Early Work

EPA

- September 27,**1962**:

Rachel Carson's *Silent Spring* published (DDT), = credited by the EPA on this site as "jump starts the environmental movement.

- June 29, **1969**

"the Cuyahoga River fire was one of the events that led to the creation of the federal Environmental Protection Agency" (industrial waste and sewage caused the river to catch on fire)

- December 2, **1970**:

Official formation of the EPA (Richard Nixon)

- December 10, **1980**:

Congress creates the Superfund Program/CERCLA to hold polluters responsible for clean up of most hazardous waste sites.

- September 15, **1982**: Environmental Justice movement begins:

A PCB landfill protest in Warren County, North Carolina - a predominantly poor, African-American area - launches the environmental justice movement. Environmental Justice is the fair treatment and involvement of all people, regardless of race or income, in decisions on development, implementation, and enforcement of environmental policies. (1)

General Accounting Office (GAO)

Credited as: .."one of the first studies to focus on the distribution of environmental risks.(6)

Purpose: "In response to a congressional request, GAO determined the correlation between the location of hazardous waste landfills and the racial and economic status of the surrounding communities in eight southeastern states. GAO also provided information on Environmental Protection Agency (EPA) site location standards and permitting procedures." (3)

Scope: EPA region 1V; Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. (2)

Radius: Most sources, including the GAO say they used zip codes, and utilized the ZIP+4, another source states they may have used counties as a unit of analysis in relation to rural areas.

Finding: "There are four offsite hazardous waste landfills in Regions IV's eight States. Blacks make up the majority of the population in three of the four communities where the landfills are located. At least 26 percent of the population in all four communities have income below the poverty level and most of this population is Black." (2)

"This study confirmed what environmental justice advocates believed, that racial minorities are burdened with a disproportionate amount of environmental risks. The report also confirmed that income was a factor in siting hazardous and toxic facilities." (6)

United Church of Christ (UCC) 1987

Purpose: "…to determine the extent to which African Americans, Hispanic Americans, Asian Americans, Pacific Islanders, Native Americans and others are exposed to hazardous wastes in their communities." (4)
Two cross sectional studies: analysis of race and location of commercial hazardous waste facilities

Scope: 415 offsite commercial hazardous waste facilities as listed by the EPA under its Hazardous Waste Data Management System, and included abandoned sites, accidental spills, and illegal discharges

Radius: By zip code in four groups: (includes rural areas)

Group 1: 5-digit ZIP code areas without operating commercial hazardous waste treatment, storage and disposal facilities
Group 2: 5-digit ZIP code areas with one operating commercial hazardous waste treatment, storage and disposal facility that is not a landfill
Group 3: 5-digit ZIP code areas with one operating commercial hazardous waste landfill that is not one of the five largest
Group 4: 5-digit ZIP code areas with one of the five largest commercial hazardous waste landfills or more than one treatment, storage and disposal facility

Findings: there are "disproportionate numbers of racial and ethnic persons residing in communities with commercial hazardous waste facilities is not a random occurrence, but rather a consistent pattern…." and "It is significant that race was consistently a more prominent factor in the location of commercial hazardous waste facilities than any other factor examined." (4)
…"confirmed that race and ethnicity were the most significant factors in deciding where to place waste facilities, landfills, and other environmental hazards." and in their **1994** follow up report stated: "people of color were 47 percent more likely than whites to live near a commercial hazardous waste facility and that between 1980 and 1993 the concentration of people of color living in areas with commercial hazardous waste facilities increased 6 percent, from 25 to 31 percent." (6)

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*Note: both of the above studies describe **"unit-hazard coincidence**" as the method of measure

Notes from Mascarenhas:

Re: GAO: Patterns discovered in the three states may not be applicable to the nation as a whole.
Re: GAO and UCC: studies conducted by Douglas Anderton et al., 1994, described this method as as "an artifact of geographic scale and not environmental racism….." and "studies using zip codes areas overaggregated their cross-sectional findings." (5)

First cases:

1979, East Houston, TX: Residents alleged the decision of placement of garbage dump in their neighborhood was racially motivated and violated the 1983 Civil Rights Act.
Re: Bean v. Southwestern Waste Mgmt. Corp (6)
.."the first lawsuit that challenged the siting of a waste facility in Houston, Texas." (8)

1979: Acknowledged as: the "**mother of the environmental justice**," Hazel Johnson founded the People for Community Recovery, labeling her neighborhood of Altgeld Gardens, Chicago as a "toxic doughnut," one surrounded by waste from refineries and steal mills.

1982, Afton, Warren County, North Carolina, African Americans (84% of the population and the poorest county in NC), protested a decision to site a PCB landfill in their community. (6)

The **United Church of Christ** (UCC) Commission for Racial Justice was the first of civil rights organizations to the raise the question of environmental racism.

“**Environmental racism** (ER) was first coined by Reverend. Benjamin Chavis in 1984 as racial discrimination in environmental policymaking, in the enforcement of regulations and laws, in targeting of communities of color for toxic waste disposal and siting of polluting industries, in the official sanctioning of the life-threatening presence of poisons and pollutants in communities of color and racial discrimination in the history of excluding people of color from the mainstream environmental groups' decision-making boards, commissions, and regulatory bodies.” (8)

1990: Robert D Bullard, book *Dumping in Dixie* and extending the analysis in the book: *Confronting Environmental Racisim:*
*“*the first documented scholarly work about environmental racism and sparked the awareness of environmental inequality as a social problem.” (8)
Most Google searches acknowledge: Dr. Robert Bullard as the “**father of environmental justice**”

1991: The First National People of Color Environmental Leadership Summit: A four day summit described as “one of the most important events in the history of the environmental justice movement.” Sponsored by the UCC, established 17guiding principals of Environmental Justice (9)

1994: Executive Order #12898: Bill Clinton: Requires that all federal agencies make achieving environmental justice part of their mission…

(1) https://www.epa.gov/history/milestones-epa-and-environmental-history

(2) General Accounting Office (GAO), **1983**: “Siting of Hazardous Waste Landfills And Their Correlation With Racial And Economic Status Of Surrounding Communities,”
https://www.gao.gov/assets/rced-83-168.pdf

(3) https://www.gao.gov/products/rced-83-168

(4) United Church of Christ (UCC),**1987**: “Toxic Wastes and Race In The United States, A National Report on the Racial and Socio-Economic Characteristics of Communities with Hazardous Waste Sites. https://www.ucc.org/wp-content/uploads/2020/12/ToxicWastesRace.pdf

(5) https://doi.org/10.3167/ares.2021.120107

(6)https://www.usccr.gov/files/pubs/envjust/ch2.htm

(7) Bullard, R. D. (Ed.). (1993). Confronting environmental racism: Voices from the grassroots. South End Press.

(8) Rainey, S. A., & Johnson, G. S. (2009). Grassroots activism: An exploration of women of color's role in the environmental justice movement. Race, Gender & Class, 144-173.

(9) https://www.ucc.org/30th-anniversary-the-first-national-people-of-color-environmental-leadership-summit/#:~:text=The%20First%20National%20People%20of%20Color%20Environmental%20Leadership%20Summit%20has,%2C%20on%20October%2024th%2C%201991.

unit-hazard coincidence/(spatial-coincidence) studies

Instructions for chart:

Key findings: Related to disparity

- What were the main conclusions about the disparity they investigated using the difference in differences approach?
- Did the intervention/exposure reduce or exacerbate disparities and for whom?

Study, (Author) Year conducted	**Disparity Investigated**	**Which populations**	**Proximal Population (Radius Distance)**	**General Population Definition (Radius/ Distance):**	**Determination and associated risk**
Standard citation, eg: Smith et al.,2020	(What specific inequality or difference were they studying, eg: access to healthy food, exposure to pollution, healthcare outcomes, education (attainment)	(eg: racial/ethnic groups, income levels, rural vs urban)	How did they define the population close to the intervention or exposure? Note: this is where the specific radius comes in, eg: within 1 mile of a new clinic, .5km buffer around polluting facility, within 15 minutes drive time —-be as precise as the study allows.	How did they define the comparison or control population? Note: This may be outside the proximal radius (eg: more than 1 mile from the clinic), a larger geographical area (eg: county-level data for comparison) or a different buffer	I added this section

Study, (Author) Year Conducted	Disparity Investigated	Which Populations	Proximal Radius	General Population Definition	Determination and Associated Risk
Berry et al, 1997 Study period 1961-1985, broken into 5 sections (1)	relationship between birthrate and mother's residence in proximity to Lipari Landfill, Mantua Township, Gloucester County, New Jersey, ranked #1 on EPA's NPL	Four municipalities in New Jersey: Mantua, Pitman, Glassboro, Harrison and included Philadelphia due to proximity to the landfill. Single live births only	A **1 km** radius in the form of an irregular polygon surrounding the perimeter of the landfill was used, including a contaminated lake and springs. This was labeled Area 1, considered to be the highest exposure area.	Areas extending beyond the 1 km boundary to the end of the four municipalities, considered unexposed were labeled Area 2. Further, Area 1 was subdivided into Area 1A, for the one neighborhood/ lake adjacent to the landfill (highest exposure risk) and Area 1B, for the rest of the area.	Area 1 was found to have significantly lower average birth weight / higher proportion of low birth weights compared to Area 2 between 1971-1975, specifically in Area 1A. Further, over the period of heaviest dumping of hazardous waste (1965-1975) the average birth weight dropped 189 g.
US Department of Housing and Urban Development (HUD), No date listed (2)	A cumulative ranking system based on social, economic, and physical factors to assess community health within neighborhoods.	Includes all city neighborhoods within the state of Minnesota.	**1km** (0.62 miles) of a superfund site that was active in 2014	"Proximity" to superfund sites is the "proportion of a neighborhood" within the 1km radial scale.	The higher the share of neighborhood located in proximity to a Superfund site, the higher risk of adverse health affects including: minor respiratory and skin irritations infant mortality, mental health, water and food borne illness, and cancer

Dolk et al., 1987-1994 (3)	Congenital anomalies data from regional registers associated with residence near hazardous, non domestic industrial waste landfill sites.	Study Area Funen County, (Denmark) Western North Thames (UK) Lyon (France) Antwerp (Belgium) Tuscany (Italy) Northern Region (UK) Glashow UK): 21 sites included Study population 1089 livebirths, stillbirths, and terminations of non-chromosomal congenital anomaly and 2366 control births without malformation, all of which lived within at least the 7 km radius.	**7 km radius was defined around each of the 21 study sites.**	The 7 km radius contained a 3 km proximate radius from the site as a method of distinguishing the area with most risk of exposure. Some study sites included more than one site within 7 km of each other. In this instance, if the proximate zone (3 km) overlapped, the study areas were combined into one large study area and the study population was allocated toward the closest site.	Residence within 3 km of a site was associated with a statistically significant, excess risk (57.7%) of non-chromosomal congenital anomalies such as neural-tube defects, malformations of the cardiac septa and anomalies of the great arteries and veins. Residence within 3-7 km from a site demonstrates a risk of 42.8%. No evidence of differences of risk between sites were found.

Noonan, et al., 2009 (4)		Populations included are those that reside in both small and large perimeters surrounding NPL and hazardous waste sites	**Radius is variable and was employed by hedonic statistical analysis to estimate property value.** Variables utilized included lot size, number of rooms, and distance to an amenities.	Hedonic estimations of property values were determined and compared to scales at the county, zip code, census tract and block group level.	Zones of impact typically extend no more than 6 miles away from an NPL site, with most effects dissipating within 2-5 miles. Results for price effect become indistinct after 6 miles. The 6 mile scale represents an area larger than census tracts or block groups and smaller than counties.

Kiaghadi et al., 2010-2015 (5)	Superfund sites as a single source of exposure and the magnitude and effect they have on mortality rates and life expectancy considering socioeconomic variables and natural hazards (e.g., flooding and wildfire)	<u>Study Area</u> National level: all unique Superfund sites within the contiguous U.S., (n=11,989) those on the NPL (n=1,303 as of 2019), proposed Superfund sites(48), and Superfund sites that have been removed from the list <u>Population Variables</u> Race: White (%) 60 yrs/ Older (%) Income Insurance (%) Married (%) Higher Education US Citizen (%) Disability (%)	**Radius encompassed each of the 72,268 census tracts** within the U.S. Census tracts with available life expectancy data in 65,226 tracts. (variable distance)	<u>Flood data:</u> Flood hazard map data obtained for all 2845 counties and 0.2 mile buffer was defined around each of the sites. A site with 25% or more area within the floodplain was specified for inclusion.	Comparisons of life expectancy (LE) of tracts with at least one Superfund site with median LE and LE of tracts with no Superfund sites revealed a -1 and -1.2 difference respectively, the adverse effect could be as high as -1.22 in tracts with Superfund sites and high sociodemo-graphic disadvantage. LE for tracts with a Superfund site and within a floodplain can further amplify the adverse effect and therefore increase the negative influence of sociodemo-graphic factors. No significant difference between all tracts (regardless of Superfund status) were determined when compared with their neighboring tract.

Baibergenova et al., 2003 (6)	Proximity to PCB contaminated sites and the incidence of low birth weight and infant morbidity	All births in the State of New York, excluding New York City. Total births = 945,077, of this total, 24.5% of all women reside within the defined radius.	**Radius established around 187 different zip codes** identified as those containing or abutting PCB contaminated sites. (variable distance)	Study includes PCB hazardous waste sites within zip code boundaries as well as contaminated bodies of water that fall within or abut these sites.	Average birth weight within the scope was an 21.6 g less than in those without PCB present. The relationship is stronger among male infants. Low birth weight in infants increases the risk of adult cardiovascular disease, hypertension, renal failure and type 2 diabetes. The PCB sites had a higher percentage of African-Americans, teenage mothers/ fathers, per capita income <%15,000, and a larger proportion of women who received Medicaid as payment.
Ettinger, A.S., et al., 2002-2008 (7)	Biological markers of fetal and early childhood exposure to mixture metals, among 532 pregnant women	Pregnant women who presented at to the only hospital in Ottawa County, Oklahoma who reside and intend to stay in proximity to the Tar Creek Superfund site. <u>Study population</u> 66.2% Caucasian and 23.5% Native-American descent living on allotted Indian land and 10.3% others	*****I did not find information that stated the study area was "an entire county-485mi^2 " The study location is stated as **"40 square miles of land in northeastern Oklahoma,"** and includes the communities of Picher, Cardin, Hockerville, Quapaw, North Miami, and Commerce.	The Tar Creek Superfund Site is part of the Tri -State Mining District which extends though southeast Kansas and into southwest Missouri and occupies 40 square miles of land in northeastern Oklahoma.	Arsenic exposure among those in the highest quartile of blood arsenic exposure had 2.8 higher odds of impaired GTT at 24-28 weeks gestation. This increases the risk of Gestational Diabetes and subsequently contributes to adverse health effects for both mother and infants, including diabetes, congenital malformations, mocrosomia and obesity.

(1) https://ehp.niehs.nih.gov/doi/epdf/10.1289/ehp.97105856

Note: “Because personal exposure information did not exist, residential distance from the landfill was used as a surrogate measure for potential past exposure. The results of this study indicate that the Area 1 designation(1-km radius from the landfill) was too large and resulted in exposure misclassification, attenuating the results. The smaller residential subdivision of Area 1A, the neighborhood immediately adjacent to the landfill, is the better exposure surrogate and provides the strongest association between residential location and birth weight.” (1)

(2) https://archives.huduser.gov/healthycommunities/indicator 18047.html#:~:text=Superfund%20sites%20contain%20toxic%20pollutants,-borne%20illness%2C%20and%20cancer

Note: This study was done to provide policy makers, city planners and neighborhood advocates “an understandable way to evaluate community health.”
By using more than 40 core indicators, such as social, economic, and physical environments (Healthy Community Index / HCL), neighborhoods are ranked by use of “Healthy Communities Assessment Tool (HCAT). Those with higher rank (i.e., 1 is best) are considered healthier and have better health prospects.

(3) Dolk, H., Vrijheid, M., Armstrong, B., Abramsky, L., Bianchi, F., Garne, E., ... & Tenconi, R. (1998). Risk of congenital anomalies near hazardous-waste landfill sites in Europe: the EUROHAZCON study. The Lancet, 352(9126), 423-427.

Note: “Cases and controls were geographically located with the address or postcode of the mother's place of residence, with an accuracy of 100 m or less. The distance of the mother's place of residence from the nearest landfill site was used as a surrogate measurement of exposure to chemical contaminants from the landfill site.”

(4) Noonan, D. S., Turaga, R. M. R., & Baden, B. M. (2009). Superfund, hedonics, and the scales of environmental justice. Environmental management, 44, 909-920.

(5) Kiaghadi, A., Rifai, H. S., & Dawson, C. N. (2021). The presence of Superfund sites as a determinant of life expectancy in the United States. Nature communications, 12(1), 1947.

Notes: Study includes Superfund sites (NPL) as well as proposed sites, those removed from the list and sites that are not overseen by the EPA. Study also explores how proximity to Superfund Sites combined with vulnerability to flooding (Can/May) amplify the magnitude of effect on life expectancy. Life expectancy from census data was only available for 65,226/72,268 census tracts within the contiguous U.S., for those without LE was gathered elsewhere and estimates were determined.

(6) Baibergenova, A., Kudyakov, R., Zdeb, M., & Carpenter, D. O. (2003). Low birth weight and residential proximity to PCB-contaminated waste sites. Environmental health perspectives, 111(10), 1352-1357 (2)

(7) Ettinger, A. S., Zota, A. R., Amarasiriwardena, C. J., Hopkins, M. R., Schwartz, J., Hu, H., & Wright, R. O. (2009). Maternal arsenic exposure and impaired glucose tolerance during pregnancy. Environmental health perspectives, 117(7), 1059-1064.
Note: **I did not find information that stated the study area was “an entire county-485mi^2 ”**

Studies RE: Issues with unit-hazard coincidence

(1) Vrijheid, M. (2000). Health effects of residence near hazardous waste landfill sites: a review of epidemiologic literature. Environmental health perspectives, 108(suppl 1), 101-112.

Note: Why surrogate measures make it difficult to ascertain degree/relevance of "exposure" Quote taken from source.
"Because knowledge of whether and to what extent substances from waste sites reach the human population is still largely lacking, and because resources are rarely available to carry out extensive exposure measurements or modeling, epidemiologic studies have based the assessment of exposure to landfills mainly on surrogate measures such as residence in an area close to a waste site or distance of residence from a waste site. The use of such surrogate, indirect exposure measurements can lead to misclassification of exposure which, if not different for diseased and non diseased persons, will decrease the sensitivity of the study to find a true effect." (1)
In re: landfill exposure:
"Low-dose exposures are generally expected to generate small increases in relative risk that will be difficult to distinguish from noise effects introduced by confounding factors and biases."

What is needed to improve investigations:
"Improved data on effects of individual chemical exposures would improve the quality of quantitative risk assessments that can be made for landfill exposures. However, quantitative risk assessments are based to a large extent on unverifiable assumptions, and therefore cannot negate the necessity for direct epidemiologic studies of people living near landfill sites."

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(2) Maantay, Julia. (2002, April). Mapping environmental injustices: Pitfalls and potential of geographic information systems in assessing environmental health and equity. Environmental Health Perspectives, 110(2), 161-171. https://doi.org/10.1289/ehp.02110s216

Definition of environmental injustice: "the disproportionate exposure of communities of color and the poor to pollution, and its concomitant effects on health and environment, as well as the unequal environmental protection and environmental quality provided through laws, regulations, governmental programs, enforcement, and policies." (1)

Note: The writer proposes a more inclusive definition for environmental justice, accounts for vulnerability should be extended to include the very young, elderly pregnant, immune compromised, infirm and future generations.

Shortcomings in environmental research:
1. Race and income, as the most prevalent indicators of risk are "inexplicably intertwined" and thus confounds base data
2. Other conditions can be labeled by proxy as race related - leading to misperceptions of risk associated with proximity to TSDF's
3. Vulnerable populations definitions are not expansive enough
4. The scope of facilities studied fails to account for other smaller contributors of environmental hazards and diminishes the magnitude of extent
5. Utilizing unit-hazard coincidence (when zip codes, census tracts, county, or other municipal boundary), as a methodology assumes exposure risks are contained within that zone and don't account for those that may be within proximity (adjacent, abutting, adjoining, beside, contiguous) but not within the host zone
6. Assumptions are made in regard to distance relationships re: exposure rather than dispersion modeling and distribution patterns

7. A overall lack of an exposure/toxicity index: what is stored at the facility, how/if it can be transmitted and to what extent (quantification of risk)

These discrepancies can be overcome by using the Modifiable Area Unit Problem (**MAUP**) as a geographic unit analysis method. The author references work by Glickman and Hersh,1995 as evidence to the claim:

" ….data aggregated at higher levels of governmental unit (county or city, for instance) will be less reliable as indicators of disproportionate burdens, and less accurate in identifying the affected populations, than data aggregated by smaller units such as census block groups or blocks."(2)

How GIS and MAUP can enhance future studies:

The author expresses the need to for future studies to demonstrate linkages between environmental burdens and adverse health impacts for findings to be meaningful toward policy changes that ensure best practices in regard to public health.

For future assessments:
"It is critical now to demonstrate correspondence between environmental burdens and adverse health impacts —to show the disproportionate effects of pollution rather than just the disproportionate distribution of pollution sources." (2)

1. Refinements in exposure indicies:

"Development of an aggregate environ-mental load index would be of value in establishing baseline profiles of communities for comparative purposes and documenting the relative environmental loads of various communities. The aggregate environmental load index would also allow communities with the highest environmental loads to be targeted for pollution prevention and remediation programs and enable examination of the correspondence between incidence of environmentally linked diseases and environmental loads. GIS could also facilitate research into the synergistic effects of toxic substances by pinpointing the geographies subjected to such environmental loads and comparing them with known or suspected health problems in these areas." (2)

2. Dispersion modeling: best means for extent and severity

3. Flow/transport modeling for contaminants in subsurface media

4. More advanced methods of proximity analysis (Proximity Ratio): See Sheppard et al, 1999
5. **Applying neighborhood scale analysis**

Advantages

- "studies covering larger geographies use coarser-resolution data and cannot pinpoint as accurately the spatial patterns and connections that may exist." (2)
- the advantage of local knowledge bases to verify accuracy

6. Employing mathematic models in GIS with attached spatial reference so annual concentrations can be estimated

7. Plume buffers (see Glickman and Hersh, 1995)

To improve assessments/refine results: (A buffered buffer approach)

Neumann et al, 1988: placed buffers around TRI facilities using Chronic Toxicity Index (CI) to estimate exposure and another buffer for the census tract centroid to capture information on those populations exposed to multiple sources of pollution by aggregating all emissions within the centroid buffers.

Mohai, P. & Saha, R. (2006)

Purpose:
Discussion of the magnitude/causes of racial and socioeconomic disparities of past studies and comparisons of their methodological approach (unit-hazard coincidence) and how this can influence inaccurate findings.

unit-hazard coincidence vs unit based distance in determining racial and socioeconomic disparity

Question:
Are disparities a result of historical patterns of the siting of polluting facilities in poor neighborhoods or are they a result of demographic changes that occurred after a facility has been placed?

Unit-Hazard Coincidence /aka: spatial coincidence

The most typical approach but the weakest in ability to control for nearby populations.

Problems
"Assumes that an environmental hazard's negative effects are confined solely to and distributed evenly throughout it host analysis unit." (2)
Produces failures in proximity and size estimations of TSDF's

method = selection of predefined geographic units (counties, zip code areas, census tracts), identifying the units that contain a hazard(s) and comparing it against those that do not contain a hazard(s). (1)

Distance-Based Methods

This method attempts to overcome unit-hazards analysis shortcomings by using precise locations of environmental hazards on a map combined with specific estimations of populations that live within these distances.

3 types:

1. 50% areal containment: "Instead of centering circles at hazard locations, these studies center their circles at the host tract centroids. Radii of 0.5, 1.0, 2.5, and 3.0 miles have been used in these studies."(1)

2. boundary intersection: "All units whose boundaries are wholly contained by, partially intersected by, or tangent to a circle of a specified distance centered at the environmental hazard are considered in the host neighborhood." (1)

3. areal apportionment: "Partially intersected units are assigned weights proportional to their intersected areas, reducing the risk that any unit over-or under influences the estimated demographic characteristics within a given distance of an environmental hazard."(1)

Determination:
Found that 49% of the nations treatment storage and disposal facilities (TSDF) are located with 1/4 mile of the boundary of their host census tract and 71% were located within a half mile of their census tract boundary. Further, when applying unit-hazard coincidence, data suggested that TSDF's are concentrated where labor pools exist. In applying a 50% areal containment (1mile) suggests location of TSDF's are not solely a function of labor force or nearby characteristics of a neighborhood.

Study, (Aurthor) Year Conducted	Disparity Investigated	Which Populations	Proximal Radius	General Population Definition	Determination and Associated Risk
Mohai and Saha (2006-2007) (1)	Racial and socioeconomic disparities in relation to proximity to of environmentally hazardous sites, did the people come first or the pollution?	populations in proximity to environmental hazards and locally unwanted land uses (LULUs) and the varying methods of scale and scope of	1, 2, and 3 mile circular buffers placed around precise geographic locations of TSDF's	50% areal containment and areal apportionment methods were applied to census tracts within the buffers	minority and poverty percentages generally decreased with increasing distance from the sites.

(1) https://www.proquest.com/docview/223001187?accountid=10920&sourcetype=Scholarly%20Journals)

(2) Downey L. (2006). Environmental Racial Inequality in Detroit. Social forces; a scientific medium of social study and interpretation, 85(2), 771–796. https://doi.org/10.1353/sof.2007.0003

Demographic studies of Near- Site Populations

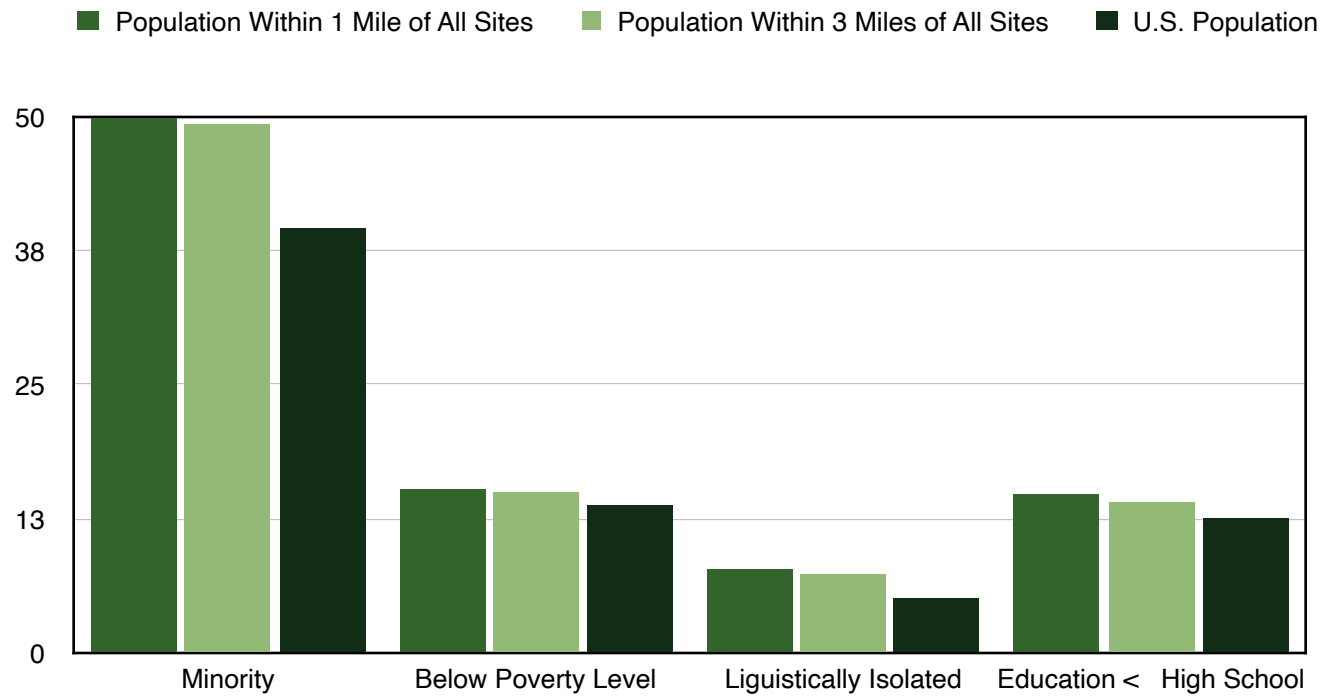
(1) **United States Environmental Protection Agency**. (2020, September). Population surrounding 1857 superfund remedial sites.https://www.epa.gov/sites/default/files/2015-09/documents/webpopulationrsuperfundsites9.28.15.pdf

What:
Summarizations of populations within 1 and 3 miles of Superfund sites. Not an EJ study

How:
Buffer rings were placed around each site boundary. For sites lacking boundary data, a circular site boundary, equal to site acreage (latitude/longitude) was fixed around each site. 2015-2018 Census data for each block group was identified for each centroid. Note: census blocks group values can be over or underestimated.

Findings:
"While there is no single way to characterize communities located near our sites, this population is more minority, low income, linguistically isolated, and less likely to have a high school education than the U.S. population as a whole." (1)

Note: Minority is not defined within this report, 21 million live within 1 mile of Superfund site (6%) and 73 million live within 3 miles of a Superfund site.



Definitions

Environmental Justice:

Environmental justice is the fair treatment of people of all races, income, and cultures with respect to the development, implementation and enforcement of environmental laws, regulations, and policies, and their meaningful involvement in the decision-making processes of the government.

Source: *Not in My Backyard: Executive Order 12,898 and Title VI as Tools for Achieving Environmental Justice* Christine Todd Whitman, administrator, U.S. Environmental Protection Agency, memorandum to Assistant Administrators et al., EPA's Commitment to Environmental Justice, Aug. 9, 2001, https://www.usccr.gov/files/pubs/envjust/ch2.htm

Secondary source: https://19january2021snapshot.epa.gov/environmentaljustice/ej-2020-glossary_.html#:~:text=Environmental%20Justice%20(EJ)%20%2D%20The,laws%2C%20regulations%2C%20and%20policies.

Superfund Sites:

When: December, 11, 1980:

What: Congressional Definition

"At the federal level, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA; P.L. 96-510) established the liability of certain categories of potentially responsible parties (PRPs) for the costs of remediating hazardous substances released into the environment, natural resource damages, and related federal public health studies. CERCLA authorized the Hazardous Substance Superfund Trust Fund to finance the remediation of sites without financially viable PRPs to fulfill their liability. The U.S. Environmental Protection Agency (EPA) administers and oversees the remediation of sites prioritized for federal involvement under the Superfund program, in coordination with the states in which the sites are located."(1)

(CERCLA), informally known as Superfund.

Superfund = trust fund established by excised taxes and administered through the EPA.

CERCLA = the law that established the framework to identify and address actual hazardous wastes sites and their potential release. EPA acts as the legal authority in enforcing this law.
(1) https://www.congress.gov/crs-product/IF11982

For defining sites, CERCLA defines "site" for the portion of the facility of released or future release of hazardous substances. NPL site boundaries are not tied or limited to property boundaries where the substances are located. The EPA implements institutional controls for Superfund sites in collaboration with state and local governments to limit the use of land and guide human behavior to minimize exposure to hazards and contamination. These boundaries will vary over time. The EPA does not establish nor recommend any safe perimeters for NPL sites. (https://semspub.epa.gov/work/HQ/174025.pdf)

Background:

Why: Public knowledge and subsequent outrage following:

1. Love Canal Disaster, 8/22/78: buried leaking chemical containers-linked to serious health treats: cancer, birth defects.Placed on the NPL list in 1981.
2. Valley of the Drums, an uncontrolled dump for industrial chemicals between 1967-1977. Placed on the NPL list in 1981.

Goals:

1. Protect human health and the environment by cleaning up contaminated sites
2. Make responsible parties pay for the cleanup work
3. Involve communities in the Superfund process
4. Return Superfund sites to productive use

Additional sources: #3 of the annotated bibliography section: Superfund Assessment Page:
https://www.epa.gov/superfund/superfund-site-assessment-home

Policies:

1. 42 U.S.C. 4321: National Environmental Policy Act, 1969: One of the first laws written to establish a broad framework for protecting the environment.

Purpose: "To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare or man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality."
https://www.energy.gov/sites/default/files/2023-08/NEPA%20reg%20amend%2006-2023.pdf, Section 2

Through this Law, the EPA is responsible as the acting “regulatory agency,” in which they write regulations to explain critical details that help in implementation of environmental laws.

https://www.epa.gov/laws-regulations/summary-national-environmental policy-act#:~:text=The%20National%20Environmental%20Policy%20Act%20(NEPA)%20was%20one%20of%20the,the%20most%20visible%20NEPA%20requirements.

legal allowable limits for superfund sites

There are no fixed “allowable limits” for each contaminant, instead they are determined on a site-by-site basis within CERCLA law by using a **Hazard Ranking System**(HRS). Sites with scores of 28.50 or greater are eligible for placement on the **National Priorities List** (NPL). Risk assessors are assigned based on current and future risk according to the level of ill health effects to humans and ecological risk.

Process of Assessment:

Discovery/Notification
Pre CERCLA screening (Federal sites may skip this step)
Preliminary Assessment
Site Inspection
HRS Score Evaluation (below 28.50 = no further assessments needed)
Determination of placement on NPL based on HRS score
Remedial Action (Record of Decision, ROD, an outline of clean up measures and rationale)
Post-Construction, potential deletion from list

This EPA page (link below) hosts a variety of tools, models and databases that can be utilized in risk assessments for both human health and ecological risks.
https://www.epa.gov/risk/human-health-risk-models-and-tools#hhdatabases

“It should be emphasized that how and to what degree a specific contaminant at an individual site must be cleaned up under CERCLA are not specified in the law itself.”

and :

“Although CERCLA established a general process for making cleanup decisions, more specific direction is provided in EPA regulation and agency guidance. Other federal agencies that administer the cleanup of federal facilities under CERCLA have developed additional guidance documents that apply to their own respective facilities.” (1)

(1) Bearden, David, M., *Comprehensive Environmental Response, Compensation, and Liability Act: A Summary of Superfund Cleanup Authorities and Related Provisions of the Act,* 2012, https://www.congress.gov/crs-product/R41039#:

Radial Distance of the Difference of Differences

- This concept combines the idea of radial distance with the "difference of differences" to measure changes in the rate of change of distances between points.
- It can be used to track how the distances between points are evolving over time or in space.
- For example, in image processing, you might track the radial distance between two points on a moving object and analyze how that distance is changing.

Applications:

- Image Processing: Analyzing motion in images, tracking object shapes, and identifying changes in radial distance.
- Signal Analysis: Identifying changes in the frequency or amplitude of a signal over time.
- Other Fields: Analyzing changes in physical phenomena, such as the rate of change of temperature or pressure.

Example Scenario:

Imagine you're tracking the movement of two dots on a screen.

- 1. Initial Radial Distance: Calculate the distance between the dots at a specific time (or spatial location).
- 2. Difference of Differences: Calculate the change in the distance between the dots over a short time interval, and then calculate the change in that change.
- 3. Radial Distance of the Difference of Differences: This measure quantifies how the rate of change of the radial distance between the dots is evolving.

Radial distance: refers to the distance of a point from a central point or origin. It's a measure of how far away a point is in a straight line from a reference point.
In 2D coordinate system:
the radial distance of a point (x,y) from the origin (0,0) is calculated as $r+ \sqrt{(x^2 + y^2)}$
In 3D coordinate system:
$r = \sqrt{(x^2 + y^2 + z^2)}$
