

Health Impacts and Inequality Associated with Air Pollution in Detroit



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**Community Action to Promote Healthy Environments:
Community Academic Partnership to Improve Air
Quality in Detroit**

Public Health Action Plan

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The "Top Ten" CAPHE Public Health Action Plan Strategies

1. **Point source controls** – control and reduce emissions at industrial facilities
2. **Renewable energy** – replace fossil fuels with non-polluting solar and wind energy
3. **Diesel engine retrofits** – fix or replace older and polluting diesel engines in buses and other equipment
4. **Idling controls** – idling engines waste fuel & money and causes emissions
5. **Clean fuels** -- replace fossil fuels with cleaner fuels like biodiesel
6. **Transit and transportation control measures** – improve mobility to reduce congestion and emissions
7. **Indoor air filters** – install filters in buildings to effectively reduce PM_{2.5} levels
8. **Buffers and barriers** –separate schools, residences and other places from highways and industry
9. **Enhanced compliance and enforcement of air quality rules** – enforce stricter laws to reform polluters, use of health impact assessments to focus on protection of public health
10. **Enhanced ambient monitoring** – document pollution problems to raise awareness and identify solutions

Air Quality in Detroit

Historically, Detroit has faced challenges with air quality

Multiple pollutant sources

Currently out of compliance with SO₂ standard

Likely out of compliance with O₃ standard

Large exposed population

Adverse health outcomes associated with air pollutants

Vulnerable communities

Opportunity to improve air quality and reduce health inequities



Source: www.acmpm.com



DTE Monroe

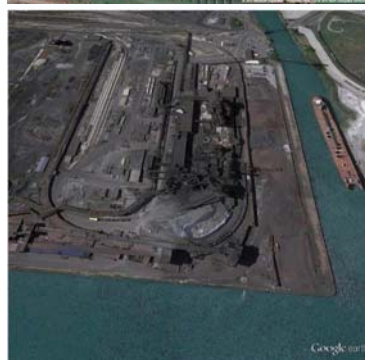


DTE River Rouge

DTE Trenton Channel



US Steel



Vulnerable populations in Detroit

Heavy health burden of ambient air pollution:
7.3 % of annual deaths in Wayne County due to criteria pollutants and air toxics

Susceptibility

- High rates of obesity, diabetes, smoking
- Asthma prevalence among children: 11.3%
 - Hospitalizations and deaths 2x and 3x the state rates

Vulnerability

- 39% of Detroit residents live below the poverty line
- Largely minority population
 - 85% Black
 - 7% Hispanic or Latino
- Multiple point, area and mobile sources

Sources: DeGuire et al. 2016; Fann et al. (2015); MDHHS (2015) MDEQ (2015); SEMCOG (2013); US Census Bureau (2015)

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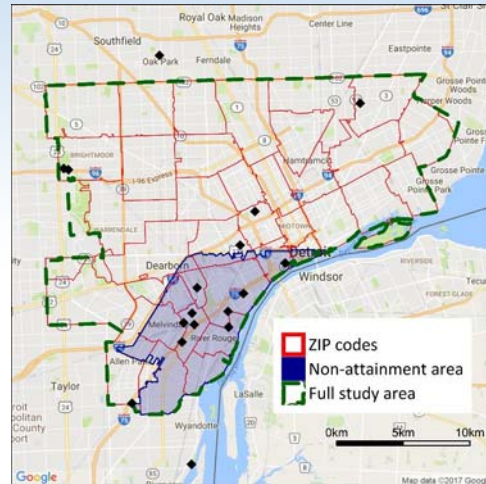
Mobile Sources



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Study area and non-attainment

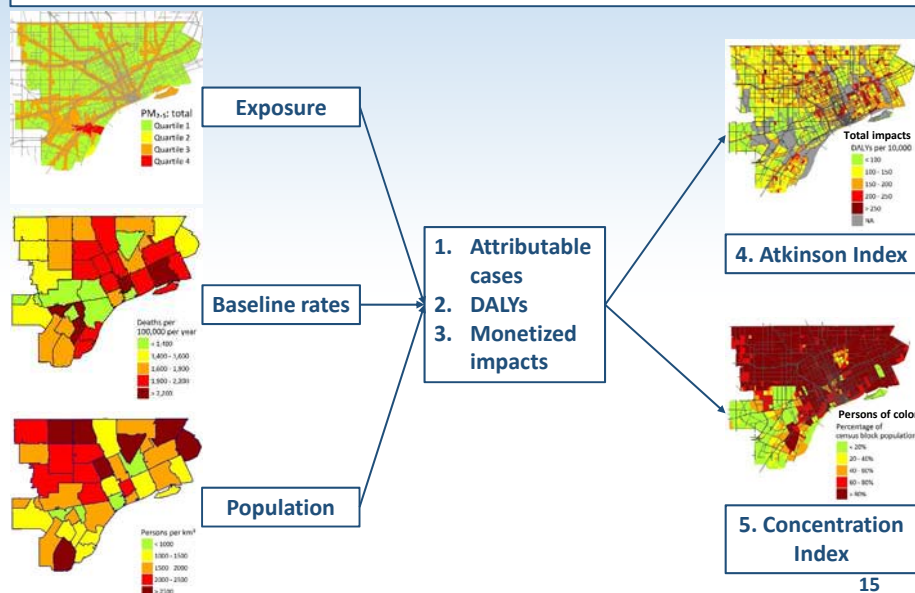
- 945,000 residents in Detroit and surrounding cities
- Many point sources and highly-trafficked roads
- SO₂ non-attainment
- Likely O₃ non-attainment
- High degree of susceptibility and vulnerability:
 - 92% non-white population
 - 40.5% of Detroit residents in poverty
 - Higher prevalence of asthma and rates of asthma-related mortality and morbidity



DeGuire et al. (2016); MDEQ (2016); US Census Bureau (2015)

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Quantitative health impact assessment (HIA)



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Annual Health Impacts in Detroit from Air Pollutants

Health impacts attributable to criteria pollutant exposures

Outcome (age group)	Annual incidence	Total (%)	Regional	Point	Mobile	Area
Mortality (cases)						
All-cause (>29)	9,400	520 (5.5)	4			
Non-accidental (>29)	8,800	140 (1.5)				
Infant (<1)	200	6 (4.0)				
Hospitalizations (cases)						
Asthma (<65)	3,200	210 (6.7)	1			
COPD (>65)	1,900	419 (22.4)	3			
CVD (>65)	9,800	160 (1.6)	1			
Pneumonia (>65)	1,500	250 (17.3)	2			
Non-fatal MI (>17)	2,600	60 (2.3)				
Asthma outcomes (cases)						
Asthma ED visit (<18)	9,000	3,300 (36.7)	2			
Day w/ cough (6 – 14)	1,700,000	210,000 (12.5)				
Day w/ wheeze (6 – 14)	1,100,000	17,000 (1.6)	13			
Day w/ SoB (6 – 14)	1,000,000	21,000 (2.1)	17			
Two or more symptoms (6 – 14)	2,000,000	180,000 (8.6)	110,000	12,000	43,000	9,000
Restricted days						
MRAD (18 – 64)	4,600,000	760,000 (16.7)	700,000	16,000	18,000	18,000
WLD (18 – 64)	1,300,000	59,000 (4.7)	47			
MSD (6 – 14)	2,700,000	570,000 (21.3)	57			
Total DALYs (years)		10,000				
Monetized impact (\$million)		6,600	5			

7% of mortalities attributable to PM_{2.5} and O₃

Previous estimate: 7.3-9.8% (Fann et al. 2012)

Large asthma burden among children

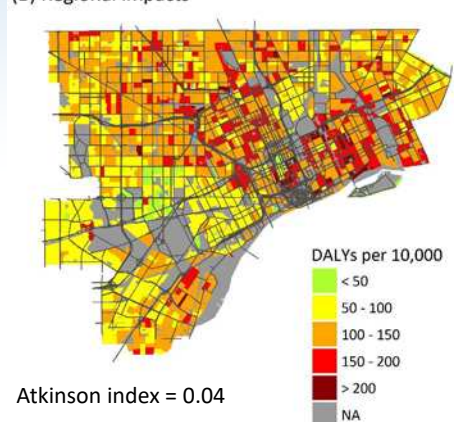
10,000 DALYs per year
\$6.6 billion per year

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Regional Sources (mostly PM)

- Health burdens from regional sources are high at 8,100 DALYs yr⁻¹)
- Inequality metrics for regional sources are low

(B) Regional impacts

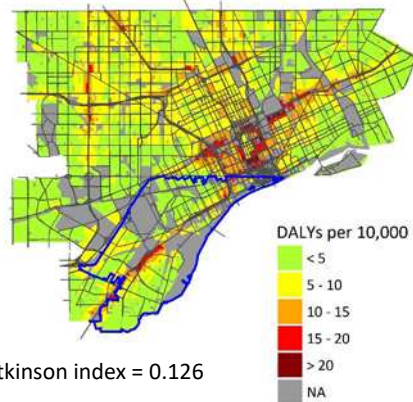


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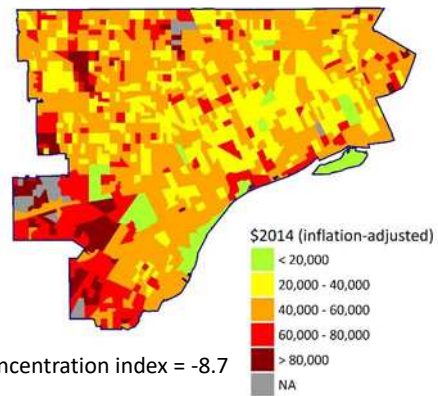
Mobile Sources

- Impacts from mobile sources are 560 DALYs yr⁻¹
- Inequality metrics for mobile sources are high

(C) Mobile source PM_{2.5} impacts



Median household income

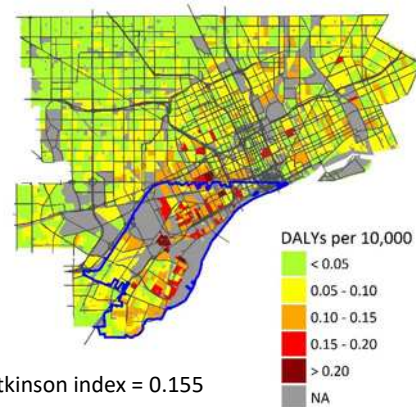


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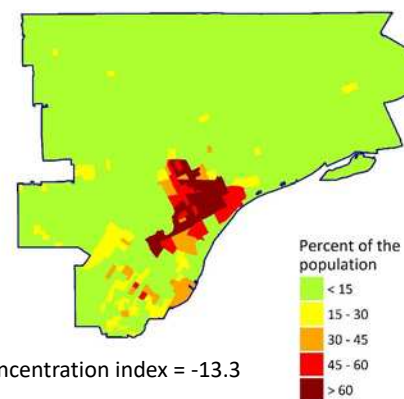
Point Sources

- Impacts from point sources are 470 DALYs yr⁻¹
- Inequality metrics for point sources are high

(D) Point source SO₂ impacts



Hispanic or Latino populations



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Summary of Burden of Disease

1. Criteria pollutants continue to have a substantial public health impact in the Detroit area
 - 7% of mortalities due to PM_{2.5} and O₃ exposures
 - 2-36% of asthma outcomes due to PM_{2.5}, NO₂, and O₃
2. Attributable burdens are largest for regional PM_{2.5} and O₃
3. Inequalities are largest for point and mobile sources of PM_{2.5}, NO₂, and SO₂
4. Low income and Hispanic or Latino population disproportionately impacted
5. Inequality metrics are sensitive to study boundary and spatial resolution
 - AI values decrease when using larger spatial units
 - CI indicates different groups are impacted when study boundaries change

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Health & Inequity Implications of Pollution Controls

What are the health and inequity implications of point source control strategies?

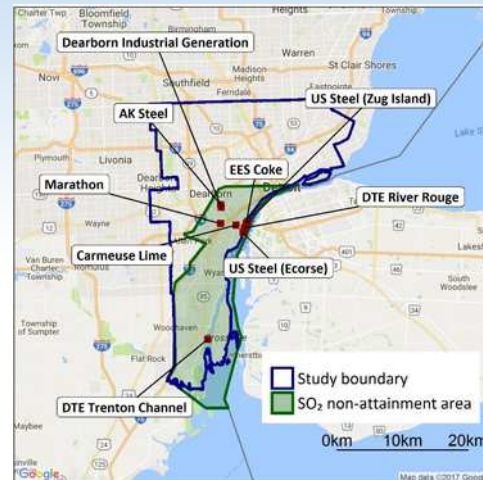


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SO₂ in Detroit

- SO₂ from point sources shown to have disproportionate impacts (Aim 2)
- 1.1 million residents in study area
- 9 culpable facilities
 - 39,000 tons SO₂ per year
 - Each emits more than 1 ton per year of SO₂
 - None has SO₂ add-on control technologies
- MDEQ developed a State Implementation Plan (SIP):
 - Reduced emissions at DTE River Rouge, DTE Trenton Channel, US Steel
 - Taller stack at Carmeuse Lime



DeGuire et al. (2016); MDEQ (2016); US Census Bureau (2015)

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How to prioritize controls?

- Ranking of sources depends on metric
- Smaller sources near populations have large impacts per ton
- Results are similar to national studies of health impacts from point, mobile, and area sources (Fann et al. 2009; Levy et al. 2007)

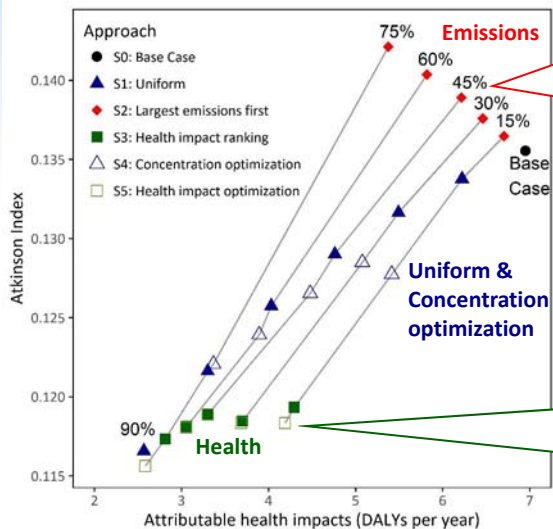
Emissions and health impacts for point sources of SO₂

Facility	Average Emissions		Attributable DALYs		Health impacts per 100 tons SO ₂ per year	
	(tons/year) (% of total)	Rank	(DALYs/year) (% of total)	Rank	(DALYs/ 100 tons-year)	Rank
Carmeuse Lime	640 (0.7)	8	0.40 (5.7)	7	0.062	1
Dearborn Industrial Generation	768 (0.8)	6	0.43 (6.2)	6	0.056	2
Severstal/AK Steel	733 (0.8)	7	0.38 (5.5)	8	0.052	3
Marathon Petroleum	268 (0.3)	9	0.13 (1.8)	9	0.047	4
US Steel Great Lakes Works	2,885 (3.1)	4	1.32 (18.9)	2	0.046	5
EES Coke	2,049 (2.2)	5	0.55 (7.9)	5	0.027	6
DTE River Rouge	10,442 (11.1)	3	0.80 (11.5)	4	0.008	7
DTE Trenton Channel	20,824 (22.2)	2	0.89 (12.7)	3	0.004	8
DTE Monroe	47,409 (50.6)	1	1.33 (19.1)	1	0.003	9
Minor point sources (n=125)	7713 (8.2)	NR	0.75 (10.7)	NR	0.010	NR
All point sources	93,731 (100)	NR	6.95 (100)	NR	0.007	NR

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Aim 3A: Results

Health and inequality tradeoffs



Disproportionate impacts **increase** for:

- Hispanic/Latino populations
- Populations with low educational attainment
- Low income populations

Disproportionate impacts **decrease** for:

- Hispanic/Latino populations
- Populations with low educational attainment
- Low income populations

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Conclusions & Policy Implications

Quantitative health impact (HIA) and inequality assessments go beyond NAAQS compliance.

Provide information that may be useful in setting local AQM priorities

Can help to develop or evaluate AQM strategies that avoid missed opportunities ("fair treatment")



Detroit. Photo by Lbeck1945 [Public domain], via Wikimedia Commons

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Recent Detroit-based Publications

1. Chad Milando, Lei Huang, Stuart Batterman, "Trends in PM_{2.5} emissions, concentrations and apportionments in Detroit and Chicago," *Atmos Environ* , 129, 197-209, 2016.
2. Martenies, S.E., Wilkins, D., Batterman, S.A., 2015. Health impact metrics for air pollution management strategies. *Environ Int* 85, 84–95.
3. Martenies, S.E., Williams, G.O., Batterman, S.A., 2017. Disease and health inequalities attributable to air pollutant exposure in Detroit, Michigan. *Int J Env Res Pub Health*, 14, 1283.
4. Martenies, S.E., Milando, C.W., Batterman, S.A., 2016. Air pollutant strategies to reduce adverse health impacts and health inequalities: a quantitative assessment for Detroit, Michigan. *Under review*
5. Martenies, S. E., Batterman, S.A., Asthma-related health benefits of efficient filters in schools and homes. *submitted*
6. Milando, C., S. Martenies, S. Batterman, "Assessing Concentrations and Health Impacts of Air Quality Management Strategies: Framework for Rapid Emissions Scenario and Health impact ESTimation (FRESH-EST)," *Environment International*, 94, 473-81, 2015..
7. Vesper, Stephen, Thomas Robins, Toby Lewis, Kevin Dombkowski, Larry Wymer, Rebeca Villegas, Stuart Batterman, "Use of Medicaid and housing data may help target areas of high asthma prevalence," *Journal of Asthma*, DOI:10.1080/02770903.2016.1212370.
8. Owais Gilani, Veronica J. Berrocal, Stuart Batterman, "Non-stationary spatio-temporal modeling of traffic-related pollutants in near-road environments," *Spatial and Spatio-temporal Epidemiology*, Feb., 2016.