Project Description *

Please provide a description of your project. Please include information on the need your project fills and how it does so. Include objectives, an anticipated timeline, and expected impact(s). Responses are limited to 3,000 characters including spaces.

Air pollution is associated with a wide range of adverse health outcomes, including but not limited to premature mortality, asthma, cancer, and neurological diseases. Air pollution levels can vary substantially over very short distances and time periods. However, regulatory monitors cannot fully characterize the air pollution patterns and trends since they are sparsely located and report only hourly values. Recent technological advancements and development of low-cost air pollution sensor technologies have the potential to address this issue. Due to their low cost (<$300 per unit) and ease of installation, high numbers of low-cost sensors can be installed in a given area and generate near real-time data. Many cities and government agencies are installing low-cost air quality sensors as parts of the 'smart city' and 'internet of things (IoT)' programs.

In this project, we will install 15 outdoor sensors and 5 indoor sensors (PurpleAirs) across the campus (10 units will be purchased and other 10 will be provided from the project PI). This will be supplemented by additional 10 mobile sensors (AirBeams). PurpleAir and AirBeam measures fine particulate matter levels. PurpleAirs are stationary and will be installed at specific locations. The sensor locations will be discussed prior to installation with Offices of Sustainability and Facilities, selected to ensure a variety of geographic locations, such as high traffic volume areas (e.g. Campbell and Speedway), green areas (e.g. gardens far away from major roads), and power generating sources. Indoor sensors will be paired with outdoor sensor locations, which will also allow us to better understand the relationship between outdoor-indoor concentration levels across campus. AirBeams are mobile and can be carried around, and we will organize a week-long sampling campaign by recruiting students to walk/bike around campus. This sampling campaign will supplement the data collected from PurpleAirs and will increase the spatial coverage of air pollution data. Modeling will be done via machine learning approaches (e.g. random forest) with geographic information systems (GIS) variables and local meteorology as predictors to generate concentration levels at locations without monitors. Real-time mapping and visualization tools will be constructed to identify and visualize pollution hotspots and trends.

This project will be among the first to establish a low-cost air pollution sensor network on a college campus, putting the University of Arizona at the forefront of the 'smart campus' movement. The sensor and data infrastructures from this study could be leveraged to pursue future collaborations and grants that expand the sensor network. For example, additional sensors could be installed to examine other air pollutants, such as ozone and ultrafine particles, or movement trackers to estimate the number of students that are exposed to air pollution throughout the day.

Project Summary Snapshot *

Please provide a short summary of your project. This summary will be used on our new website and other Office of Sustainability materials, if approved. Think of this as a hyper-concentrated summary limited to just a few sentences. Responses are limited to 800 characters (~60-100 words).

Low-cost air pollution sensors will be installed across the UA campus. The collected data will be used to create machine learning-based models to predict and visualize real-time air pollution levels across the entire campus. The data and visualizations will be shared online so that community members can see and better understand air quality patterns and their personal exposures.

Project Feasibility & Logistics *

Please provide a description of the work that has been completed so far to make this project feasible. Have all relevant partners been contacted/coordinated with? Please identify them in your response. Have you received reasonable quotes for supplies? What research has been completed to lay the foundation for this project? Proposals that have not thoroughly pre-planned may be rejected outright. Responses are limited to 3,000 characters including spaces.

I have extensive experience with sensor development and deployment, including organizing sampling campaigns and studies in partnership with local environmental justice groups. I have worked with PurpleAirs and AirBeams for scientific and community research. I have received quotes for the required supplies. I have conversed with the Office of Sustainability to discuss the project. I have also prior established partnership with the Pima Department of Environmental Quality. Before the sensors are installed, they will need to be tested next to reference monitors to assess their accuracy and precision, as sensor measurements can sometimes vary between individual units.

Environmental Sustainability Outcomes *

Please provide a brief description of how you expect your project to advance environmental sustainability on campus. Responses are limited to 3,000 characters including spaces. A definition of environmental sustainability is provided in our Spring 2022 Information.

This study directly addresses air quality, an important facet of environmental sustainability. By creating a real-time air pollution model, this study will allow us to predict air pollution hotspots and times when concentration levels are elevated, which will bring awareness and generate evidence needed to advance solutions to mitigate exposures. Characteristics of buildings with poor indoor air quality can be identified and remedied to improve ventilation. Some proven avenues, such as additional trees in especially polluted locations, could be proposed to decisionmakers to improve air quality on campus and protect public health.

Social Sustainability Outcomes *

Please provide a brief description of how you expect your project to advance social sustainability on campus. Responses are limited to 3,000 characters including spaces. A definition of social sustainability is provided in our Spring 2022 Information.

Air pollution exposure is disparate across populations. Numerous studies have established that minorities and lower income populations are exposed to higher levels of air pollution, and thus suffer more associated health outcomes. While this specific study focuses on the local campus population and surrounding areas, I am leading another related study to install sensors at Pima County schools and model air quality across Tucson. This will allow us to measure disparities in air quality in Tucson, and the data from UA campus will contribute to the city-wide modeling efforts. The website will also include a section on environmental justice of air pollution to educate students on this important issue. Furthermore, by potentially protecting campus public health, especially those with asthma or other pre-existing respiratory conditions, we will increase the overall safety of the students.

Student Leadership & Involvement *

Please provide a brief description of how you expect your project to benefit students on campus regrading the creation of leadership opportunities or student engagement. What leadership opportunities exist within your proposal? If you plan to hire/ or involve students, please describe in what capacity. For example, if you plan to hire students, create an internship, or seek student involvement, please describe relevant details thoroughly (wages, responsibilities, duration of job, extent of involvement, how you will solicit/ market these opportunities etc.). Responses are limited to 3,000 characters including spaces.

Students on campus will benefit from this project by understanding their personal-level exposure. Students who are especially vulnerable, such as those with asthma, can modify their behavior to protect themselves and limit outdoor physical activity levels. We will recruit students to walk/bike around campus with AirBeams to sample and collect additional air quality data. They will be trained in sensor operation and to take stewardship of their collected data, including management, cleaning, and sharing. PhD student Tina Fingesi will serve as secondary leader for this project. Undergraduate Nathan Mottern has experience with sensor installations and will help coordinate efforts.

Education, Outreach, & Behavior Change *

Please provide a brief description of how you expect your project will communicate its impacts to the campus community. How will your project educate the campus community and/or incorporate outreach and behavior change? How are you reaching beyond the "sustainability choir?". Responses are limited to 3,000 characters including spaces.

We will create a website to be shared with the campus community. This will have a map of sensor locations, graphs of sensor readings, and a visualization of modeled air pollution levels across campus. We will create an infographic on the website to summarize the air pollution and health literature, and ways to minimize exposure and associated health risks. We will make a warning system on the webpage for alerts on days and time periods with dangerously elevated concentration levels, and connect with campus offices to make this information more readily available, such as broadcasts on Twitter.