

# Cumulative Risk: What is it and why does it matter?

AMY SCHULZ, PHD

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**Figure 5-1.** Aerial photo of the Trenton Channel power plant, which can burn coal, natural gas, fuel oil and residual paint solids, is an example of a major point source in southwest Detroit. Each stack is over 560 feet tall. Photo from Google Maps.





# Cumulative Exposure Assessment

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Total exposure to a substance over a lifetime

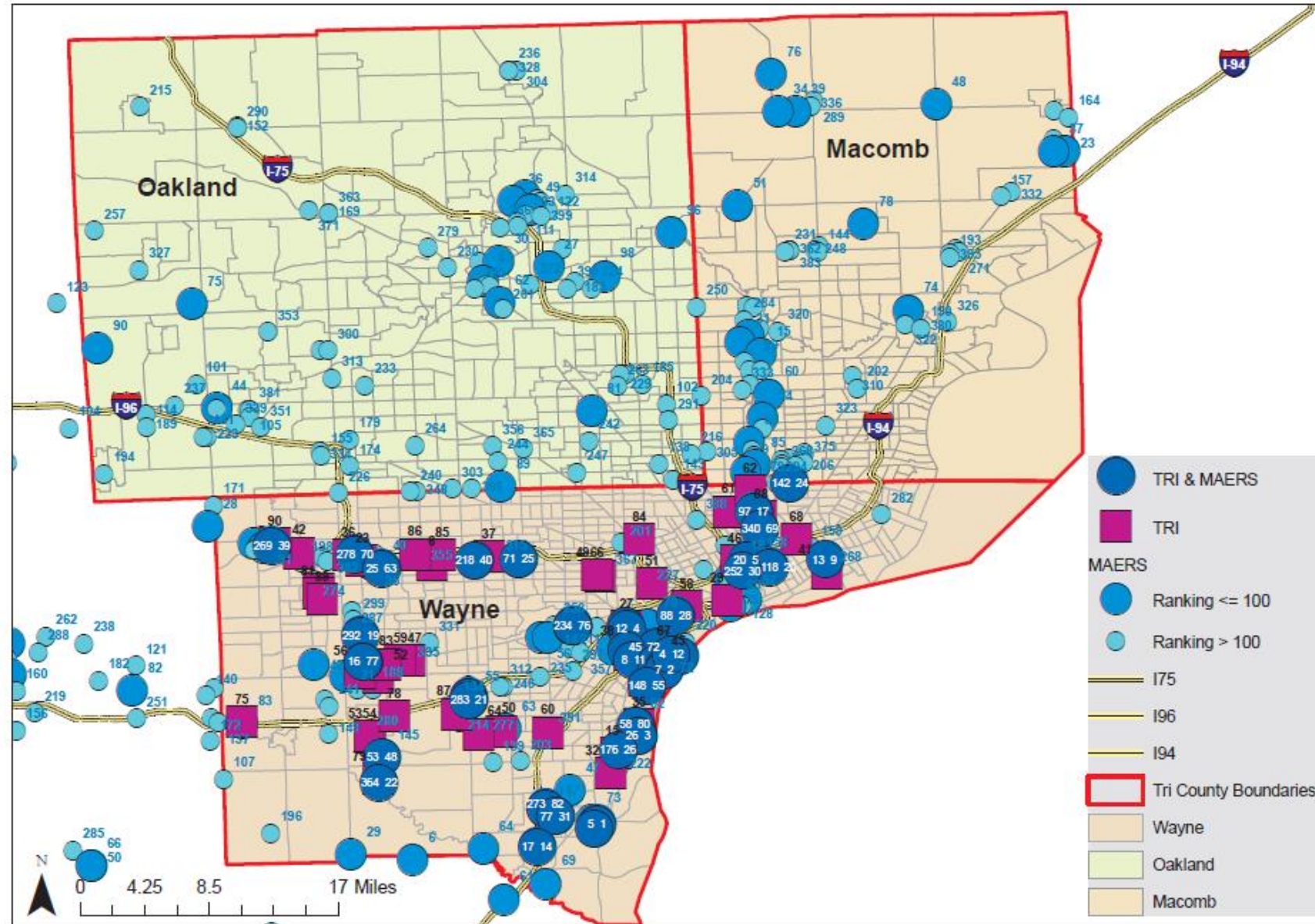
Depends on *concentration* and duration of *exposure*

Traditionally, estimated for a single pollutant

**Table 5-2. Summary of number of facilities by county listing emissions in the 2010-2014 period in MAERS.**

Type	County	NOx	SO2	PM2.5	PM10	VOC	CO
Number of Facilities Reporting Emissions Over 1 tons/yr							
	Wayne	88	24	38	70	109	83
	Washtenaw	26	4	7	12	20	23
	Oakland	56	12	16	32	61	46
	Monroe	14	4	5	19	8	13
	Macomb	43	5	13	29	60	38
	Livingston	8	0	1	4	11	5
	Lenawee	9	3	2	9	10	10
	Total	244	52	82	175	279	218
Number of Facilities Reporting Any Emissions							
	Wayne	125	125	115	143	157	117
	Washtenaw	28	28	28	29	31	28
	Oakland	68	70	66	84	101	63
	Monroe	16	16	14	21	16	15
	Macomb	51	49	49	58	67	49
	Livingston	8	9	8	13	14	8
	Lenawee	13	13	10	16	16	11
	Total	309	310	290	364	402	291

# Air Pollutant Point Sources in the Detroit Tri-County Area

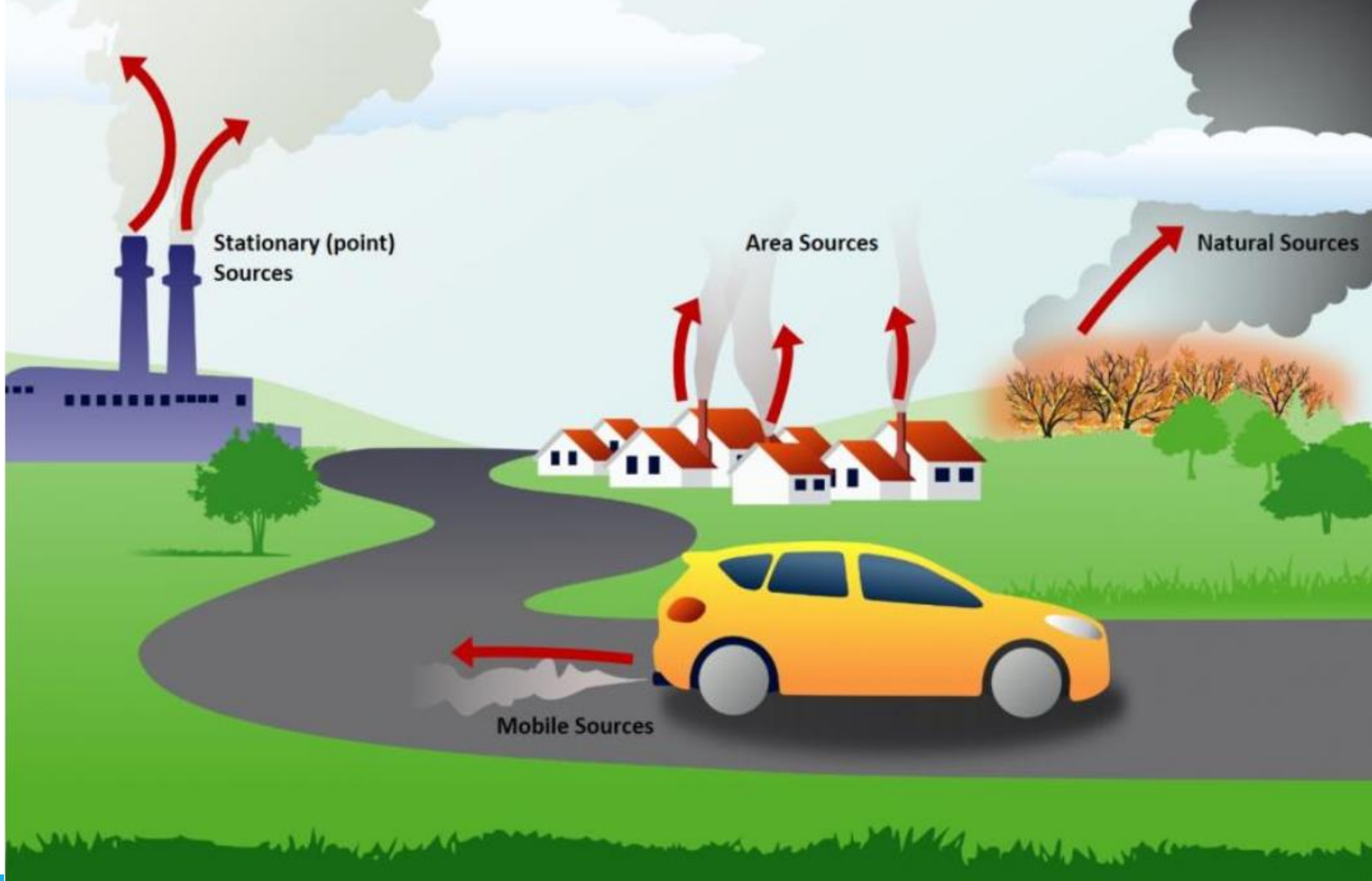


NOTE: TRI & MAERS Source Rank: First number indicate MAERS rank, second number indicate TRI rank.

Rank	Facility	Acids	VOC	Metals and Metal Compounds	Nitrogen Compounds	Sulfur Compounds	Other
8	EES Coke Battery LLC	41754	16500	24	14246	15740	0
11	Marathon	9759	12763	101	15484	7513	21
28	Magni Industries	0	1994	719	0	0	0
38	Air Products & Chemicals INC/Detroit Hydrogen	0	55	0	3078	0	0
57	EDW C Levy Co Plant	0	0	109	0	0	0
58	Inland waters pollution control Detroit facilities	0	89	0	0	0	0
67	Superior materials 32	0	56	0	0	0	0
72	St. Mary's cement	0	0	17	0	0	0

**Table 6-3:** Emissions of toxics pollutants (pounds/year) by facility in Southwest Detroit by pollutant type. Average 2010-2014. In approximate rank by total TRI emissions. Excerpted from **Table 5-6**.





# Conceptualizing Risk

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APPENDIX F: Health Effects for the six criteria pollutants (ozone, lead, nitrogen oxide, particulate matter, carbon monoxide, sulfur dioxide), and diesel. Drawn from the EPA's Integrated Science Assessments.<sup>162</sup>

	Ozone	Lead	NO <sub>x</sub>	PM <sub>2.5</sub>	CO	SO <sub>2</sub>	Diesel
<b>Respiratory Effects</b>							
Lung diseases (COPD, chronic bronchitis, emphysema, and/or cancer)	X		X			X	X
Asthma incidences, attacks, hospitalizations, and aggravations	X			X			X
Aggravation of bronchitis	X						X
Impaired lung growth				X			X
Decreased lung function			X	X			
Difficulty breathing	X			X	X	X	
Lung irritation (airway hyper responsiveness and inflammation)			X	X		X	X
Lung related emergency visits	X		X				
Irritation of the nose and throat; coughing	X			X		X	X
<b>Cardiovascular Effects</b>							
Coronary heart disease		X					
Heart attacks				X			X
Hypertension or increases in blood pressure		X		X			X
Reduce oxygen carrying capacity of the blood		X			X		
Aggravation of existing heart disease					X	X	
<b>Reproductive Effects</b>							

# Cumulative exposure vs Cumulative risk

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**Cumulative exposure:** Total exposure to a substance over time (e.g., over a lifetime)

**Intensity:** Concentration or density.

**Duration:** How long the exposure lasted

**Cumulative risk:** Probability that an exposure (or multiple exposures over time) will result in an adverse (health) outcome

TRACTID10	PM2.5 concentration	Percent households below the poverty line	Number of TRI or hazardous land uses	Percent of population age 65 and older	Percent of population age 5 and under
26099228100	9.98	8%	2	13.1%	5.8%
26099230800	10.12	15%	1	8.8%	6.0%
26099247500	9.98	20%	1	15.9%	3.8%
26099251100	10.16	4%	0	21.3%	3.5%
26099260400	10.28	4%	0	25.3%	5.6%
26099262100	10.37	32%	2	5.6%	13.2%
26099264000	10.44	34%	4	7.8%	7.9%
26125128300	9.46	6%	0	10.2%	4.6%
26125132500	9.51	16%	1	12.4%	6.2%
26125142100	9.76	36%	1	11.6%	4.5%
26125144800	9.62	21%	0	10.3%	9.6%
26125150200	9.88	3%	0	25.9%	2.0%
26125152000	9.98	2%	1	27.4%	3.7%



Rank Order	Quintile	PM2.5	Tract number (Cx)
1	1	9.46	26125128300
2	1	9.51	26125132500
3	1	9.62	26125144800
4	1	9.76	26125142100
5	1	9.77	26125154000
6	1	9.87	26125194500
7	2	9.88	26125150200
8	2	9.98	26125152000
9	2	9.98	26099247500
10	2	9.98	26099228100
11	2	10.06	26125196700
12	2	10.12	26099230800
13	3	10.14	26125160900
14	3	10.16	26099251100
15	3	10.21	26163563300
16	3	10.25	26125180300
17	3	10.27	26125198100
18	3	10.28	26099260400
19	4	10.29	26163558300
20	4	10.34	26163500100
21	4	10.35	26163593300
22	4	10.36	26125184100
23	4	10.37	26099262100
24	4	10.44	26099264000
25	5	10.48	26163505100
26	5	10.59	26163985100
27	5	10.61	26163516500
28	5	10.67	26163578600
29	5	10.67	26163521800
30	5	10.69	26163574202

Rank Order	Quintile	Percent below poverty	Tract number (Cx)
1	1	0.81	26125196700
2	1	2.15	26125152000
3	1	2.60	26125150200
4	1	4.12	26099251100
5	1	4.41	26099260400
6	1	5.26	26125154000
7	2	5.62	26163558300
8	2	6.16	26163593300
9	2	6.46	26125128300
10	2	7.46	26163574202
11	2	7.66	26163563300
12	2	8.14	26099228100
13	3	8.75	26125194500
14	3	8.97	26125184100
15	3	9.27	26125180300
16	3	14.88	26099230800
17	3	16.33	26125132500
18	3	18.94	26125160900
19	4	19.00	26125198100
20	4	20.31	26099247500
21	4	20.98	26163578600
22	4	21.05	26125144800
23	4	25.04	26163516500
24	4	31.85	26099262100
25	5	33.52	26099264000
26	5	34.84	26163500100
27	5	35.91	26125142100
28	5	39.68	26163505100
29	5	44.59	26163985100
30	5	48.05	26163521800

Rank Order	Quintile	TRI or hazardous waste facility	Tract number (Cx)
1	1	0	26125196700
2	1	0	26125150200
3	1	0	26099251100
4	1	0	26099260400
5	1	0	26125128300
6	1	0	26125180300
7	2	0	26125144800
8	2	0	26163500100
9	2	1	26125152000
10	2	1	26125154000
11	2	1	26163593300
12	2	1	26125184100
13	3	1	26099230800
14	3	1	26125132500
15	3	1	26125160900
16	3	1	26099247500
17	3	1	26125142100
18	3	1	26163521800
19	4	2	26163574202
20	4	2	26099228100
21	4	2	26163516500
22	4	2	26099262100
23	4	3	26163505100
24	4	4	26125194500
25	5	4	26099264000
26	5	6	26163985100
27	5	7	26125198100
28	5	9	26163578600
29	5	13	26163563300
30	5	41	26163558300



Rank Order	Quintile	% age 5 or younger	Tract umber (Cx)
1	1	0.00	26163985100
2	1	0.43	26163516500
3	1	1.39	26125194500
4	1	1.50	26163521800
5	1	1.98	26125150200
6	1	3.21	26125180300
7	2	3.55	26099251100
8	2	3.72	26125152000
9	2	3.80	26099247500
10	2	4.03	26163558300
11	2	4.54	26125142100
12	2	4.55	26125128300
13	3	4.71	26163593300
14	3	4.75	26125196700
15	3	5.13	26125184100
16	3	5.56	26099260400
17	3	5.85	26099228100
18	3	5.88	26163505100
19	4	6.05	26099230800
20	4	6.13	26163578600
21	4	6.18	26125132500
22	4	6.25	26125160900
23	4	6.64	26125198100
24	4	6.67	26163563300
25	5	6.70	26125154000
26	5	7.88	26099264000
27	5	8.42	26163574202
28	5	9.61	26125144800
29	5	12.87	26163500100
30	5	13.21	26099262100

Rank Order	Quintile	% age 65 or older	Tract Number (Cx)
1	1	0.00	26163985100
2	1	4.73	26163500100
3	1	5.61	26099262100
4	1	7.79	26099264000
5	1	8.00	26125184100
6	1	8.75	26125160900
7	2	8.82	26099230800
8	2	9.67	26163593300
9	2	9.97	26163516500
10	2	10.19	26125128300
11	2	10.30	26125144800
12	2	10.35	26163578600
13	3	10.91	26163505100
14	3	11.57	26125142100
15	3	12.38	26125132500
16	3	13.15	26099228100
17	3	15.91	26099247500
18	3	16.56	26163563300
19	4	16.91	26125196700
20	4	17.04	26125154000
21	4	21.33	26163558300
22	4	21.33	26099251100
23	4	22.26	26163521800
24	4	22.27	26163574202
25	5	23.20	26125180300
26	5	25.28	26099260400
27	5	25.88	26125150200
28	5	27.41	26125152000
29	5	27.99	26125198100
30	5	34.35	26125194500

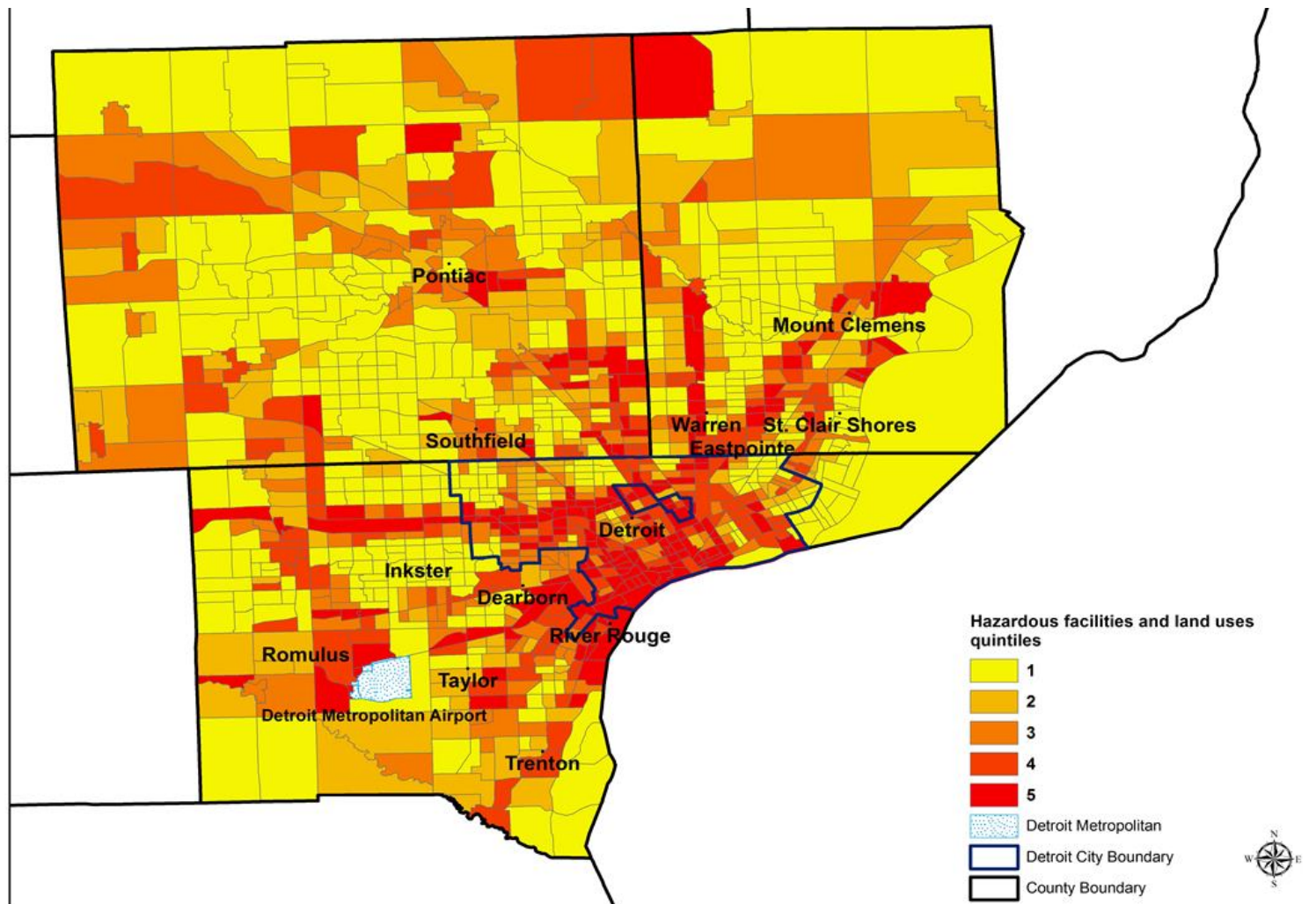




# Proximity to Hazardous Land Uses and Facilities

real

- Hazardous Facilities
  - TRIs
  - Chrome platers
  - Hazardous waste sites
- Hazardous Land Uses
  - Railroads
  - Ports
  - Roads
  - Airports
  - Refineries
  - Intermodal facilities

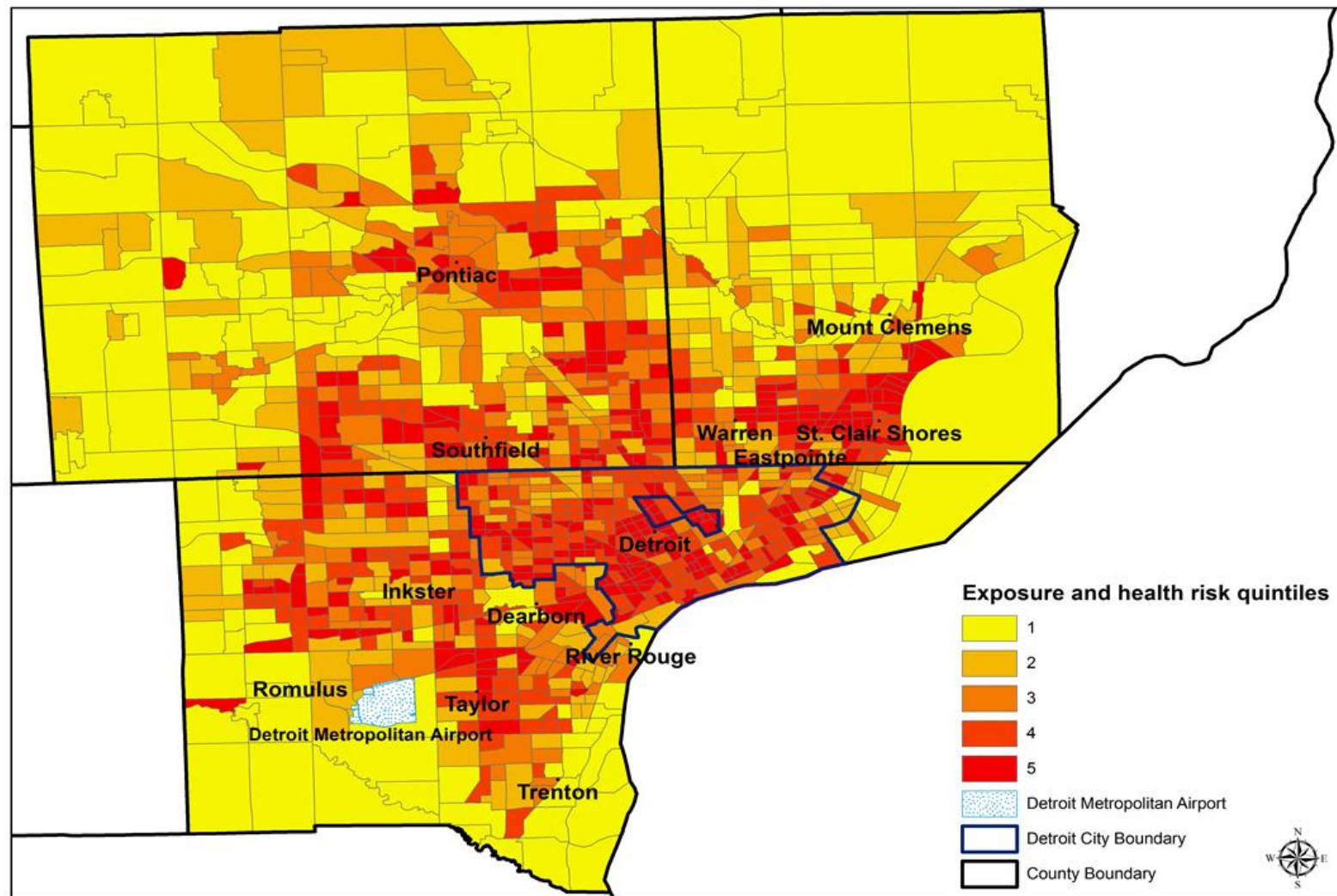


Cumulative impact polygons (CI) include: residential areas, child care facilities, health care facilities, schools and playgrounds. Hazardous Facilities and Land Uses include: Childcare, Healthcare, Schools K-12, Urban Playgrounds, TRI, Chrome-platers, Hazardous Waste sites, Railroad tracks, Ports, Airports, Refineries, Intermodal Distribution and Main roads.



# Environmental Exposures and Health Risks

- Estimated respiratory risk from mobile & stationary sources (NATA 2011)
- Estimated cancer risk attributable to air pollutants (NATA 2011)
- Diesel PM exposure (modeled)



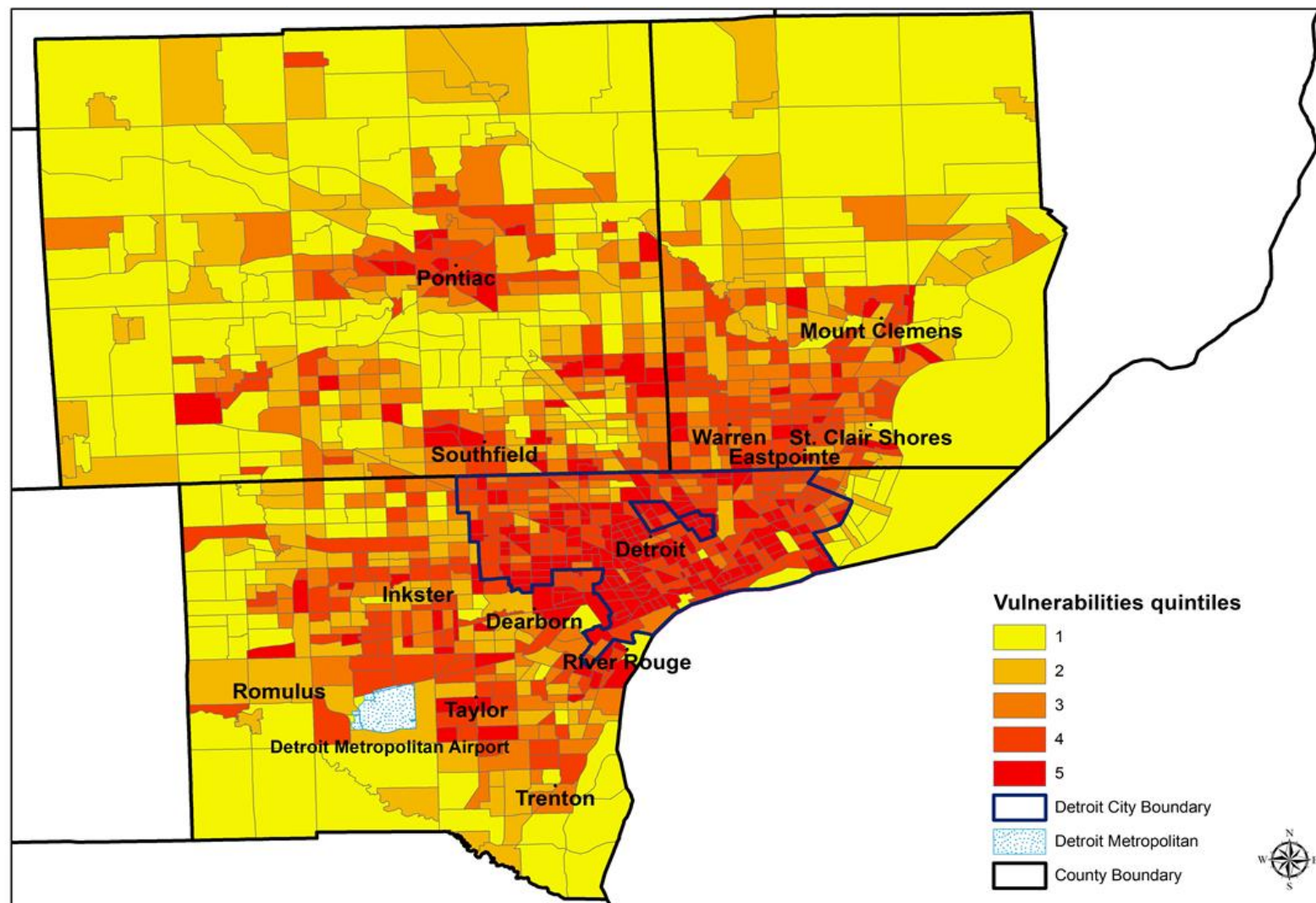
Cumulative impact polygons (CI) include: residential areas, child care facilities, health care facilities, schools and playgrounds.  
Exposure and Health risk include: 2011 NATA estimates of respiratory risk, cancer risk and diesel PM (non-cancer) concentration.





# Population Vulnerability

- Vulnerable Populations
  - % Below Poverty
  - % < H.S. Graduation (> age 24)
  - % Renters
  - % < age 5
  - % > age 60
  - Linguistic isolation
  - % People of Color



Cumulative impact polygons (CI) include: residential areas, child care facilities, health care facilities, schools and playgrounds. Vulnerabilities includes: % below the national poverty level, % renters, median house value (reverse coded), % > age 24 with < high school completion, children age < 5, adults age >= 60. and linguistic isolation.

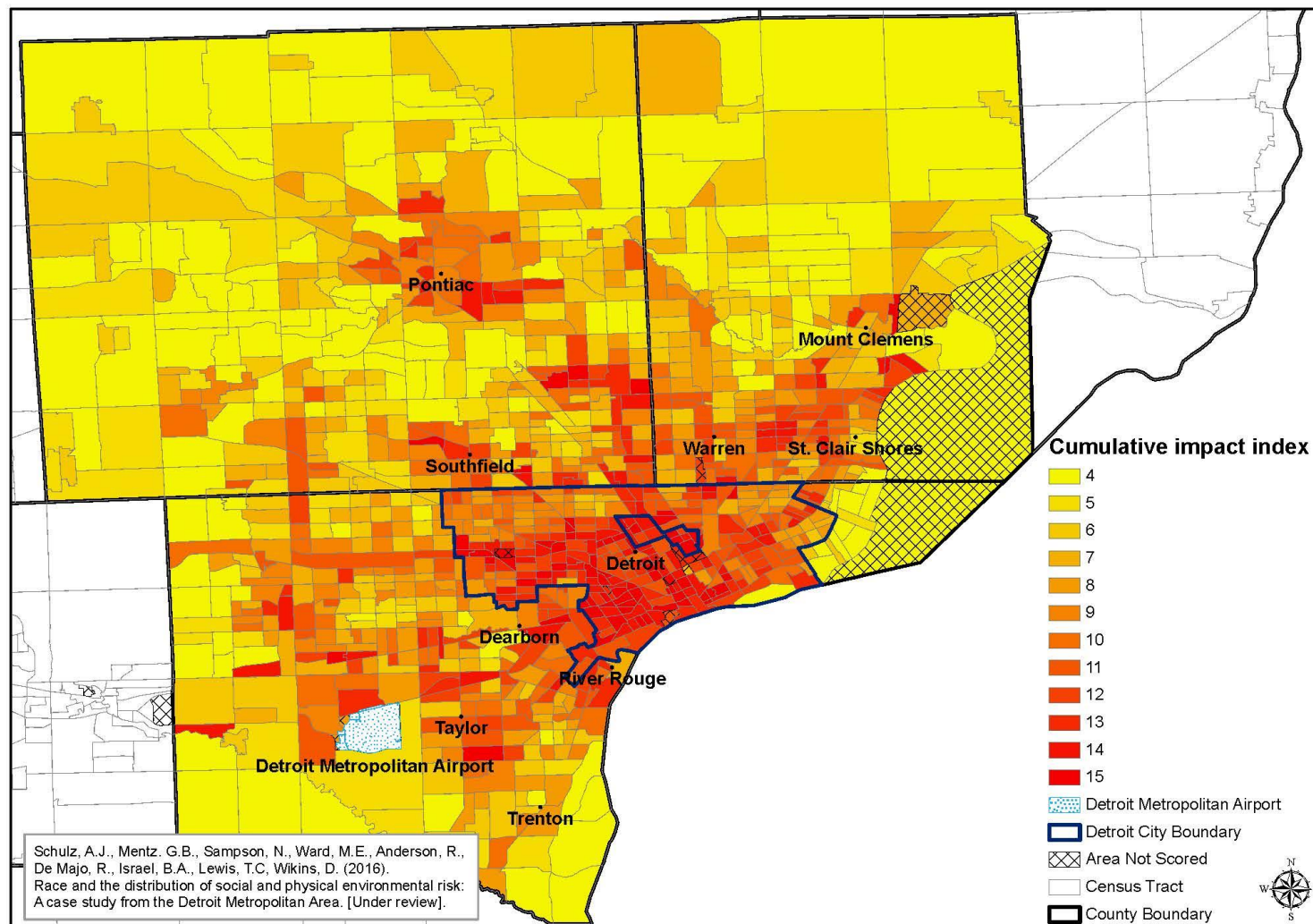




# Cumulative Risk: Exposure + Vulnerability (ns)

Detroit Metropolitan Area

- Hazardous Land Uses & Facilities
- Diesel Exposure, Respiratory & Cancer Risks
- Cumulative Vulnerability



Cumulative impact polygons (CI) include: residential areas, child care facilities, health care facilities, schools and playgrounds. Total Cumulative Impact includes: Hazardous Facilities and Land Uses, Exposure and Health Risk and Vulnerabilities

# Resources

<http://caphedetroit.sph.umich.edu/resource-manual-cover-page-with-full-manual/>

<http://caphedetroit.sph.umich.edu/public-health-action-plan/>

<http://caphedetroit.sph.umich.edu/wp-content/uploads/2016/10/Schulz-et-al.-2016-Dubois-Review.pdf>

[https://seas.umich.edu/sites/all/files/AssessingtheStateofEnvironmentalJusticeinMichigan\\_344.pdf](https://seas.umich.edu/sites/all/files/AssessingtheStateofEnvironmentalJusticeinMichigan_344.pdf)



# Partner Organizations and Partnerships

