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ON URBAN AND PLACE-BASED RESEARCH

2021 Fall Research Showcase

Developing Descriptive and Predictive Causal Models to Study the Impacts of Highway Construction on Ambient Air Quality in the Front Range

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Team



CU Denver

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Colorado Department of Transportation

- Stephen Cohn (Co-I), Research Branch Manager



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- Michael Ogletree (CO-I), Air Quality Program Manager
- William Obermann, Air Policy Program Manager



Project purpose and objectives

1. Air pollution is an important determinant of health
[World Health Organization 2013]
2. Traffic and road construction is a significant contributor to air pollution
[Matson 2006, Cowie 2012]
3. There is significant inequality in exposure to air pollution
[World Health Organization 2013]

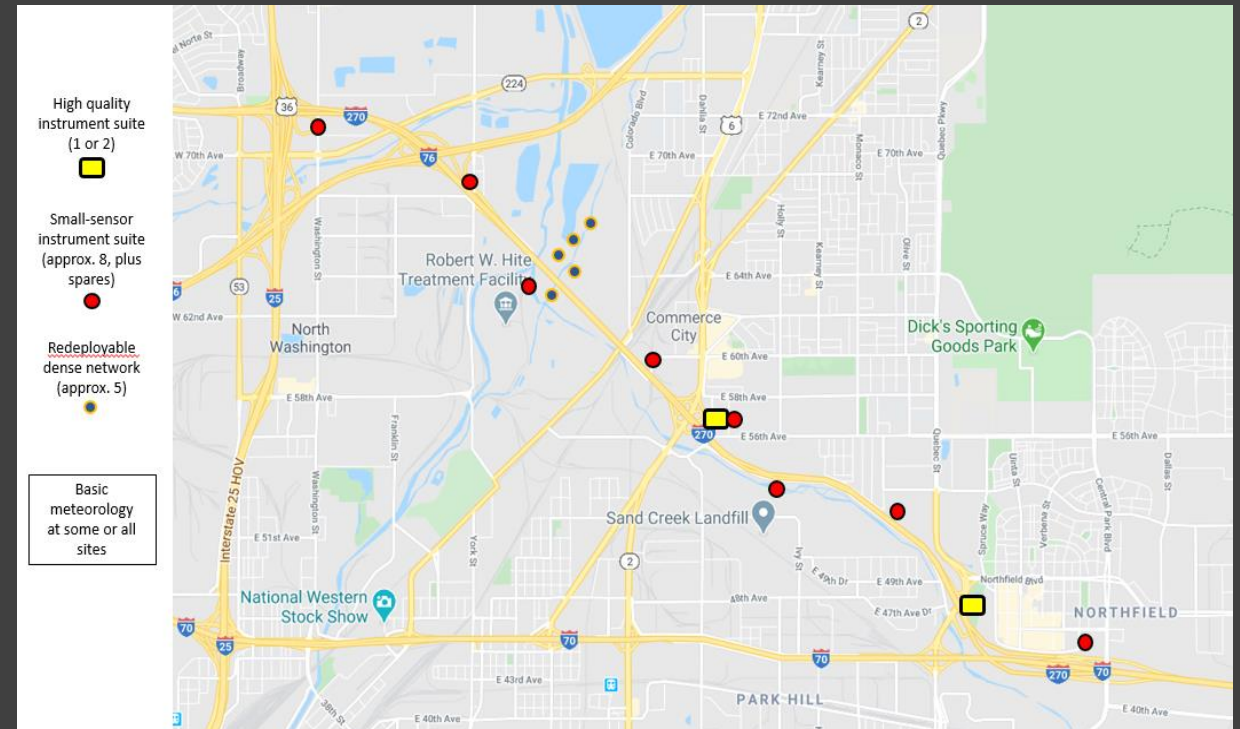


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Project purpose and objectives (cont'd)

- Joint CDOT-DDPHE data collection project along I-70 corridor
 - Sponsored by Federal Highway Administration (FHWA), starting 2017
- In Summer 2021 extended to cover I-270
- CO, BC, O₃, PM_{2.5}, PM₁₀, NO_x, and tVOC (Total Volatile Organic Compounds) per minute data from 15 stations



Project purpose and objectives (cont'd)

1. Fuse and augment the air quality data with publicly available construction event, traffic, and weather datasets
2. Use the fused data to develop descriptive and predictive causal models that can quantify the impact of highway traffic and construction projects on air quality

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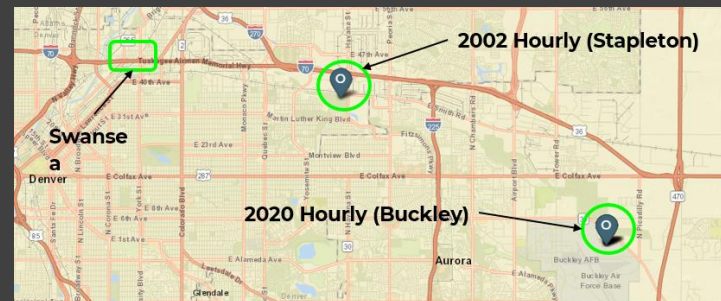
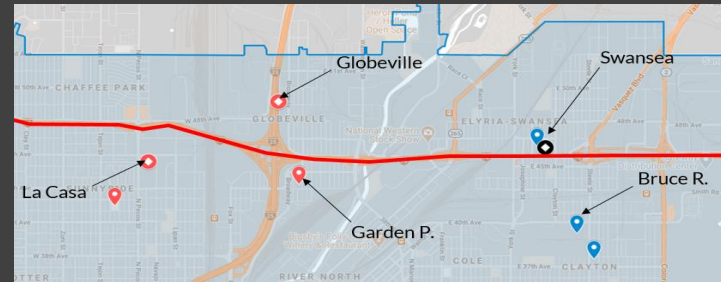
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Methods and activities: Data Fusion (Task #1)

□ Air Quality Data

□ Traffic Data

□ Weather Data



Methods and activities: Model Development (Task #2)

1. Prediction Models (linear regression, elastic net regression, lasso regression, neural network, decision tree, boosted tree, graph neural network)

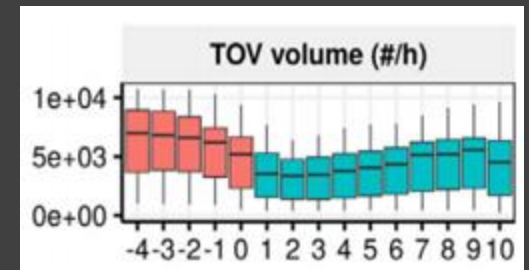
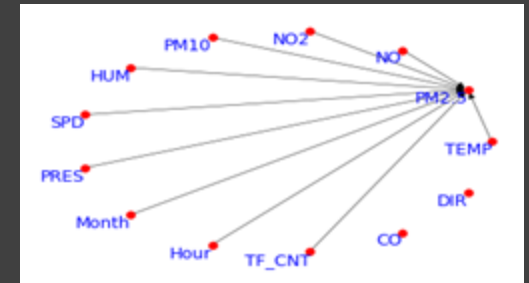
- How does air quality change from before a typical highway improvement project to after?

2. Probabilistic Estimation Models (Bayesian belief network)

- How can we estimate the impacts of better traffic flow with less idling, and the impacts of higher traffic flow due to induced demand (e.g., due to road expansion projects)?

3. Causality Analysis Models (graphical granger network)

- How does air quality change as a function of downwind distance from the activity, height above the ground, or meteorological conditions?



Next steps

External Partnership: Joint Proposal to FHWA

“Using Causal Modeling to Generate Effective Plans for Multi-source, Multi-Modal, and Multi-criteria Sensor Deployments: A Case Study in Air Quality Monitoring to Measure Impact of Highway Construction”

- **Description:**
 - Problem: Effective Multi-source, Multi-Modal, and Multi-criteria Sensor Deployments with application in Air Quality Monitoring to Measure Impact of Highway Construction.
 - Benefits DOT and other agencies that frequently need to monitor air quality impacts of their construction projects
- **Objective(s):** A tool for automated generation of effective sensor deployment plans to enable both accurate and cost-effective assessment of construction impacts on air quality
- **Benefits to DOT:** Given that construction impact on air quality is an emphasis area, this tool allows for automated, efficient and frequent sensor deployment planning for current and future DOT construction projects; hence significant cost and time saving
- **Implementation:** Engineers will be able to utilize the user-friendly tool to automatically generate sensor deployment plans for DOT construction projects

Not Meant for Reading

Next steps (cont'd)

□ University partnerships

- Informatics for Air Quality Monitoring Infrastructure: Prof. Benjamin Crawford (Assistant Professor of Geography & Environmental Sciences, CLAS)
- Robust Smoke and Fire Detection using Citizen Sensors: Prof. Jan Mandel (Professor of Mathematics, CLAS)