Estimating $PM_{2.5}$ and Ozone-Related Health Impacts at the Urban Scale

Applying local emissions, air quality and health data to generate better estimates of air pollution health impacts

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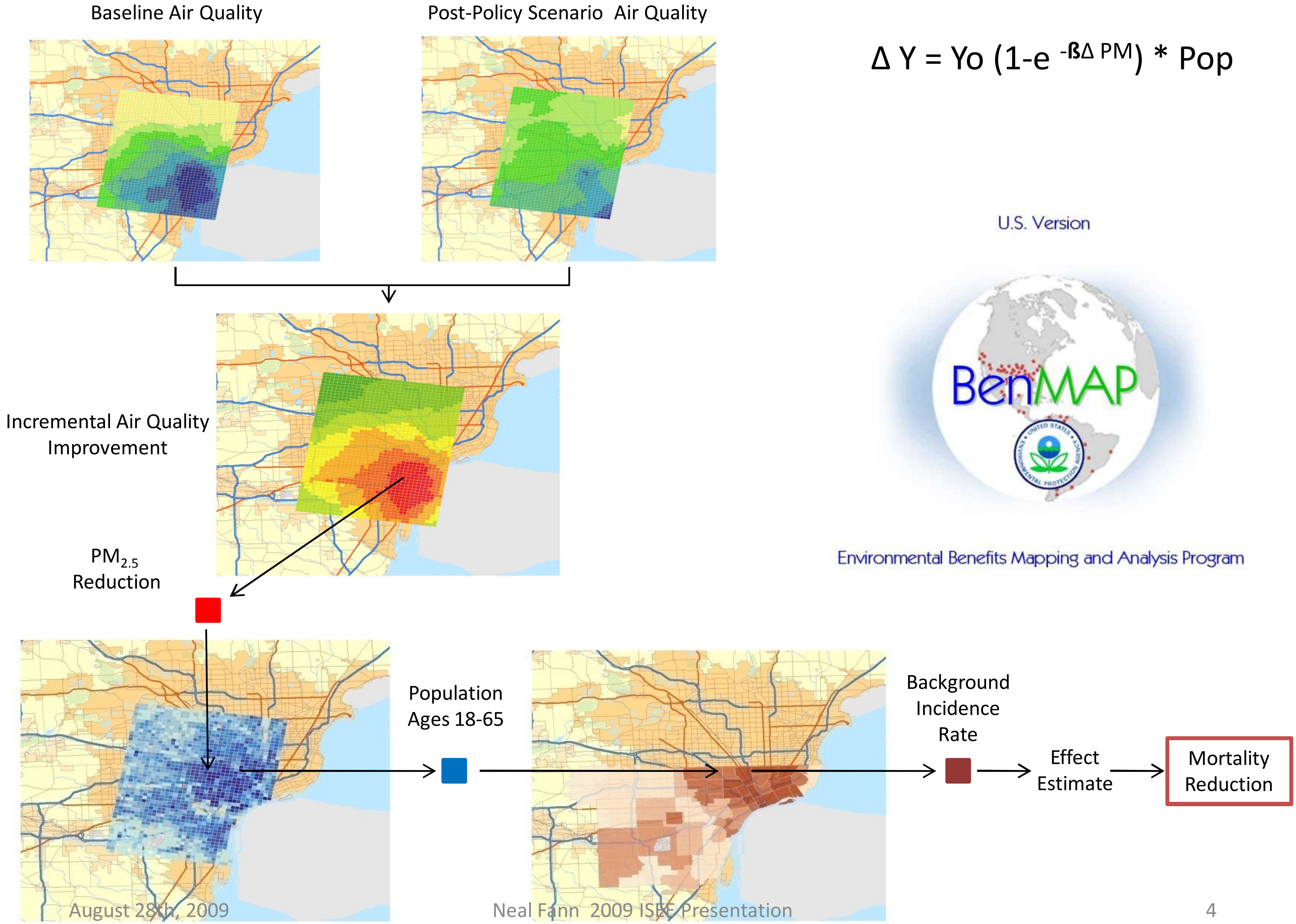
Overview

- Analytical objectives
- Methods
- Results
- Directions for future research
- Questions

Analytical objectives

- Estimate multi-pollutant air-pollution related health impacts at the urban scale, using Detroit as an example
- Understand how local-scale health impacts estimates are influenced by:
  - Resolution of exposure estimates
  - Scale of baseline incidence rates
  - Geographic specificity of health impact functions

$$\Delta Y = Yo\,(1-e^{-\beta \Delta PM}) * Pop$$

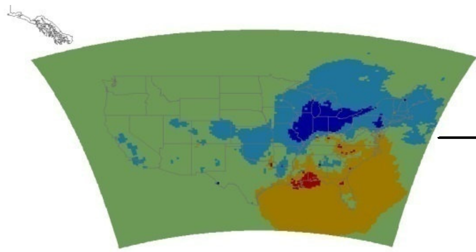


U.S. Version

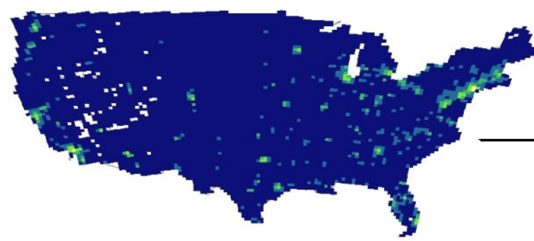
BenMAP

Environmental Benefits Mapping and Analysis Program

National-Scale Modeling Calls for Coarse-Scale Health Inputs

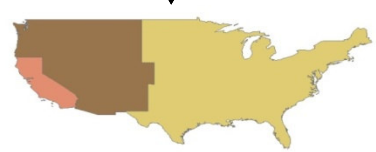


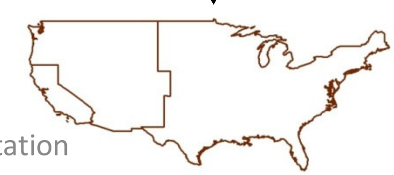
Coarse-scale air quality modeling



Coarse-scale population exposure

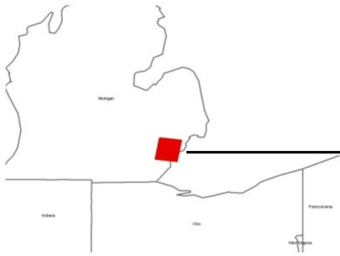
Regional or national-scale
Baseline incidence and **ß** estimate



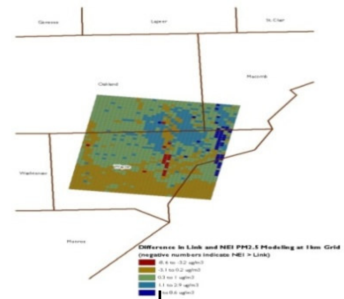


Regional or national Incidence count

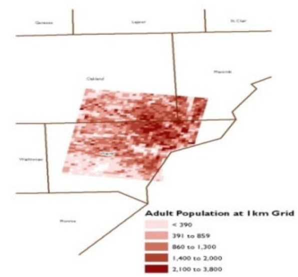
Local-Scale Modeling Calls for Location-Specific Health Inputs



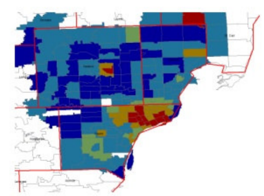
Fine-scale air quality modeling



Fine-scale population exposure



City-specific
baseline incidence and **ß** estimate

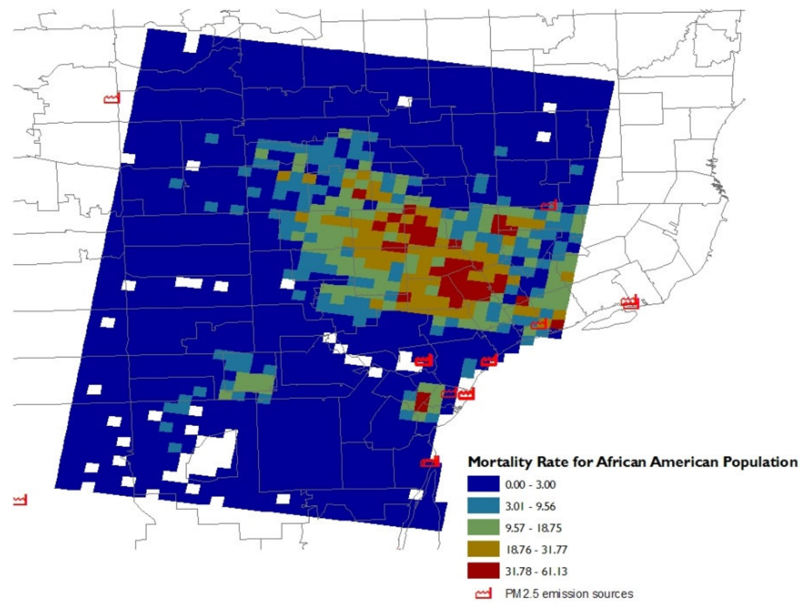


Local Incidence count

Specifying the Air Quality Strategies

- Two example air quality strategies for the Detroit metropolitan area:
  - One that aimed to achieve ozone and $PM_{2.5}$ air quality targets
  - One informed by expected health impacts of emission controls

Distribution of baseline mortality rates and location of major $PM_{2.5}$ point source facilities



Air Quality Strategies

Strategy 1

Pollutant	Emission Reductions (tons/year)	Percentage from Baseline
$PM_{2.5}$	1,800	6%
SO_2	10,000	5%
VOC	5,800	6%
NOx	31	0.03%
CO	1,600	0.4%

Strategy 2

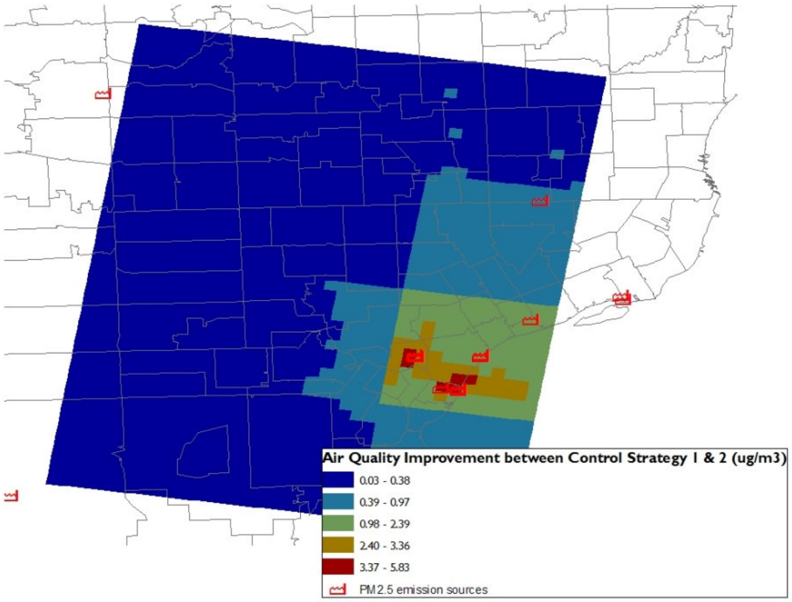
Pollutant	Emission Reductions (tons/year)	Percentage from Baseline*
$PM_{2.5}$	3,200	**10%**
SO_2	2,400	*1%*
VOC	8,600	**8%**
NOx	2,000	**2%**
CO	64,000	**15%**

*__Bold__ indicates an increase in emission reductions compared to strategy 1
Italics indicate a decrease in emission reductions compared to strategy 1

Air Quality Results

- Control strategy two yields significantly larger air quality improvements
- Air quality improvements occur in highly populated areas

Incremental Change in Annual Mean $PM_{2.5}$ Levels between Control Strategy 1 and 2



Population-weighted AQ changes

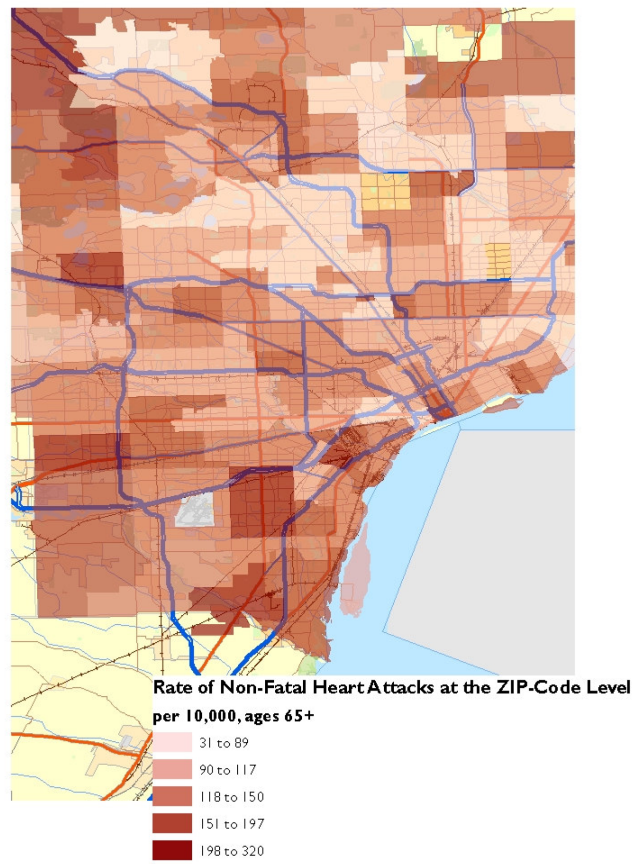
	Strategy 1			Strategy 2		
	12km resolution	1km resolution	% Difference	12km resolution	1km resolution	% Difference
Total Population	0.249	0.271	8%	0.706	0.721	2%
Black Non-Hispanic	0.249	0.258	3%	0.802	0.803	<1%
Asian Non-Hispanic	0.254	0.282	10%	0.626	0.652	4%
White Non-Hispanic	0.249	0.278	10%	0.613	0.658	7%

Strategy two achieves a **2.7**x larger population-weighted air quality change across the total population

Incorporating Local Health Data

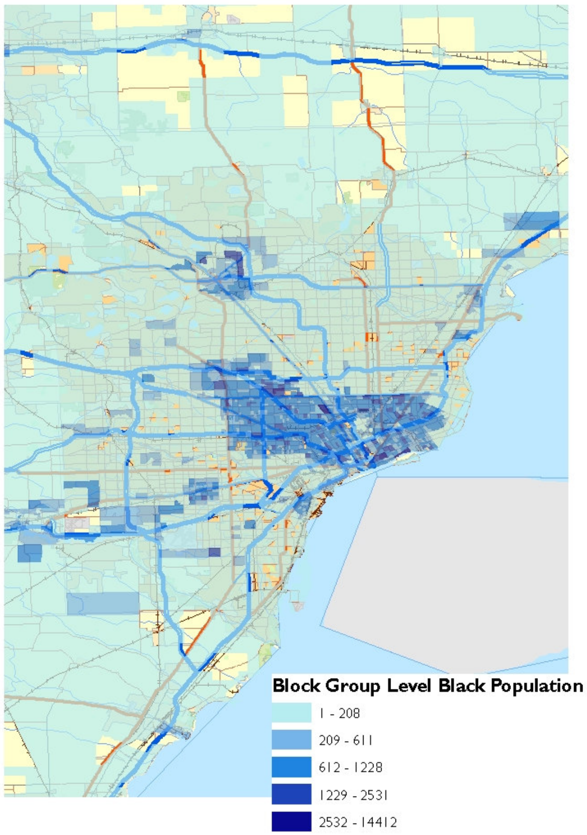
Area	Age Range	Value (per 10,000)
Nationwide*	0-17	0.03
	18-64	17.8
	65+	149
Detroit*	0-17	No reported cases
	18-64	0 to 36
	65+	31 to 320

*Nationwide rates represent defaults used for national-scale analyses, drawn from National Hospital Discharge Survey. Detroit estimates provided by Wayne County Dept. of Environmental Quality.

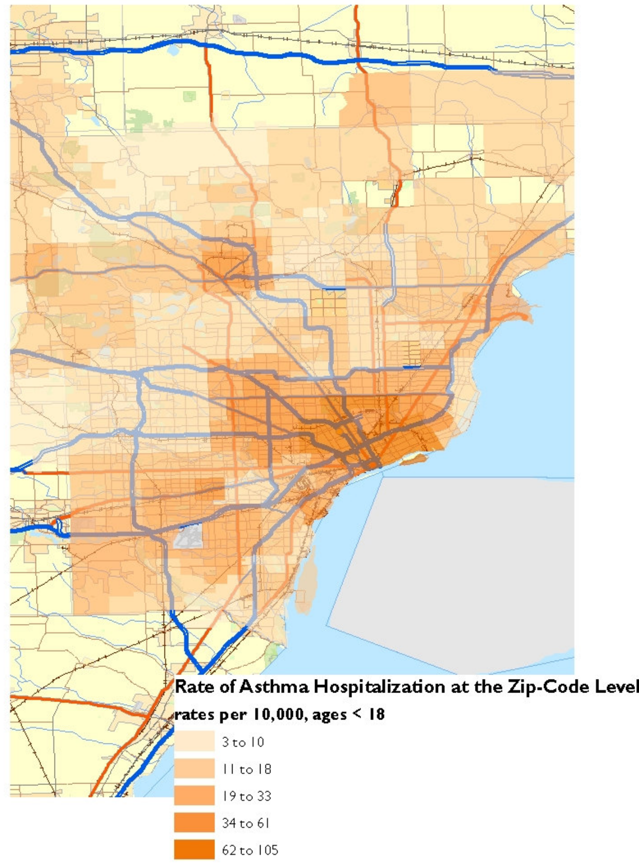


Certain Incidence Rates are Highly Correlated with Subpopulations

African-American Population

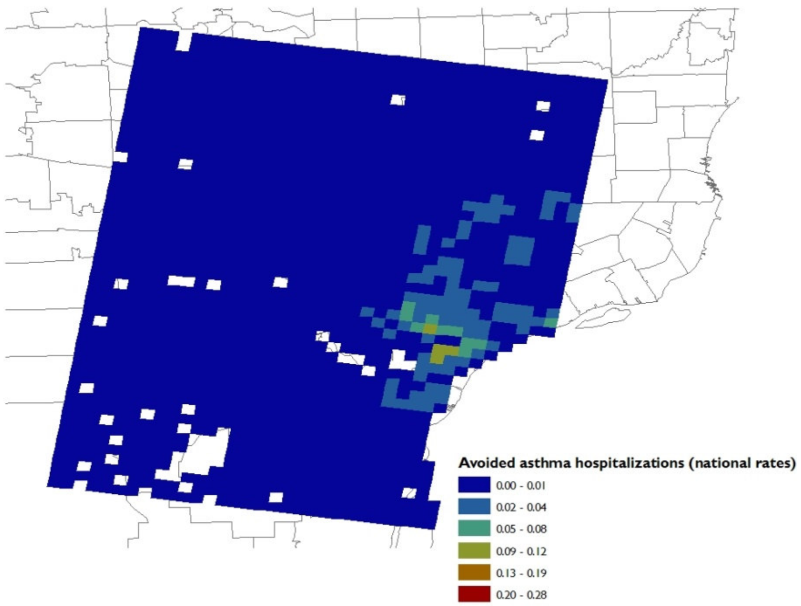


Asthma Hospitalization Rate

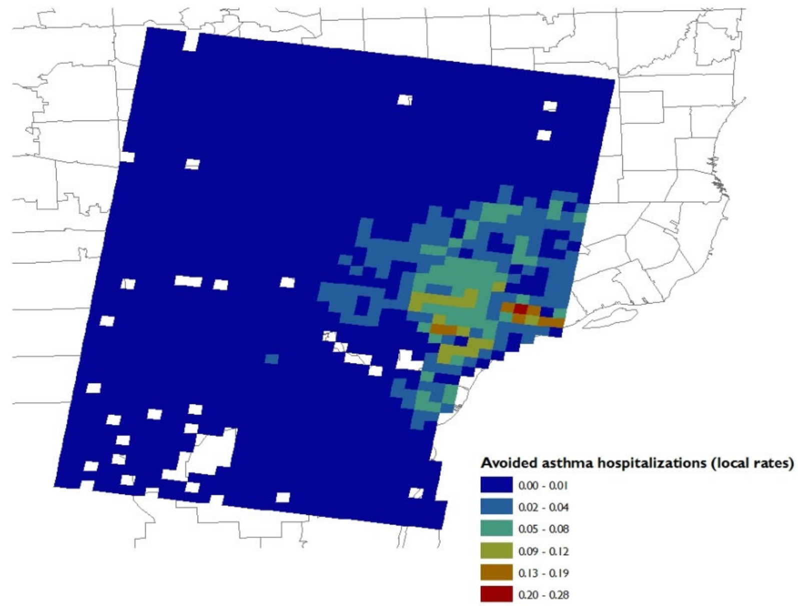


Distribution of Health Impacts

Asthma hospitalizations (national incidence rates)

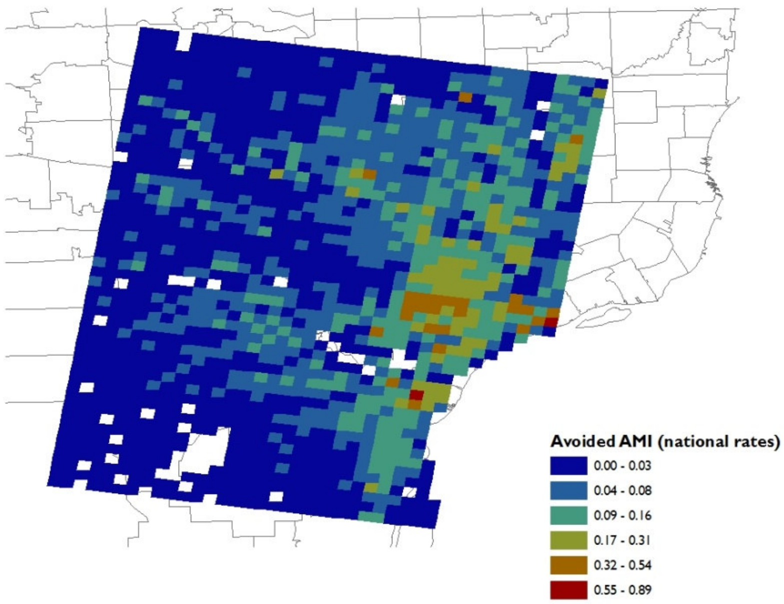


Asthma hospitalizations (local incidence rates)

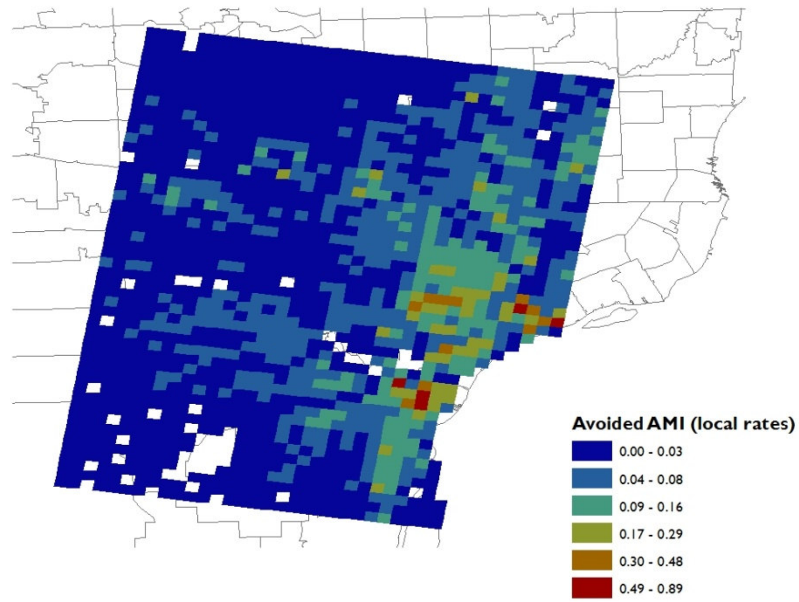


Distribution of Health Impacts

Acute myocardial infarctions among populations >65 (national rates)



Acute myocardial infarctions among populations >65 (local rates)



Directions for Future Research

- Develop new approaches for:
  - interpolating baseline incidence rates
  - using baseline health information to inform emission control strategy development
- Systematically assess the bias introduced by using coarse-scale baseline incidence rates
- Consider distributional impacts across sensitive subpopulations