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CHALLENGES IN URBAN AIR QUALITY DATA VISUALIZATION

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1. INTRODUCTION

Poor air quality (AQ) is one of the most important challenges of increased urbanization. Recent advances in sensing technology have brought low-cost, real-time AQ sensing to cities around the globe [4,9]. Many of these sensors measure fine-particulate matter (PM2.5) — particles with diameters smaller than 2.5 microns — which has the greatest adverse effect on health [1,5,7]. Salt Lake City has a diverse set of PM2.5 sensor networks, including low-cost sensor networks supported by grassroots organizations [6] and government-run networks of high-quality, gold-standard sensors, to measure PM2.5. Currently, the city has no system that unifies all these sensor measurements of diverse sources to provide a comprehensive estimate of PM2.5 levels for its residents [2,8].

2. MEASUREMENT SYSTEM

To meet this challenge, we are developing the AQ&U instrument, a multi-layered tool that collects, unifies and displays PM2.5 measurements from sensors across the city. We collect the data from available sensor networks, while also filling in measurement gaps with our own network of calibrated sensors that are hosted by citizens at their homes. The data from the variety of sensor networks are combined in a modelling layer that generates a continuous estimate of PM2.5 levels across the city, along with measurements of uncertainty. These estimates are visualized in a public-facing web portal to provide real-time information to the public.

3. DESIGN PROCESS

During our formative study, we conducted 6 semi-structured interviews with SLC residents to better understand their motivations to use and assumptions about AQ [3]. These residents were part of a convenience sample but represented a diverse set of people with different socio-economic backgrounds. Based on the results of this study, we built our current prototype to address two use cases: giving sensor hosts access to their AQ measurements and providing us with a testbed to develop our model. When we have gained a better understanding of our model, we will invite multiple sensor holders to participate in a contextual inquiry. We will also include logging to our visualization interface to understand how it is being used.

4. CHALLENGES

In designing the visualization interface, we encountered three challenges that we speculate are general to other environmental sensor endeavours. We are interested in discussing these challenges with other workshop participants.

The first challenge we faced stems from the seasonality of public interest in AQ. Poor AQ occurs mainly in the winter during 1-2 week episodes of meteorological inversions. These weather events trap air in the city and lead to a build-up of PM2.5. During the winter, and particularly during inversions, the public is highly interested in local AQ — but during other times, it is difficult to engage with residents, particularly passively through an instrumented website. This seasonality has non-negligible impacts on us, as researchers, in terms of the timeline to gather data and test the tools, as well as on when to engage the public for ecologically valid formative work.

The second challenge comes from the gulf between what the general public wants to know about AQ and what questions the data can actually answer. When questioning the general public about what they would like to do when gaining access to air quality data during formative work, they responded with a variety of high-level questions. For example, they wanted to understand what they could be doing to improve air quality, such as if buying an electric car would have a beneficial impact on their air quality. Answering these types of questions requires significant analysis of the PM2.5 measurements in combination with simulations, predictions and data from other sources. Simply providing the AQ data is unlikely to meet the public's expectations of what they would like to know, potentially resulting in frustration.

The third challenge involves reconciling the public's mental model for interpreting AQ measurements with the types of measurements our instrument produces. In Salt Lake City, as in many other cities in the US, AQ measurements are communicated based on an EPA classification that associates levels with health impact. For example, green means healthy whereas red means dangerous to health. This classification scheme, however, was not developed for real-time measurements, and thus is not suited for the estimates we produce. It is unclear how to meaningfully, and rigorously, present AQ measurements to the public to support individual decision-making.

5. CONCLUSION

We believe these challenges are likely faced by other visualization design teams working with environmental sensing systems and communication for the public. We are interested in brainstorming with other participants about possible solutions.

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