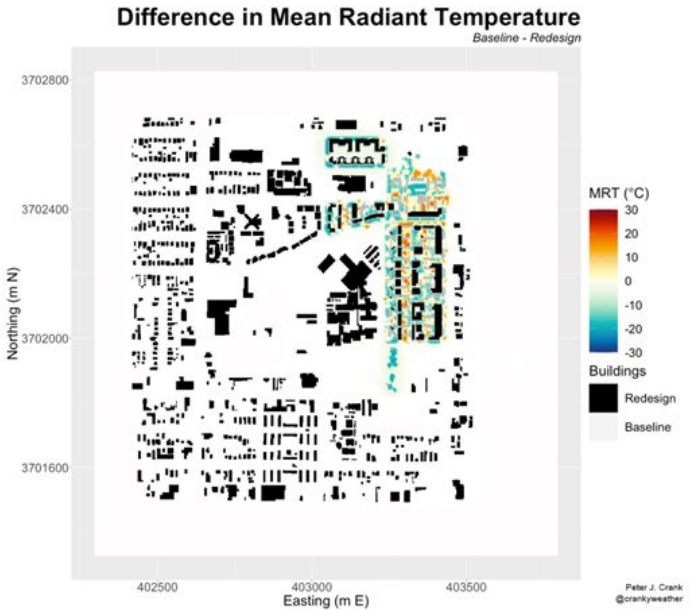
Peter J. Crank
@crankyweather

Detailed plans by the city for redevelopment
2-4 story buildings with units for mixed income

Expansion of Edison Park in the north
Extension of the park
New units north of the elementary school

This approach will enable practitioners and researchers to better understand the thermal impacts in both space and time of various proposed designs in comparison to the existing design. The results indicate cooling underneath trees and in the shade of buildings/shade structures, and warming in locations of sun-exposure and proximity to buildings that are radiating heat (see image below). The research also found:

- Broad cooling in areas of redesign
- Slight warming on south-facing courtyards (NW end of modified region)
- Warming also at the southernmost new units, mainly south and east sides of units
- Downwind propagation of cooling (50-100 m)



* MRT (Mean Radiant Temperatures) is highly dependent on shade. Under shade, MRT is ~air temperature. In full sun, MRT can be 40-60 °C warmer.

To improved air quality, reduced heat impacts, and soliciting desired design outcomes from community

members the researchers recommend:

- Modeling of design alternatives must start with application-specific validation to ensure model accuracy.
- Designs should include a variety of building heights (e.g., 2-4 story) to provide more shade and facilitate vertical air mixing.
    - Mixing of the air can improve air quality and promote downwind cooling.
- Outdoor courtyards should be oriented to maximize shading by buildings. If north-facing orientation is not possible, artificial shade structures or substantial vegetation canopies should be used to shade the courtyard.
- Vegetation augmentation should focus on use of cool corridors along high pedestrian traffic routes to provide local cooling and shading.
- Green areas should be expanded, potentially using existing flood-irrigation infrastructure.

Photocatalytic Solar Panels to Control NOx

The initial HUE funded project on photolytic NOx destruction on solar panel was a laboratory proof of concept study. We were successful in showing proof of concept that NOx can get photocatalytically reduced on titanium oxide nanoparticles applied to glass, in our laboratory reactor. In these last weeks of the current project we are further studying the reactions and extending our measurement range but all in controlled laboratory conditions.

However, to clearly demonstrate the ability for this approach to lower ambient NOx levels, the approach must be shown to be viable outside the laboratory through field demonstrations. For this, a pilot scale investigation aiming to demonstrate *in situ* the feasibility of photocatalytic NOx reduction on solar cells through field monitoring.

The field project will deploy four different glass panels - each coated with a different photocatalyst shown in laboratory experiments to effectively remove NOx and form nitrate - plus two uncoated glass panels as controls. These panels will be mounted on the roof of the ISTB4 building on ASU's Tempe campus. Above each panel we will place a Clarity NO_2 sensor to continuously monitor NO_2 concentrations. An independent NO_2 sensor, away from all panels will be used as additional control measurement. After 2 weeks of continuous measurements, the panels will also be rinsed with DI water and any nitrate accumulated and the panel surface will be quantified with ion chromatography. The sensor data will get statistically analyzed to quantify any differences in NO_2 concentrations. The panels will remain deployed to quantify if rinsing the panels decreases control effectiveness.

Our project will collaborate with ongoing research on NOx monitoring - sponsored by the Maricopa County Air Quality Department - as well as with Swifcoat - an ASU spinoff company which focuses on nanomaterial coating of glass products. This will ensure the results of the project will be translated for key stakeholders.

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 30, 2020 Status:

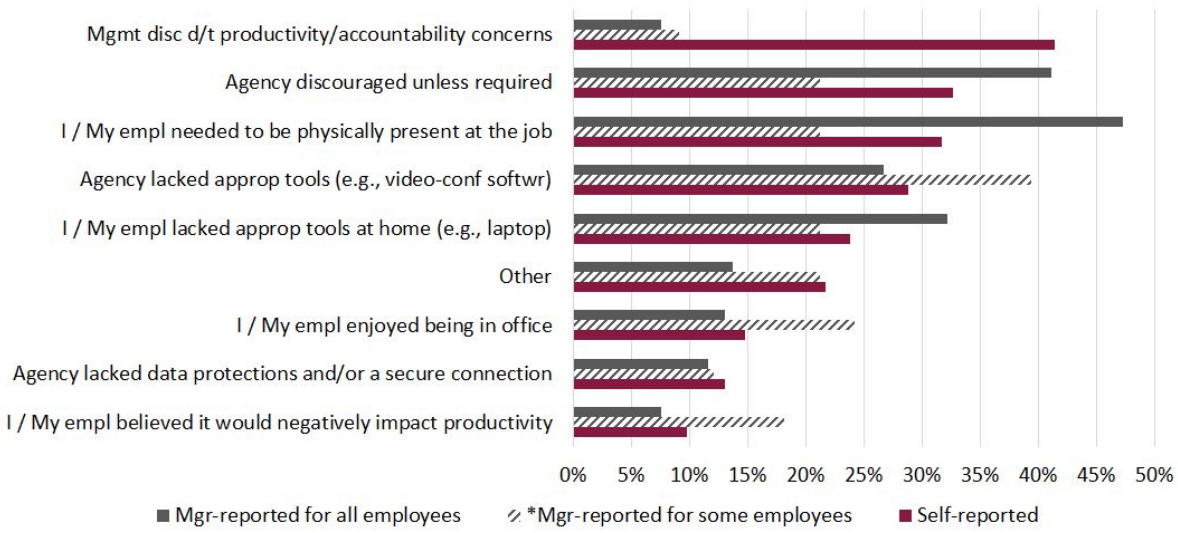
Arizona Heat Preparedness and Resilience Working Group

There is a need to share best practices and approaches to heat relief across municipalities in Arizona, especially during the pandemic where many businesses, schools, and recreation areas have temporarily closed. The Arizona Heat Preparedness and Resilience Working Group, comprised of municipalities, public health departments, academia, utility companies, faith communities and not for profits has met weekly since April, 2020 to ensure that cities and counties have the weather data they need and to connect cities and counties to regional and state resources and information. Many topics were discussed including the economic impact of heat (over $56 million in Maricopa County, AZ in health costs alone), the provisioning of cooling centers to strategically address the needs of the most vulnerable, communication strategies about heat warnings, available aid for utility bills and air conditioner repair, and emergency management expressly for extreme heat. In October the group shifted to a monthly format, but the work continues to be prepared for the next heat season. The AZ Heat Preparedness and Resilience Working group has been actively promoting the All Hazards Mitigation planning underway to include extreme heat as a hazard and, therefore, apply for mitigation and adaptation funding from FEMA.

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 30, 2020 Status:

Encouraging Teleworking as a Strategy to Reduce Ozone from Commute Trips in Maricopa County
This project was proposed and started prior to the COVID-19 pandemic and subsequent stay-at-home order that led to a significant increase in teleworking statewide. Despite this change in circumstances, the team leading the project was able to successfully pivot their strategy. Initial results from this project lend promising insights to the implementation of teleworking as a strategy for reducing vehicle emissions in Maricopa County. A survey was conducted of City of Tempe employees after the conclusion of the stay-at-home order but before in-office work resumed (June 5-14, 2020). The survey received 512 responses, for a total response rate of approximately 25%. A large percentage of respondents indicated their willingness to continue teleworking at least part time in the future.
In addition to the air quality benefits from reduced commuting, numerous benefits for employees were identified as well, including improved work/life balance, improved health management, reduced stress, reduced costs from commuting, and increased productivity. As the final outcome of this project will be a toolkit of best practices for implementing teleworking, barriers to teleworking that were identified via the survey will be especially important to address in the final toolkit. These barriers include reduced opportunities for building social connections and office camaraderie, technological limitations, and unclear guidelines and policies.



Barriers to teleworking prior to staying at home

The next steps for this project will be further in-depth focus groups and additional research on best practices identified in related experiments in other regions.

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 30, 2020 Status:

Arizona State University School of Sustainability Masters students advance HUE projects

The School of Sustainability offers Masters' tracks that culminate in real-world sustainability interventions completed over a one-year period. HUE is advising three graduate students to advance the work of HUE grantees. One Master of Sustainability Solutions (MSUS) graduate student will examine the findings from the HUE project on neighborhood scale comparison of heat mitigation strategies in Phoenix to develop a toolkit promoting best practices for culturally and contextually appropriate heat mitigation strategies that can be used by large scale developers, architects, and designers. Another MSUS student is exploring energy insecurity while working with partners at the Maricopa County Department of Public Health to ensure that the most vulnerable do not have to make the difficult tradeoff of providing home air conditioning or paying for necessities, which is especially applicable to mobile home park residents. Lastly, a graduate student in the Master of Sustainability Leadership program will follow the progress of the HeatReady School project and apply those findings to his high school in Scottsdale, developing a strategy to introduce the HeatReady Schools framework to other school systems.