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Smart Sensors for Smart Cities: Two Examples of Multi-Sector Collaborations in Central Ohio

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GLOBAL SIGNIFICANCE, LOCAL IMPACT

Purpose:

1. Learn about a proposed project involving OSU, Advanced Manufacturing Composites and City of Dublin on air quality sensors.

2. Learn about an ongoing and funded project at OSU that involves citizen scientists (i.e., high school students in Hilliard City School District)

3. Ask questions and explore new collaborations.

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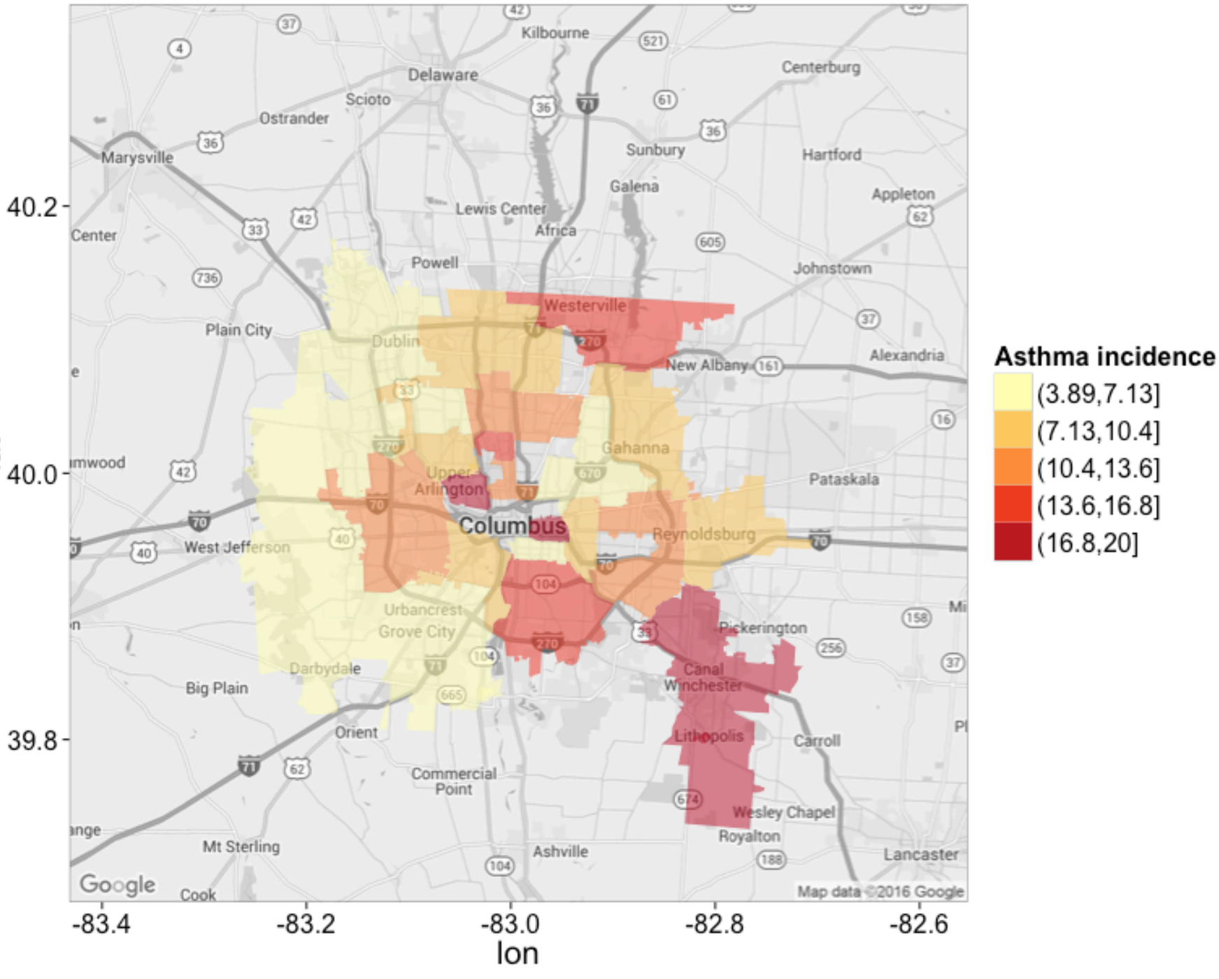
Scientific Rationale

1. Disparities in air quality-related health outcomes.

2. Lack of information on local-level air quality.

3. Limited knowledge about impact of “Smart” transportation and infrastructure on health and well-being.



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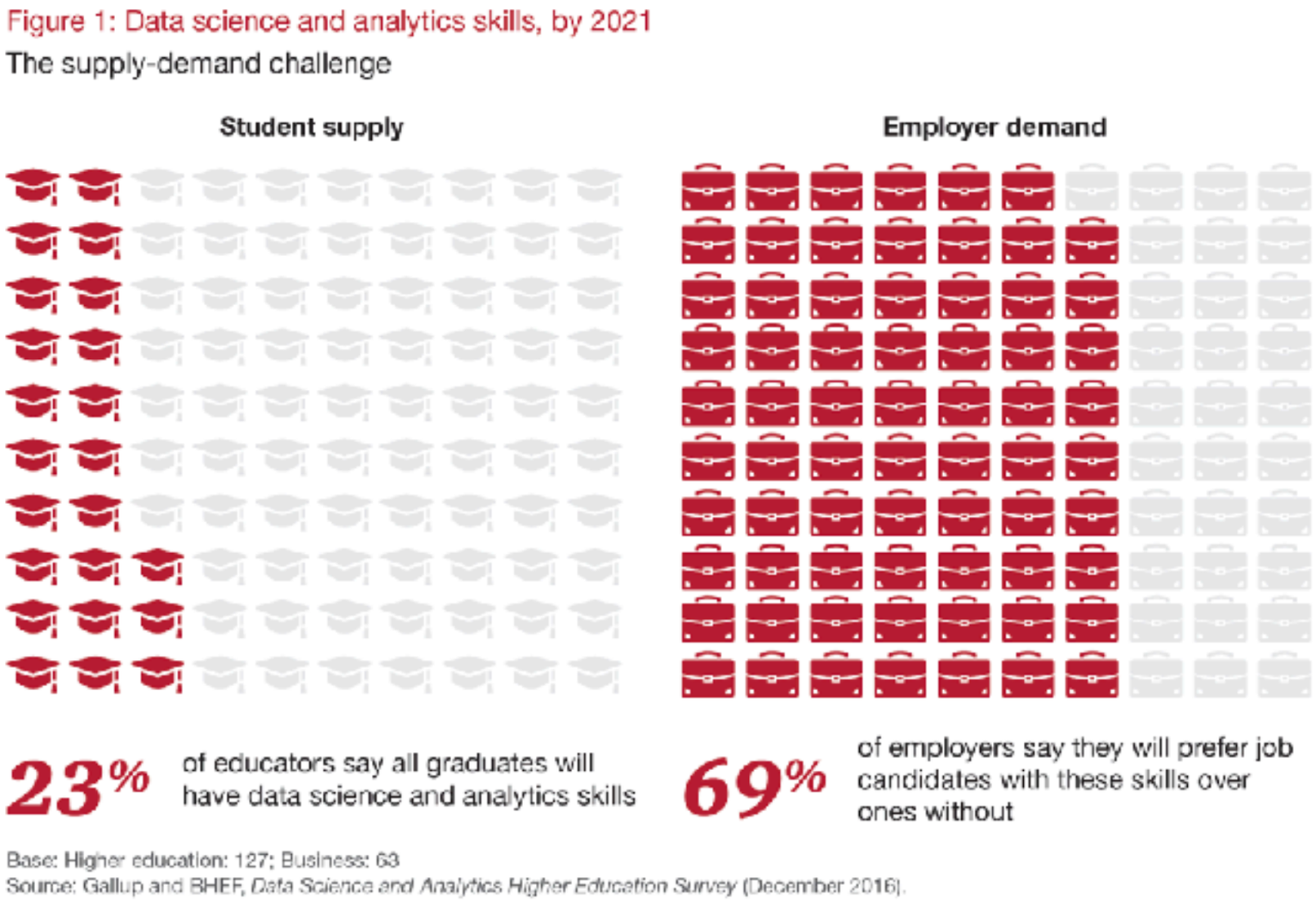
Educational Rationale

1. Data Science in a rapidly growing field in many industries.

2. Education and training is lacking at multiple levels in academia.

3. Smart Columbus is creating demand and opportunity in many disciplines.



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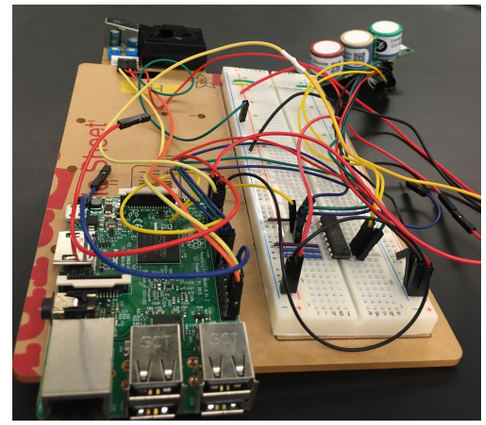
Project I: Incorporating Citizen Science Into Real-Time Sensor-Based Estimates Of Traffic-Related Air Pollution Exposure



Objective Deploy low-cost air quality sensors via citizen scientists to provide reliable air quality data within micro-environments.

Products

1. Air quality sensor package connected to Raspberry Pi. We provided materials and students built the sensor package.
2. End-to-end IoT solution for sensor-based data transmitted to the cloud-based database (Google Firebase) and web-based data visualization and analytical tools.

ACKNOWLEDGEMENTS

This project received support from the National Science Foundation under Grant Number 1645226 and was co-funded by the Midwest Big Data Hub.

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Progress to date:

- Sensor packages sent to Davidson High School students
- Monitors put together by Engineering class students
- Monitor deployed at Davidson and transmitting data regularly
- Website up and running with near real-time updates

Project I: Incorporating Citizen Science Into Real-Time Sensor-Based Estimates Of Traffic-Related Air Pollution Exposure

Progress to date:

- Additional deployment sites identified and permissions granted by Hilliard City School District for use of school buildings
- Students presented on project at Professional Development Day events (Hilliard U)

Project I: Incorporating Citizen Science Into Real-Time Sensor-Based Estimates Of Traffic-Related Air Pollution Exposure

Progress to date:

- Hilliard Davidson teachers engaged to develop curriculum activities for Engineering, Chemistry and Statistics classes in Summer 2018.
  - Formalize the engagement process between students and academic researchers.
  - Showcase local data from local sensor for what matters
  - Highlight value of “Big Data” and “IoT” through real-world applications.

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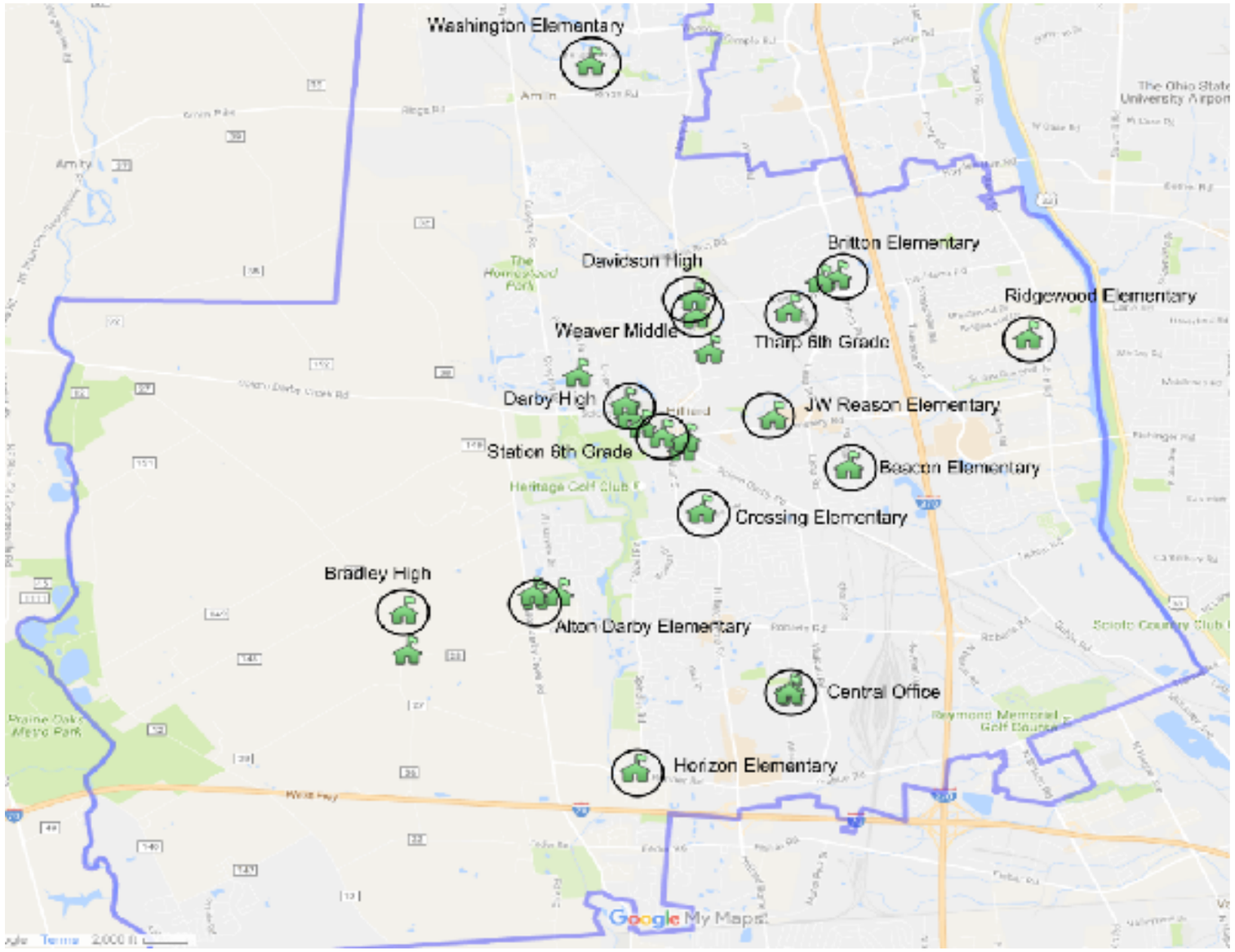
Sites for deployment of sensors in Hilliard



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Screenshots of website.

Air Hilliard | EPA data | Hilliard air quality sensor data

Enter air toxicant to plot:

pm25

Enter a date range:

2017-10-01 to 2018-01-25

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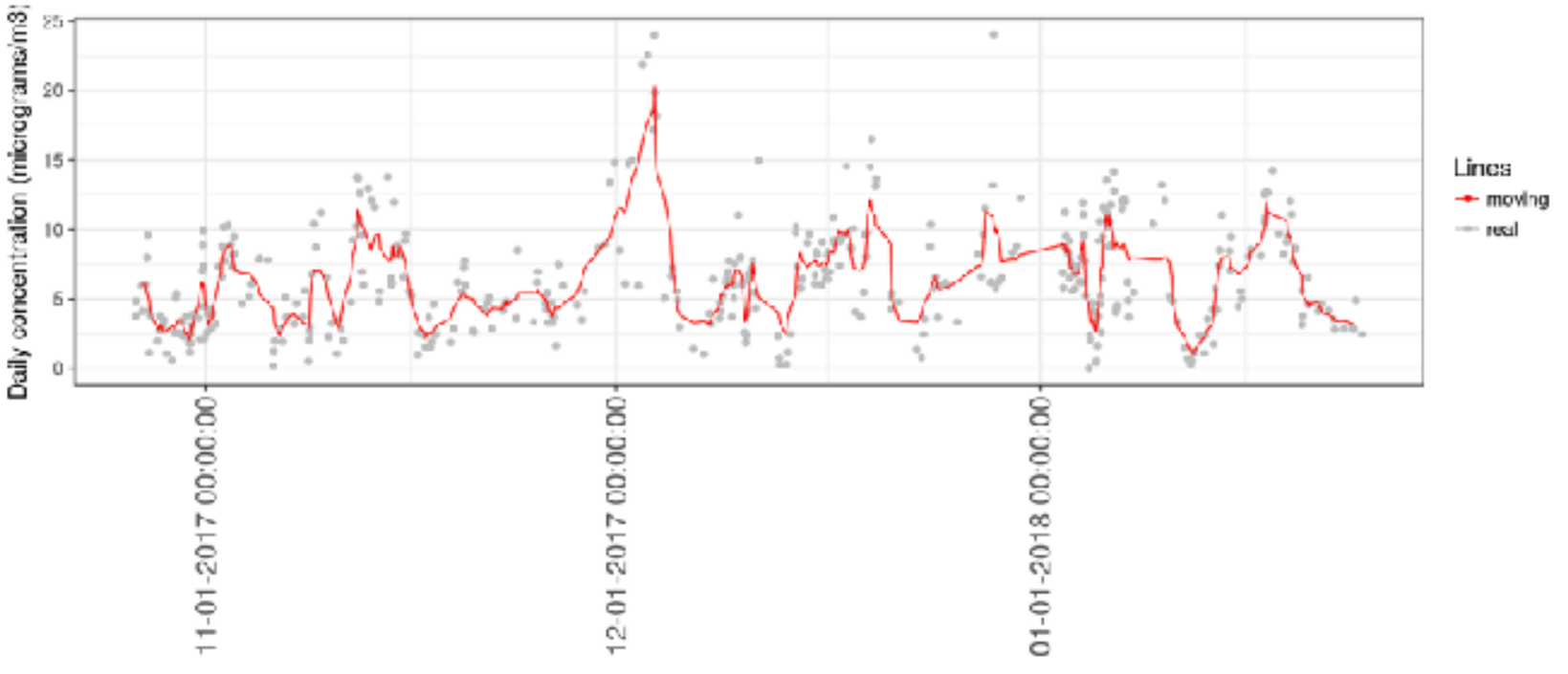

Pollutant	Mean	SD	Min	Max
pm25	6.46	4.61	0.00	35.90

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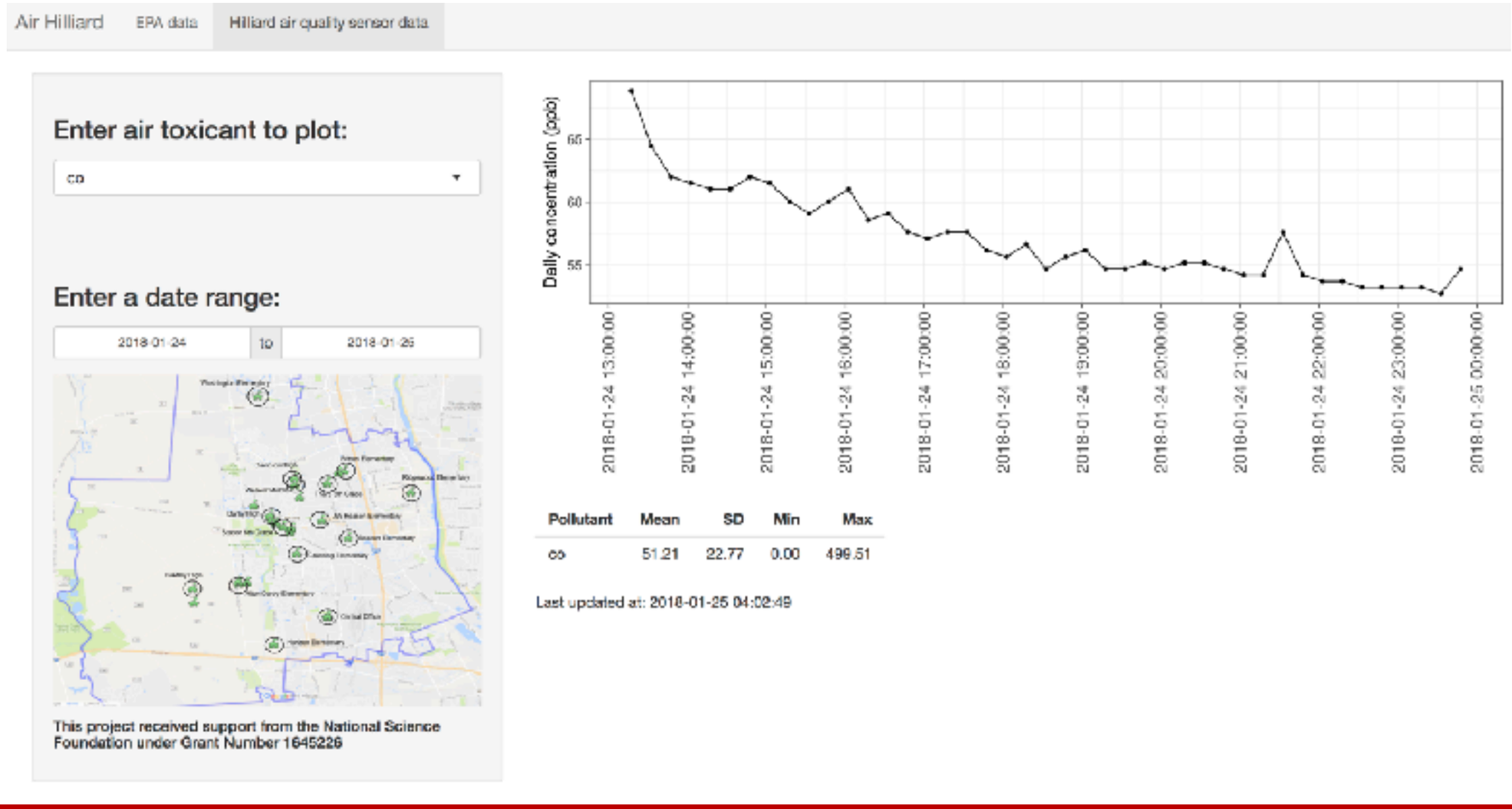

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Lessons learned

- **High school students** very willing to participate in citizen science project when motivated by the use case.
- **High school science teachers** eager to engage with academic researchers.
- **Interest in curriculum development** using data collected and web application requires trust building and long-term

Project I: Incorporating Citizen Science Into Real-Time Sensor-Based Estimates Of Traffic-Related Air Pollution Exposure

Future directions

- Expand to other school districts in Greater Columbus Region.
- Currently working on environmental education project at Worthington City Schools through a Ohio Environmental Education Fund project in partnership with Columbus Public Health
- Partner with hospitals, libraries and community to expand sensor network.
- Develop user-specific modules for data analytics, data visualization and environmental health education.
- Evaluate PM sensors for indoor air quality and smart building systems applications.

Project II: OSU + AMC + Dublin [Proposal Stage]

Purpose: To address environmental health disparities by leveraging advanced manufacturing capacity of an Ohio-based company to prototype sensor-embedded building materials.

Project goals:

1. *[Long-term]* Develop an **environmental health data analytics platform** to make decisions faster, smarter and more cost-effectively.

2. *[Short-term]* Prototype, deploy and evaluate a **building material product that is embedded with a low-cost sensor package** to measure environmental exposures with for real-time cloud-based data collection capabilities.
3. To develop integrated curriculum modules based on each component of the environmental health sensor project for IT, Engineering and

Project II: OSU + AMC + Dublin

Project goals:

1. *[Long-term]* Develop an **environmental health data analytics platform** to make decisions faster, smarter and more cost-effectively.

2. *[Short-term]* Prototype, deploy and evaluate a **building material product that is embedded with a low-cost sensor package** to measure environmental exposures with for real-time cloud-based data collection capabilities.
3. *[Short-term]* To develop **integrated curriculum modules based on each component of the environmental health sensor project** for IT, Engineering and Biomedical academics at the Emerald Campus of Dublin City Schools.

Project II: OSU + AMC + Dublin

Proposed Methods:

Activity 1. Designing building materials (OSU + AMC)
Activity 2. Identifying and deploying sensors (OSU+Dublin+AMC)
Activity 3. Develop cloud-based solution and test completed prototype (OSU+Dublin).
Activity 4. Curriculum development (OSU+Dublin City Schools)

Roles:

- ➡ **OSU** will design and deploy sensors and develop data analytics tools.
- ➡ **AMC** will design, embed, and evaluate sensors.
- ➡ **Dublin** will provide input on potential deployment sites, assist in putting up sensors, and give feedback on data analytics tools.

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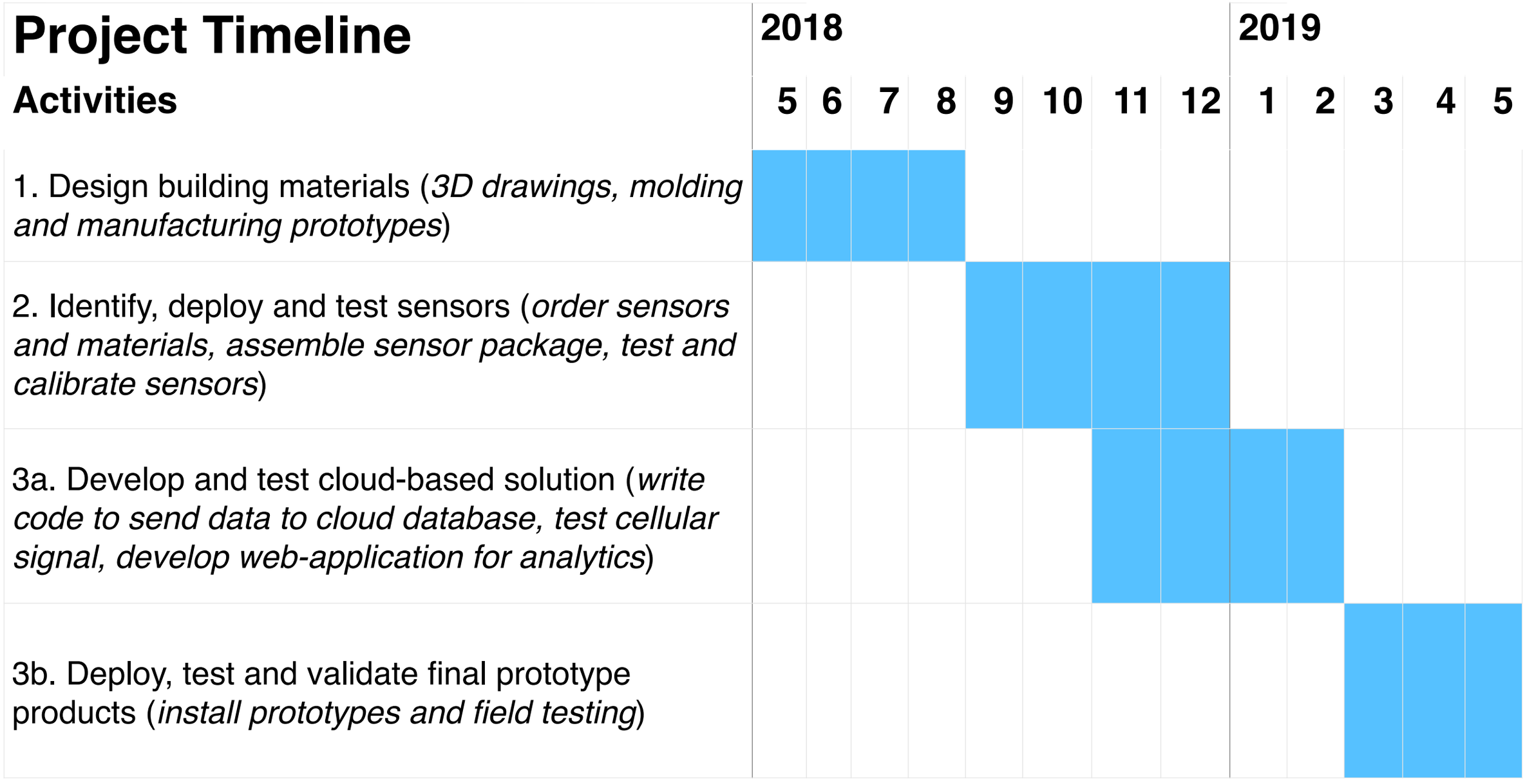
Project II: OSU + AMC + Dublin

Project Timeline



Project II: OSU + AMC + Dublin

Readiness

OSU and manufacturing partner (AMC) met with officials from City of Dublin, Smart Dublin and Dublin City School District on January 25, 2018.

- Dublin officials highly supportive of the project
- Buy-in from city departments (Facilities, Parks and Recreation and Economic Development)
- Dublin City Schools Emerald Campus Academies interested in using project deliverables to demonstrate collaboration between several academies (Business, IT, Biomedical)

Evaluation

Measuring outcomes

- Outcome: Enhance collaboration with AMC.
  - *Measure: Patent application for sensor embedded materials and process facilitated by OSU Technology Commercialization Office.*
- Outcome: Preliminary results for Federal grant applications.
  - *Measure: Number of publications and presentations in peer-reviewed journals/conferences.*

Measuring impacts

- Impact: Academic-community collaboration with City of Dublin in the area of translational environmental health data analytics.
  - *Measure: Number of sensor packages deployed by project end date.*
- Impact: Training opportunities in translational data analytics.
  - *Measure: Development of STEM-related curriculum or curricular activities within Dublin City School District.*

Sustainability

Sensors

- AMC will leverage prototype products and workflows to build demand for environmental health sensors
- Dublin City School District could provide maintenance and deployment of additional sensors as part of a STEM-related curriculum
- OSU researchers plan to apply for Federal grants at EPA, NIH, and NSF to improve sensors and translate sensor-based environmental measurements for improving human health and well-being (e.g., environmental education

Data collection, analysis and visualization

- Cloud-based computing/data storage and web-application for data analytics are pay-per-use products from highly reputable companies (RStudio and Google)

Thank you for listening.
What questions do you have?

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