CAPHE PHAP-RM

6. CUMULATIVE RISK: AIR POLLUTION & POPULATION VULNERABILITY

2016

This work is made possible by National Institute of Health and Environmental Sciences, RO1ES022616, and the Fred A. and Barbara M. Erb Family Foundation. Additional support was provided by the Michigan Center on Lifestage Environmental Exposures and Disease (M-LEEaD), #P30ES017885.

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6 CUMULATIVE RISK: AIR POLLUTION AND POPULATION VULNERABIITY

6.1 Vulnerability: Factors that influence health effects of exposure

Some communities or individuals may be more vulnerable than others to the adverse effects of exposure to air pollutants. In this document, we use the term "susceptibility" or "more strongly affected" when describing those who are likely to have a stronger or more negative health effect at any given level of exposure. We use the term "vulnerability" when we are referring to those who are more likely to be exposed to higher levels of a pollutant. Note that some groups, such as children, may be both more vulnerable to high levels of exposure and more susceptible to the adverse effects of those exposures (see below for more detail).

Note: *Sometimes the terms susceptibility and vulnerability are used interchangeably, and sometimes they are lumped together and referred to as "at-risk" populations, or those who experience increased risk of adverse health effects of exposure to air pollutants.*

Below, we detail several of the factors that increase susceptibility or vulnerability to air pollutants. Area-specific statistics on several of these for Detroit, the tri-county area, and for the seven-county Southeast Michigan are available in Table 6-1. Table 3-2 shows at a glance the evidence base for specific vulnerable or susceptible populations for each of the six criteria pollutants covered by the Environmental Protection Agencies' National Ambient Air Quality Standards (NAAQS).

Genetic: Children with asthma who have a genetic susceptibility and low vitamin C intake are more susceptible to adverse health effects from exposure to the air pollutant ozone (O_3) than children without genetic susceptibility.[1]

Behavioral: Individuals with reduced intake of Vitamins E and C are at risk for ozone-related health effects.[2] Those with iron deficiency are more susceptible to negative health effects of exposure to lead.[3] Diets rich in antioxidants (found in many fruits and vegetables) may provide some protection against adverse effects of exposure to airborne particulate matter (PM). Thus, people living in neighborhoods with poor access to foods that are rich in antioxidants, including vitamins E and C, and iron, may be more susceptible to adverse health effects of exposure to ozone, lead, and PM.

People who spend a lot of time outdoors, working, playing or exercising, are more vulnerable to adverse health effects from outdoor air pollution, including ozone[4] and sulfur dioxide (SO_2)[5] as they are likely to breathe in more of these pollutants.

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[1] Moreno-Macias H, Dockery D, Schwartz, J, et al. 2013. Ozone exposure, vitamin C intake, and genetic susceptibility of asthmatic children in Mexico City: a cohort study. Respir Res 2013; 14(1): 14. doi: 10.1186/1465-9921-14-14

[2] Moreno-Macias H, Dockery D, Schwartz J, et al. 2013. Ozone exposure, vitamin C intake, and genetic susceptibility of asthmatic children in Mexico City: a cohort study. Respir Res. 2013; 14(1): 14. doi: 10.1186/1465-9921-14-14

[3] Baker RD, and Greer FR. 2010. Diagnosis and Prevention of Iron Deficiency and Iron-Deficiency Anemia in Infants and Young Children (0–3 Years of Age). American Academy of Pediatrics Clinical Report. 126:5

[4] EPA (Environmental Protection Agency). 2016. Integrated Science Assessment of Ozone and Related Photochemical Oxidants. Available: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492 [Accessed 4 April 16].

[5] ATSDR (Agency for Toxic Substances & disease Registry). 2016. Sulfur Dioxide. Available: http://www.atsdr.cdc.gov/phs/phs.asp?id=251&tid=46 [Accessed 4 April 16].

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Existing health conditions: Several health conditions are associated with more adverse health effects at any given level of exposure to some air pollutants. For example, those with asthma or other existing lung diseases such as cardiopulmonary disease (COPD), cardiovascular disease, obesity, and metabolic disorders are more adversely affected by exposure to ozone.[6] There is also suggestive evidence that pre-existing health conditions may make an individual more susceptible to adverse health effects of exposure to nitrogen oxides (NO, NO_2, NO_x)[7], and particulate matter (PM).[8]

Children: There is substantial evidence that children are more strongly affected by exposure to air pollutants, including $PM_{2.5}$ and ozone. Exposure can result in developmental effects that increase risks for some diseases later in life (e.g., metabolic disorders, asthma) and may also exacerbate some existing conditions (e.g., more severe asthma attacks). Because children are growing and developing, and breathing in a greater volume of air per body size, they are more susceptible to the adverse impacts of air pollutants.[9] In addition, because children tend to spend more time out of doors than adults, they may also have higher levels of exposure to air pollutants in outdoor air.

Pregnant women and infants: While the evidence is not yet certain, there is concern that pregnant women and infants have heightened vulnerability to adverse health effects of air pollution. For women, this concern is due to heightened respiration (intake of air) during pregnancy and for infants, the concern is due to developmental stages. There is evidence to suggest that pregnant women may be more susceptible to adverse health effects of NO_2, carbon monoxide (CO), and SO_2.[10]

Adults 60 or older: There is evidence that older adults (definitions vary, but generally refers to those older than 60-65 years of age) are more susceptible to adverse health effects of exposure to Ozone. There is suggestive evidence that older adults are more susceptible to negative health effects from NO_2, PM, CO, and SO_2 and lead.[11]

Race and ethnicity: Some studies have found that non-Latino Black and Latinos in the United States are more likely to live near to pollutant sources, or in areas with higher levels of contamination in the air, water and/or

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[6] EPA (Environmental Protection Agency). 2016. Integrated Science Assessment of Ozone and Related Photochemical Oxidants. Available: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492 . [Accessed 4 April 16].

[7] EPA (Environmental Protection Agency). 2016. Integrated Science Assessment for Nitrogen Dioxide. Available: https://www.epa.gov/isa/integrated-science-assessment-isa-nitrogen-dioxide-health-criteria [Accessed 4 April 16]..

[8] EPA (Environmental Protection Agency). 2016. Integrated Science Assessment for Particulate Matter. Available: https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matte r [Accessed 4 April 16].

[9] Department of Health and Human Services, The Center for Disease Control and Prevention. 2016. Healthy People 2000. Available: http://www.cdc.gov/nchs/data/hp2000/hp2k01.pdf [Accessed 4 April 16].

[10] EPA (Environmental Protection Agency). 2016. Integrated Science Assessment for Nitrogen Dioxide. Available: https://www.epa.gov/isa/integrated-science-assessment-isa-nitrogen-dioxide-health-criteria [Accessed 4 April 16]. and EPA (Environmental Protection Agency). 2016. Integrated Science Assessment for Sulfur Dioxide. Available: https://www.epa.gov/isa/integrated-science-assessment-isa-sulfur-dioxide-health-criteria [Accessed 4 April 16]. .

[11] Simoni M, Baldacci S, Maio S, et al. 2014. Adverse effects of outdoor pollution in the elderly. Journal of Thoracic Disease. (1):34-45. doi: 10.3978/j.issn.2072-1439.2014.12.10.

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soil.[12] These differences often persist after accounting for disproportionate representation of NLB and Latinos in areas with lower socioeconomic status.[13]

Socioeconomic status: There is evidence that people with lower socioeconomic status are more likely to live near sources of air pollutants and other pollutants.[14] They may also be more susceptible to adverse health effects of air pollutants, as described below.

Income: Those with low household incomes are more likely to live in poor quality housing (see below), have reduced access to health insurance, and live in communities with higher levels of exposures. These and other factors associated with low incomes may combine to create a stronger or more adverse effect of exposure to air pollutants like PM on health.[15]

Housing: Poor housing conditions can also negatively impact communities and individuals' ability to protect themselves from adverse health effects of exposure to air pollutants.[16] For example, older houses may lack the capacity to support air conditioners that clean pollutants from indoor air. Older and poorly maintained houses may also contain higher levels of molds and allergens, which may exacerbate or compound the effects of exposure to air pollutants.

Education: Education status or attainment can also impact a communities (or individuals) ability to withstand an environmental insult.[17] There is suggestive evidence that lower education can make an individual more susceptible to PM exposure.

Community preparedness: Differences across communities in terms of emergency preparedness or access to health care may influence susceptibility to adverse effects of air pollutants. For example, communities with emergency medical response systems with greater capacity are likely to have faster response times in, for example, transporting a child with a severe asthma attack to a health care setting. Thus the adverse health effects for children in such communities may be smaller than those for children in communities with poorer systems.

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[12] Downey L, Hawkins B. 2009. Race, income, and environmental inequality in the United States. Social Perspectives Author manuscript; available in PMC 2009 Jul 2. Published in final edited form as: Social Perspectives 2008 Dec 1; 51(4): 759–781.doi: 10.1525/sop.2008.51.4.759

[13] Mohai P, Lantz P, Morenoff J, House J. 2011. Racial and socioeconomic disparities in proximity to polluting industrial facilities. American J of Public Health. 2009; S649-S656.

[14] Mohai P, Lantz P, Morenoff J, House J. 2011.Racial and socioeconomic disparities in proximity to polluting industrial facilities. American J of Public Health, 2009; S649-S656.

[15] EPA (Environmental Protection Agency). 2016. Integrated Science Assessments. Available: https://www.epa.gov/isa [Accessed 4 April 16].

[16] EPA (Environmental Protection Agency). 2016. Integrated Science Assessments. Available: https://www.epa.gov/isa [Accessed 4 April 16].

[17] EPA (Environmental Protection Agency). 2016. Integrated Science Assessments. Available: https://www.epa.gov/isa [Accessed 4 April 16].

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6.2 Table 6-1. Vulnerability: Factors that influence health effects of exposure

Vulnerability: Factors that influence health effects of exposure											
		Location							P<0.05?		
		Southwest n=84,122	Central n= 29,458	Eastside n= 240,621	Westside n= 352,462	CITY n= 706,663	Tri-County	Seven-county	City vs. 3-Cnty	City vs. 7-Cnty	3-County vs. 7-Cnty
Demographic	Children < 5	9.5%	4.0%	6.4%	6.8%	6.8%	6%	5.90%	Y	Y	Y
	Adults >=60	13.9%	17.8%	17.0%	18.5%	17.5%	19.50%	19.40%	Y	Y	N
	% People of Color	80.8%	82.1%	93.2%	94.6%	91.8%	40.8%	36.41%	Y	Y	Y
	% Non Hispanic Black	33.9%	73.5%	88.6%	91.0%	82.8%	30.90%	26.60%	Y	Y	Y
	% Hispanic	43.9%	1.4%	0.8%	1.5%	6.0%	4.2%	4.00%	Y	Y	Y
	Median Household Income*	$27K	$22K	$26K	$30K	$28K	$56K	$57K	Y	Y	N
	% Households < Poverty	20.2%	22.9%	22.1%	19.5%	20.7%	9.5%	9.10%	Y	Y	Y
	% Unemployed	12.9%	13.3%	14.4%	15.2%	15.6%	9.7%	9.2%	Y	Y	Y
	% Renters	55.3%	76.2%	48.5%	44.8%	49.0%	32.40%	31.70%	Y	Y	Y
	Median Home Value*	$44K	$83K	$45K	$55K	$51K	$122K	$130K	Y	Y	Y
	Residents >25 with < HS Diploma	39.9%	17.7%	23.9%	19.2%	23.1%	13.70%	12.70%	Y	Y	Y
Health Risk	Diesel PM (non-cancer)	1.47	1.91	1.25	1.36	1.36	1.13	1.08	Y	Y	Y
	Cancer Mortality Risk (per million)*	49.73	49.21	38.52	38.96	40.59	36.41	35.55	Y	Y	Y
	Respiratory Mortality Risk*	1.69	2.18	1.60	1.75	1.71	1.67	1.64	Y	Y	N

*Mean across census tracts in the area

Table 6-1. Vulnerability: factors that influence the health effects of exposure outlines four areas of Detroit, the City of Detroit, the tri-county area and the seven county area. For expanded Figure, please see Appendix.

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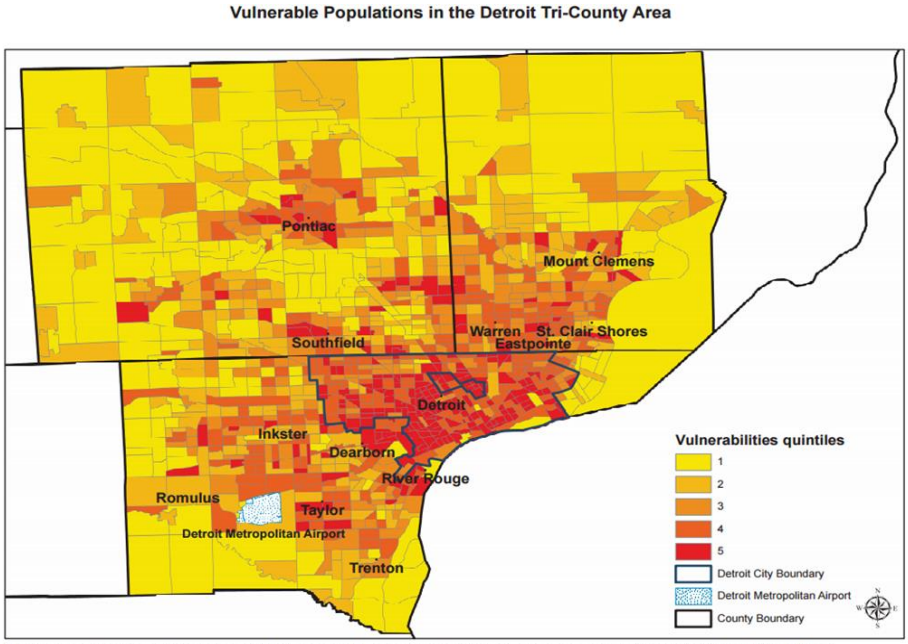
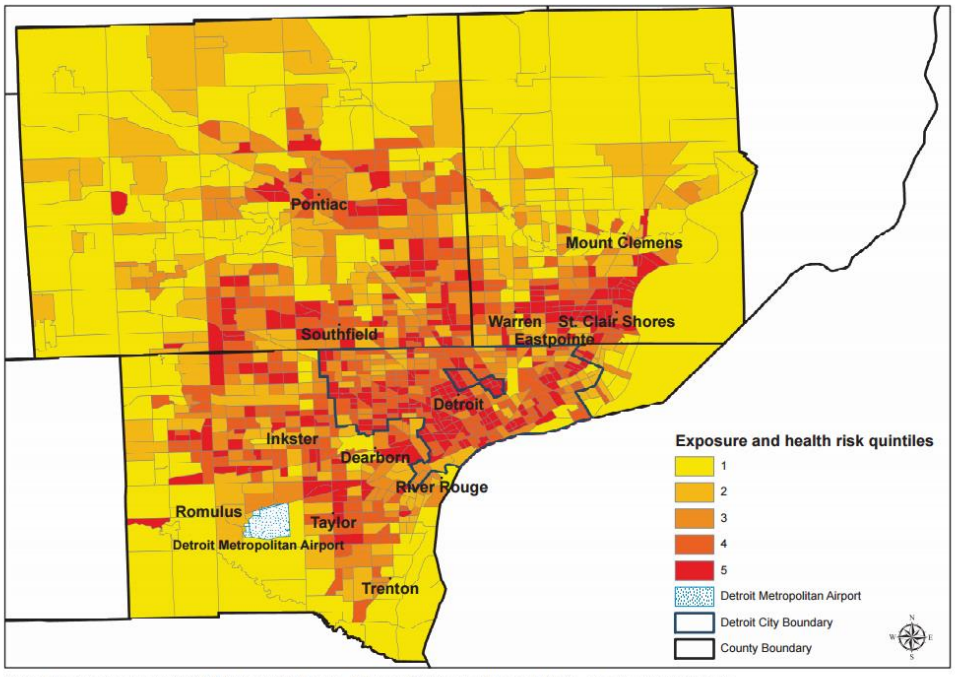
6.3 Figure 6-1. Tri-county: Vulnerable populations



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.

6.4 Figure 6-2. Tri-county map: Exposure and health risk



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.

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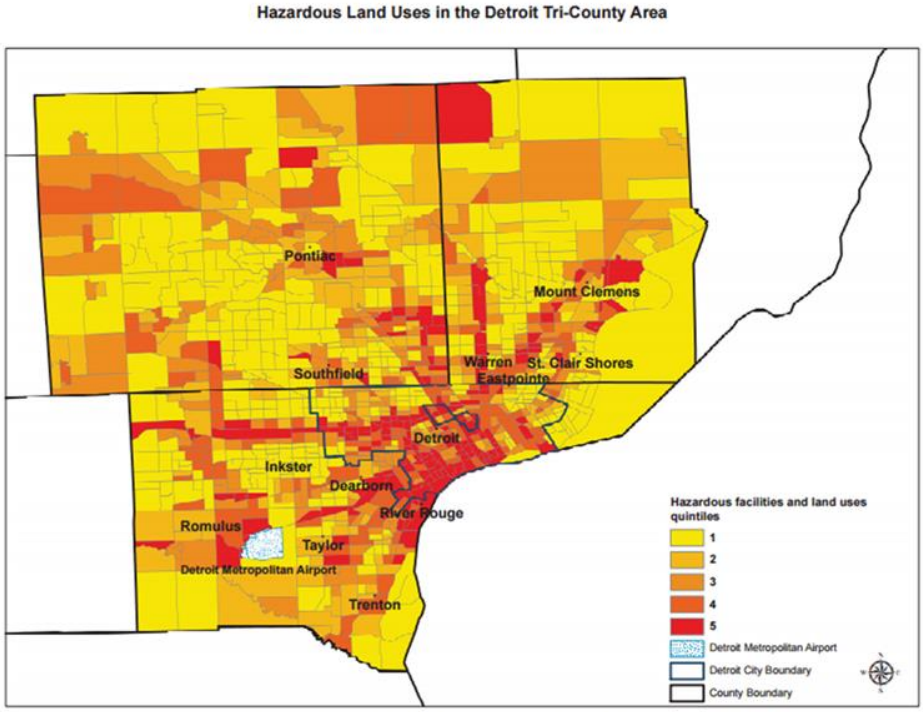
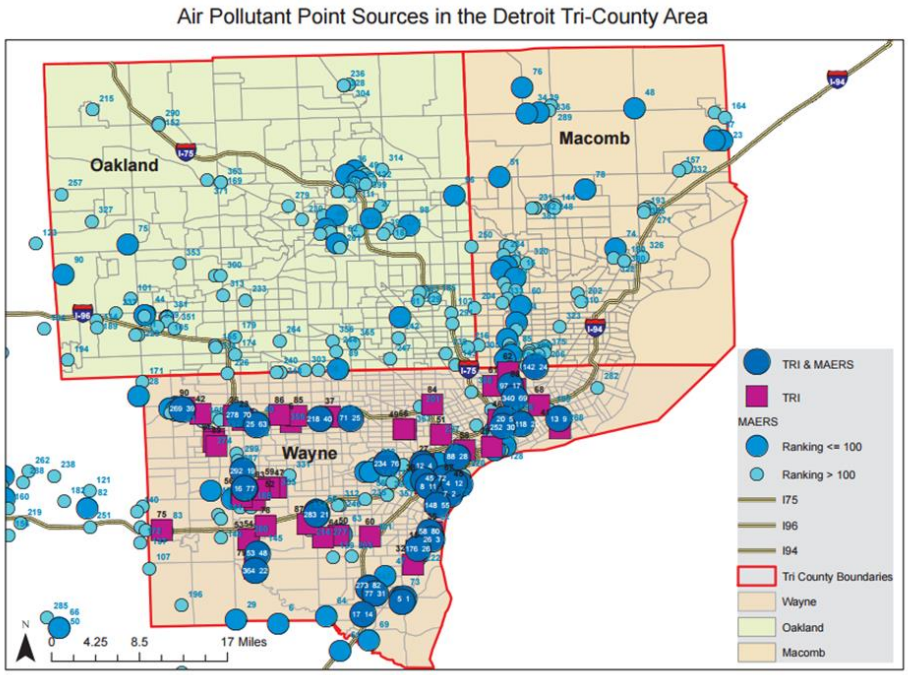
6.5 Figure 6-3. Tri-county map: Hazardous land uses in the Detroit tri-county area



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.

6.6 Figure 6-4. Tri-county map: Toxic release inventory (TRI) sites and Michigan Air Emission Reporting System (MAERS) Sites



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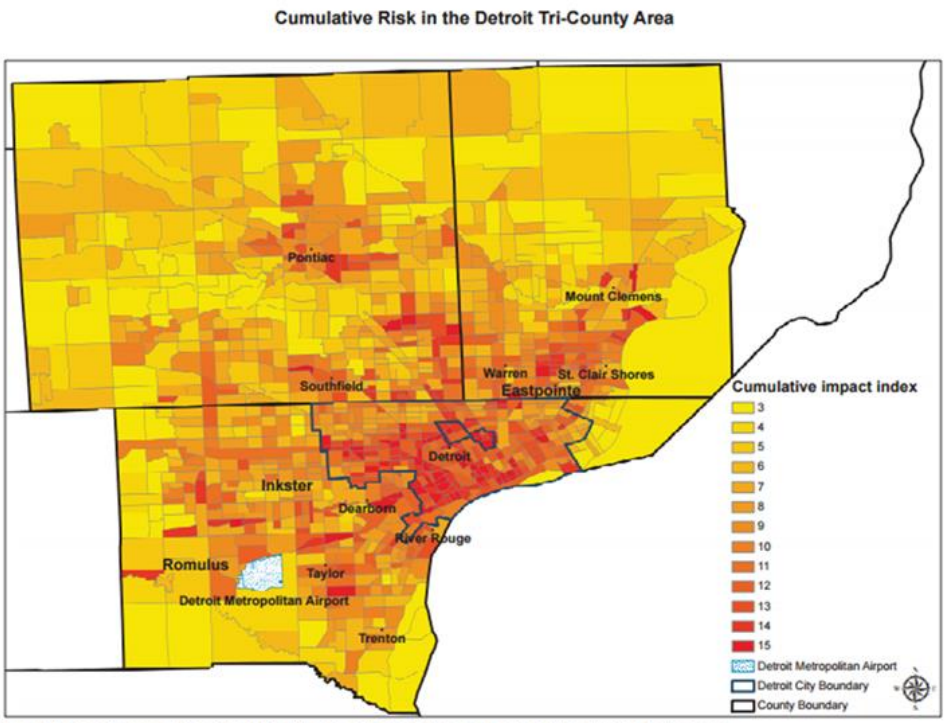
6.7 Figure 6-5. Tri-county: Cumulative risk



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

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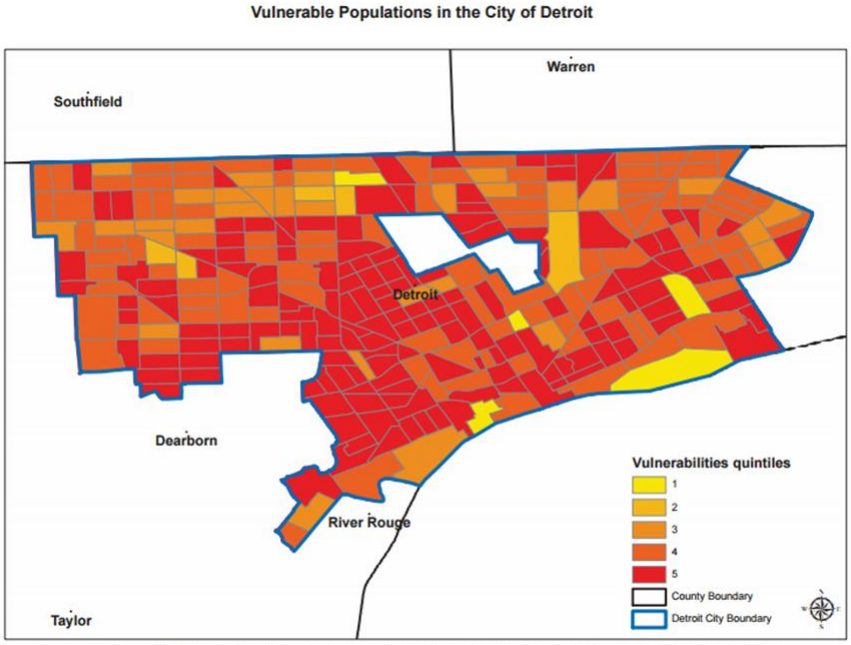
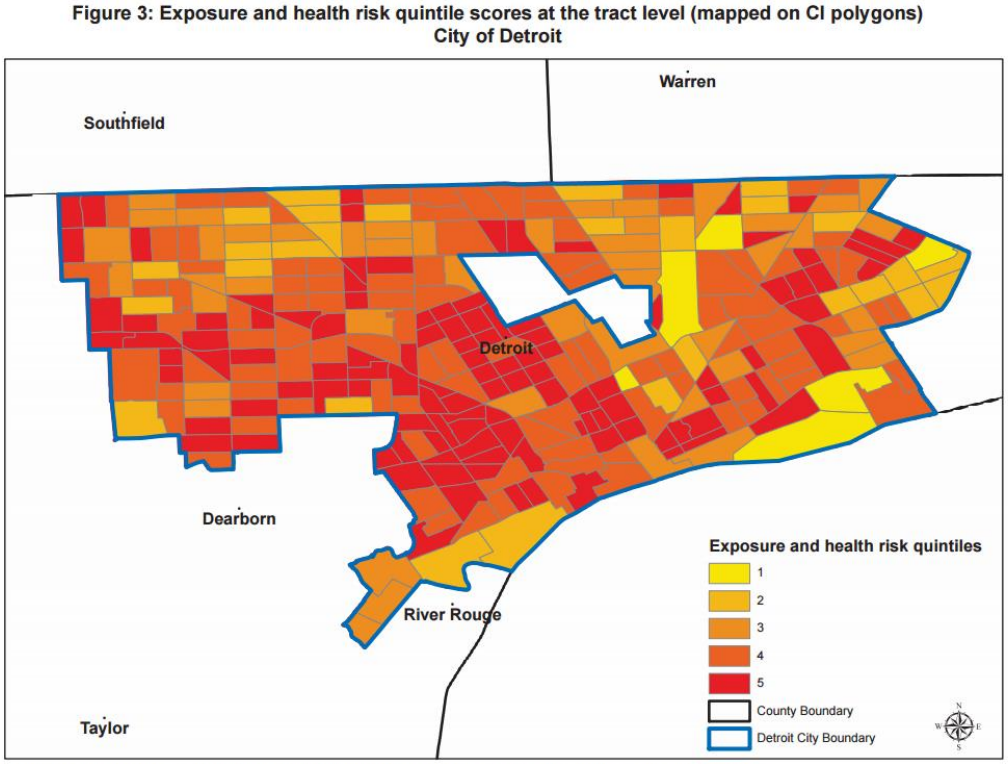
6.8 Figure 6-6. City of Detroit: Vulnerable populations



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.

6.9 Figure 6-7. City of Detroit: Exposure and health risk



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.

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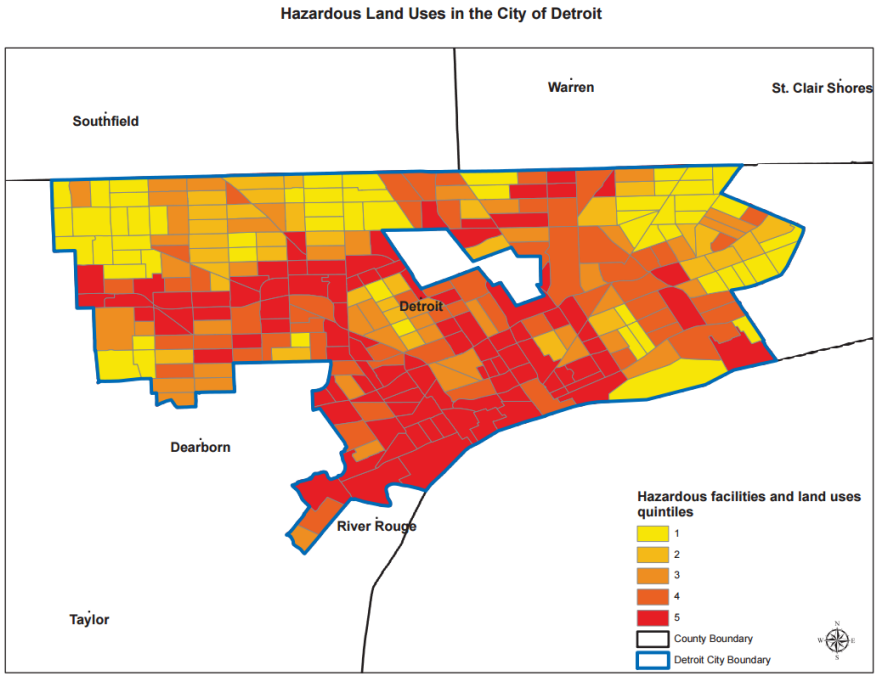
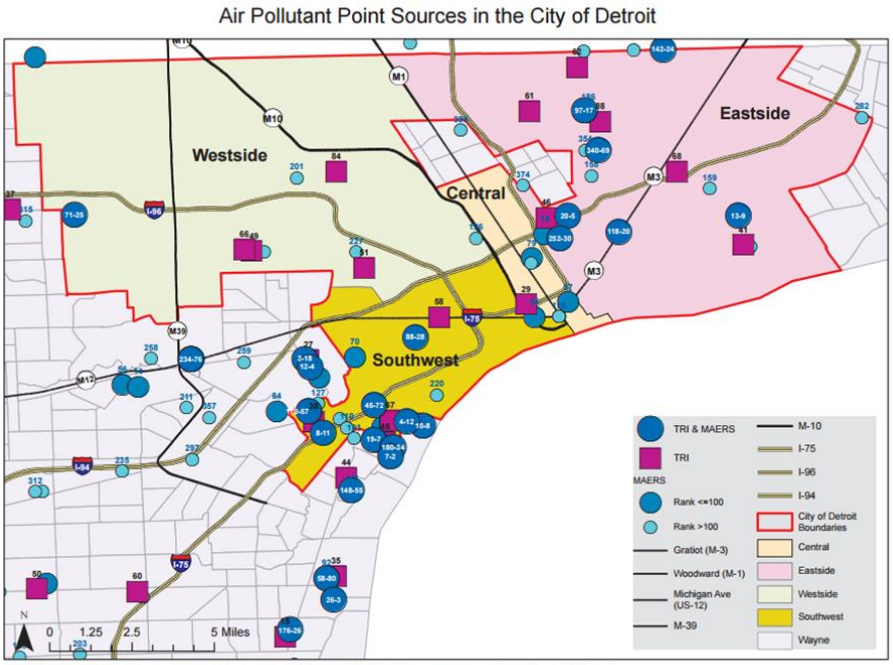
6.10 Figure 6-8. City of Detroit: Hazardous land uses



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.

6.11 Figure 6-9. City of Detroit: Toxic release inventory (TRI) sites and Michigan Air Emission Reporting System (MAERS) Sites



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

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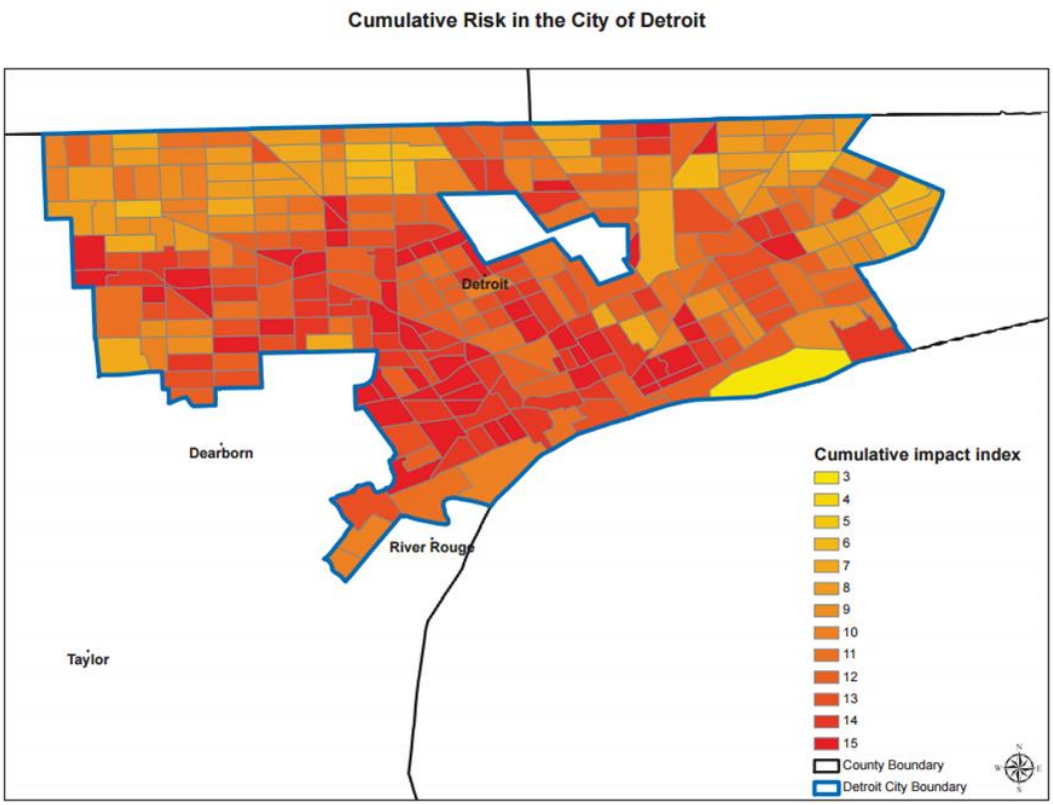
6.12 Figure 6-10. City of Detroit: Cumulative risk



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

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