Chapter 3

Racial and Socioeconomic Disparities in the Distribution of Environmental Hazards: Assessing the Evidence Twenty Years after *Toxic Wastes and Race**

The publication in 1987 of the United Church of Christ (UCC) Report, *Toxic Wastes and Race in the United States*, led to increasing public awareness about disproportionate environmental burdens in people of color communities and further fueled the growing environmental justice movement. It also led to a closer examination by academic researchers of the claims of the Report and movement about the extent, causes and consequences of disproportionate environmental burdens.

One of the most comprehensive examinations of the links between race, class and environmental quality in the wake of the 1987 UCC Report was provided in 1990 by Professor Robert D. Bullard's groundbreaking book *Dumping in Dixie*. The UCC Report and growing visibility of the environmental justice movement also spurred Professors Bunyan Bryant and Paul Mohai of the University of Michigan's School of Natural Resources and Environment to organize in 1990 the "Michigan Conference on Race and the Incidence of Environmental Hazards." The Michigan Conference was the first to bring together researchers from around the nation examining the links between race, poverty and environmental burdens. Conference participants presented the findings of their latest research, which were published in the Conference Proceedings[1] and forwarded to the U.S. Environmental Protection Agency (EPA).

The growing environmental justice movement, UCC Report, Michigan Conference Proceedings and a direct appeal made to U.S. EPA Administrator William Reilly by Michigan Conference participants (later dubbed by EPA as the "Michigan Coalition"[2]) led to the EPA's own investigation of the issues. In 1992 the EPA published the report *Environmental Equity: Reducing Risk for All Communities*, which summarized EPA's findings and outlined draft recommendations for dealing with the issues of environmental injustice. This chain of events led to further political and academic interest. A major policy milestone was reached when in 1994 President Bill Clinton issued Environmental Justice Executive Order 12898, which calls upon all agencies of the federal government, not just the EPA, to take into account the environmental justice consequences of their actions. At the same time, the number of research studies examining racial and socioeconomic disparities around environmentally hazardous sites grew dramatically and steadily over the 20 years since publication of the 1987 UCC report.

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In that time period, three systematic reviews of the existing research have been conducted (Mohai and Bryant 1992; Goldman 1994; Ringquist 2005). All these reviews have found a preponderance of evidence that environmental hazards of a wide variety are distributed inequitably by race and socioeconomic status. Most studies have found the racial and socioeconomic disparities to be statistically significant. However, the disparities often have been found to be modest (Ringquist, 2005). Some studies have found no statistically significant disparities (e.g., Anderton et al., 1994; Oakes et al., 1996; and Davidson & Anderton, 2000). In a recent paper published in the journal *Demography,* Professors Paul Mohai and Robin Saha (2006) explain how much of the early environmental justice research has employed methods

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that failed to adequately account for where people live in relation to hazardous sites. If it is true that a disproportionate number of people of color and poor people live near where environmental hazards are located, then failure to adequately match the location of where people live and where environmentally hazardous sites are located will lead to an underestimation of these disparities.

In this chapter, we describe advances in environmental justice research that better determine where people live in relation to where hazardous sites are located than do earlier, more traditional methods. We show in this chapter and in the next that, by better matching the locations of people and hazardous sites, racial and socioeconomic disparities around the nation's hazardous waste facilities are found to be far greater than what previous studies have shown. The differences are even greater than those reported in the 1987 UCC Report.

The Traditional Method of Conducting Environmental Justice Analyses

The traditional method of conducting environmental justice analyses has been to use census data to look at the racial and socioeconomic characteristics of people living inside geographic units, such as zip code areas and census tracts,[3] containing or "hosting" hazardous sites, and then compare these against the racial and socioeconomic characteristics of the geographic units not containing or hosting the sites. In making this comparison, researchers have tended to assume that people living in the host units are located closer to the hazardous sites under investigation than those living in the non-host units. However, this is not necessarily true. First, the hazardous sites may be near the boundary of the host units, and hence the area and populations of neighboring units may be as close to the sites as those of the hosts. Note the proximity of adjacent units west and south of the unit containing a commercial hazardous waste facility in Figure 3.1A. That hazardous waste facilities and other potential environmental hazards are located near the boundaries of their host units is not a rare event. Mohai and Saha (2006), for example, found that almost 50% of commercial hazardous waste facilities are located within a quarter mile of their host tract boundaries while more than 70% are located within a half mile.

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Second, there is a great deal of variation in the size of the geographic units typically used in environmental justice analyses and, depending on the size, not all the units do an equally good job of controlling for the proximity between hazardous sites and nearby residential populations. Again as an illustration, Mohai and Saha (2006) found that the smallest census tract containing a commercial hazardous waste facility is less than one-tenth of a square mile, while the largest is over 7,500 square miles, with all sizes in between. When a host unit is small, such as the tract that is only one-tenth of a square mile, then anyone living in it will necessarily live close to the facility. However, if a host unit is large, such as the tract that is over 7,500 square miles in area, most people in it likely live quite far from the facility, especially if the facility is located on the tract's boundary, as it is in this case (see Figure 3.1B).

Newer Methods of Matching Where People and Hazards Are Located

As environmental justice research efforts have progressed, newer methods have been introduced that do a better of job of matching where people live with where environmental hazards are located. Mohai and Saha (2006) have referred to these methods as "distanced-based" methods. Earlier research did not determine precise geographic locations, just that the environmental hazard and geographic unit were "coincident" (thus the term "unit-hazard coincidence method" has been used to refer to this method). In applying distance-based methods, however, the precise geographic locations of the environmental hazards are determined. Once the precise geographic location of the hazard is known, *all* geographic units within a specified distance of the hazard - not just the host unit – are combined to form the host *neighborhood* around the hazard. The racial and socioeconomic characteristics of the host neighborhood are then compared against the characteristics of areas outside the neighborhood.

Figure 3.1 – Comparing Methods of Matching Where People and Hazardous Waste Facilities Are Located

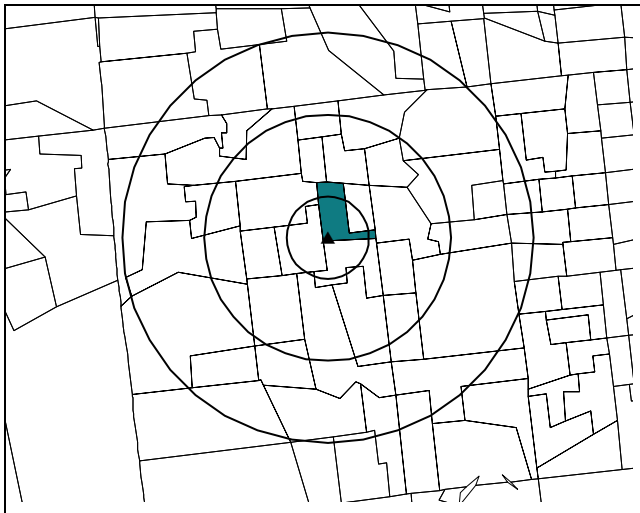


Figure 3.1A: Host tract and 1, 3, and 5 km. circles

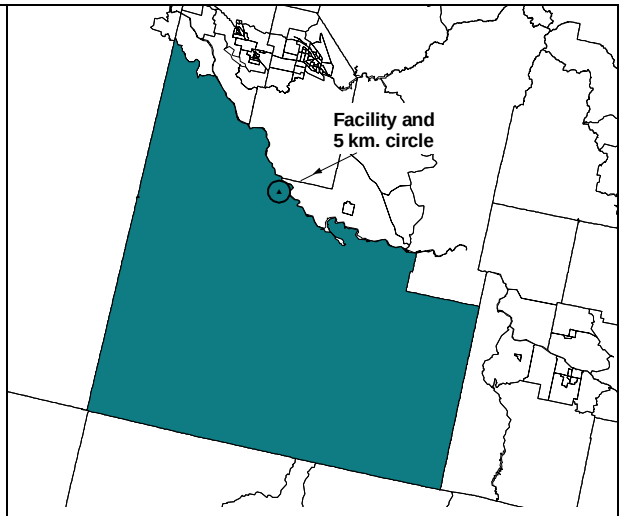


Figure 3.1B: Largest host tract in U.S.

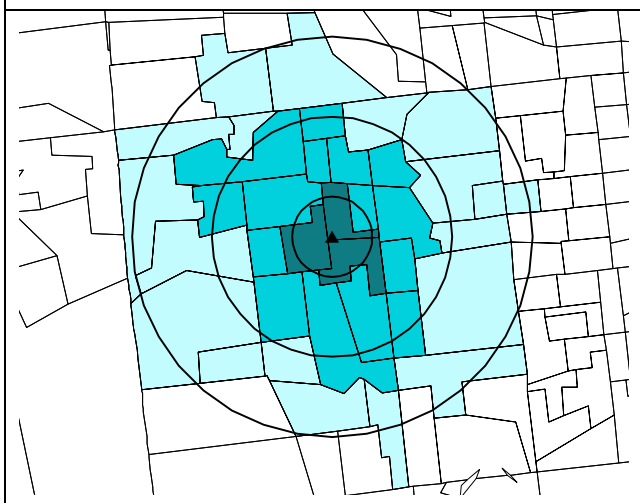


Figure 3.1C: 1, 3, and 5 km. host neighborhoods using 50% areal containment method

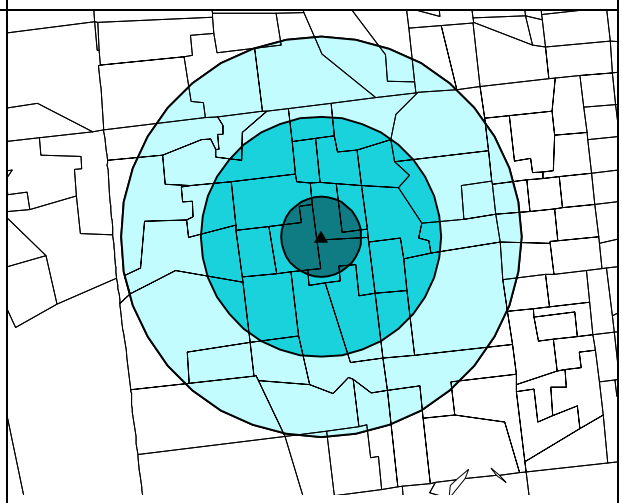


Figure 3.1D: 1, 3, and 5 km. host neighborhoods using areal apportionment method

Figures 3.1C and 3.1D provide illustrations of neighborhoods around the hazardous waste facility that are at distances of one, three and five kilometers (0.6, 1.8 and 3.1 miles, respectively) from the facility. Note in these figures that not all the neighboring units (in this case census tracts) fit neatly within the specified distances. Some neighboring units may be only partially inside the distance. Should the partially "captured" unit be considered a part of the host neighborhood? If most of the unit (say 90% of it) is within the specified distance, the decision to include it is probably a reasonable one. However, what if only 10% of the unit is captured? Figures 3.1C and 3.1D illustrate the results of applying two different rules or methods for making this decision. Mohai and Saha (2006) refer to these as the "50% areal containment" and "areal apportionment" methods.

Figure 3.1 (continued)

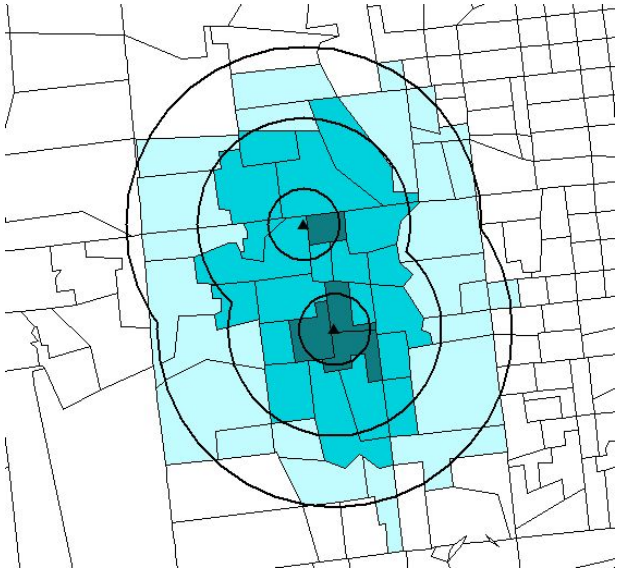


Figure 3.1E: Overlapping host neighborhoods using 50% areal containment method

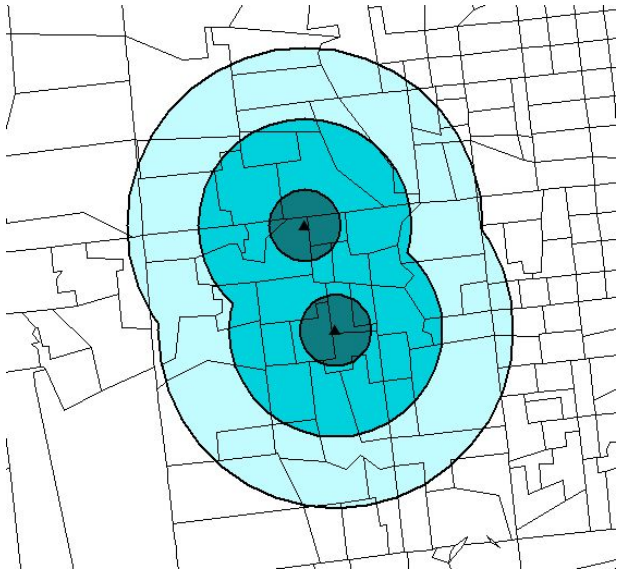


Figure 3.1F: Overlapping host neighborhoods using areal apportionment method

In applying the 50% areal containment method, any unit in which at least 50% of its area is within the specified distance of the hazard is considered to be part of the host neighborhood. The result is a roughly circular neighborhood as illustrated in Figure 3.1C. In applying the areal apportionment method, every unit that is at least partially inside the specified distance, no matter how little is captured, is given some weight in constructing the host neighborhood. Specifically, a portion of the unit's population is used to estimate the population characteristics within the distance. This portion is based on the proportion of the unit's area that lies inside the distance. For example, if 20% of the area of a unit is captured, then 20% of its population is used. If 90% of the area is captured, then 90% of the unit's population is used, and so on. The sum (or aggregate) of these populations are then used to determine the population characteristics within perfectly circular neighborhoods within the specified distances, as illustrated in Figure 3.1D. If the hazardous sites "cluster" (i.e., are so close to each other that their respective neighborhood boundaries overlap), the respective boundaries can be merged such as in Figures 3.1E and 3.1F.

Mohai and Saha (2007) found distance-based methods to be robust. In other words, both 50% areal containment and areal apportionment methods lead to similar estimates about the racial and socioeconomic characteristics of the neighborhoods within specific distances of the nation's hazardous waste facilities. The use of different building block units to construct the neighborhoods - such as census tracts, zip code areas or other geographic units (e.g., census block groups) - also leads to similar estimates of the characteristics of these neighborhoods.

Data and Analysis

Commercial hazardous waste treatment, storage and disposal facilities (TSDFs) analyzed in this chapter and the next were identified from information provided in 1) the U.S. Environmental Protection Agency's *Biennial Reporting System* (BRS), 2) EPA's *Resource Conservation and Recovery Information System* (RCRIS), 3) EPA's *Envirofacts Data Warehouse* and 4) the *Environmental Services Directory* (EDS).[4] These databases were cross-checked and used to identify commercial hazardous waste TSDFs receiving waste from off-site operating in the U.S. at the time data for the 2000 Census were being collected (in 1999). All together, 413 facilities were identified (more details about how hazardous waste facilities were identified are given in the next chapter). The status of the facilities, their addresses and precise

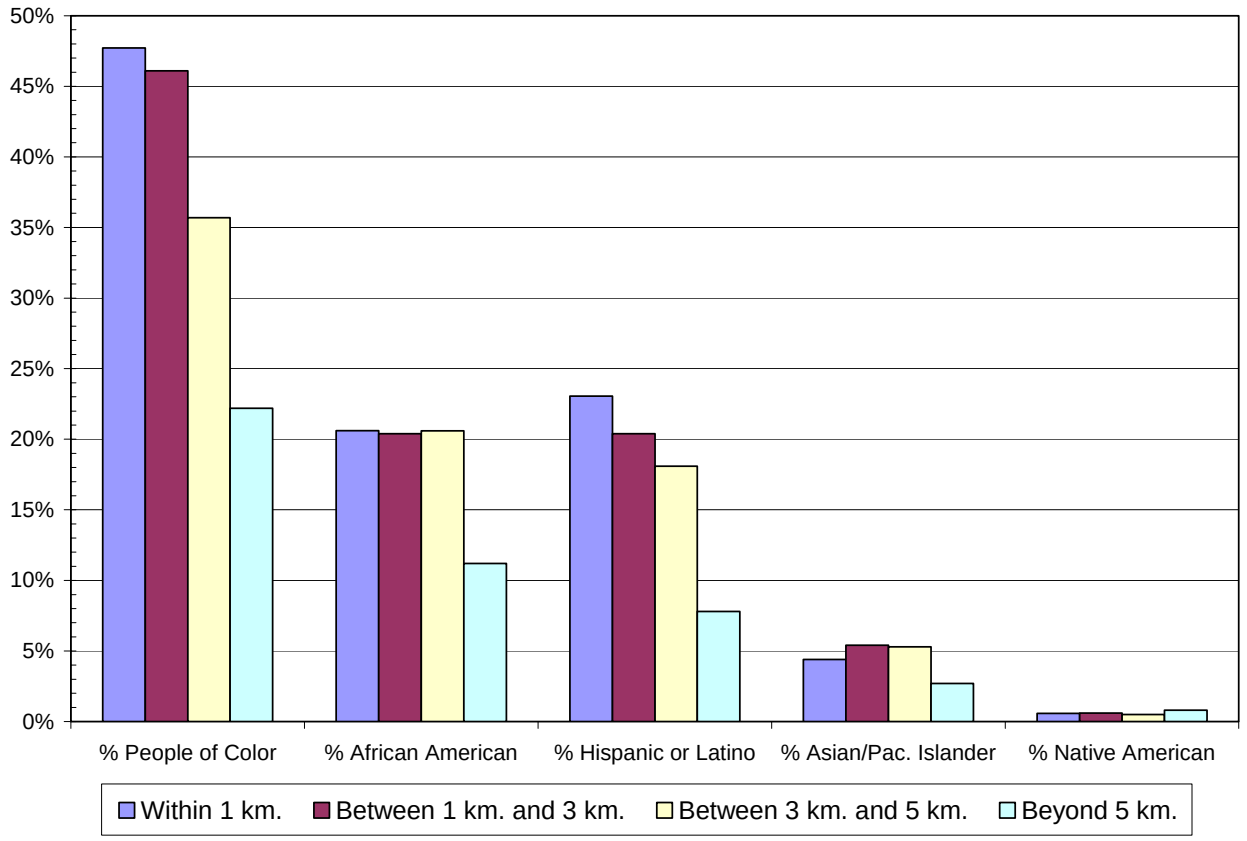
geographic locations (determined by Geographic Information Systems' [GIS] geocoding procedures) were verified by contacting the companies. Using census tracts as the building block units, GIS also was used to construct circular neighborhoods within one, three and five kilometers of the facilities by applying the 50% areal containment and areal apportionment methods. These distances were chosen because they are well within the distances used in prior studies and within which health, economic and other quality of life impacts have been found to exist (Mohai and Saha, 2006, 2007).

The demographic characteristics of these neighborhoods were determined using 1990 census data (U.S. Bureau of the Census, 1990). The 1990 census data were used in order to better compare the results of using distance-based methods with those using the more traditional unit-hazard coincidence method since most of the earlier studies relied on the 1990 census. In the next chapter people of color percentages around the nation's hazardous waste facilities are given using the more recent 2000 census.

Results

Figure 3.2 and Table 3.1 display people of color percentages in the circular neighborhoods around the nation's hazardous waste treatment, storage and disposal facilities using the areal apportionment method (see Figure 3.1D). The 50% areal containment method yields similar results and thus the results are not shown. People of color percentages are given in the circular neighborhoods at the varying distances from the sites. These include: 1) within one kilometer, 2) between one and three kilometers, 3) between three and five kilometers and 4) beyond five kilometers. People of color percentages are examined within these distances in order to see how these percentages change with varying distances to the facilities.

Figure 3.2 – Percent People of Color Living Near Hazardous Waste Facilities



It is clear from an examination of Figure 3.2 and Table 3.1 that the proportions of people of color are higher closer to the facilities (poverty rates are also higher, as seen in the table, while mean household incomes and mean housing values are lower). Beyond five kilometers of the nation's hazardous waste facilities the proportion of people of color is only 22.2%. However, at distances between three and five kilometers, the proportion of people of color increases to 35.7%. It increases again to 46.1% between the distances of one and three kilometers, and reaches 47.7% within a distance of one kilometer. Figure 3.2displays the percentages of African Americans, Latinos, Asian and Pacific Islanders, and Native Americans individually within the varying distances of the sites. In all cases except for Native Americans, the percentages within five kilometers of a hazardous waste facility are larger than the percentages beyond five kilometers.

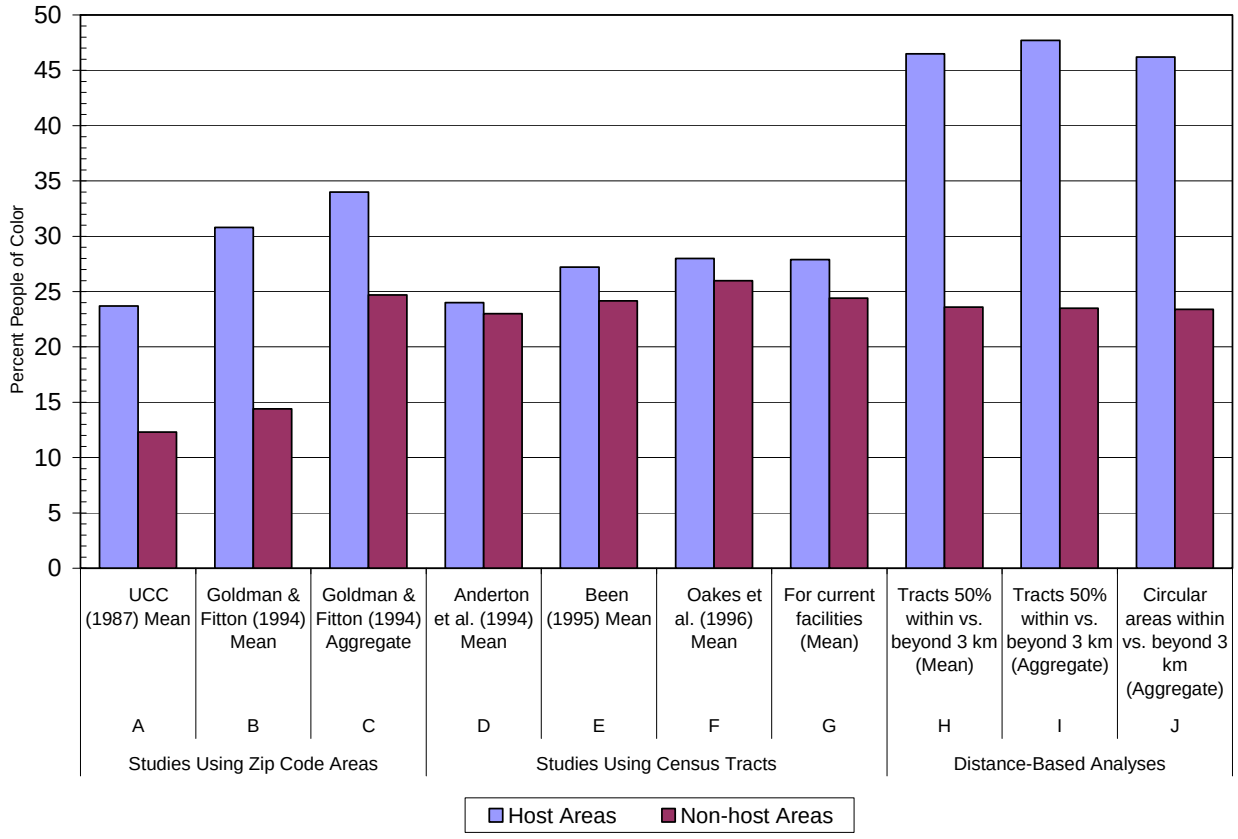
Table 3.1 – Racial and Socioeconomic Characteristics of People Living Near Hazardous Waste Facilities

	Within 1 km.	Between 1 km. and 3 km.	Between 3 km. and 5 km.	Beyond 5 km.
Population				
Total Population (1000s)	845	7,828	14,101	225,936
Population Density (persons per square kilometer)	690	840	810	24
Race/Ethnicity				
Percent People of Color	47.7%	46.1%	35.7%	22.2%
Percent African American	20.6%	20.4%	20.6%	11.2%
Percent Hispanic	23.1%	20.4%	18.1%	7.8%
Percent Asian/Pacific Islander	4.4%	5.4%	5.3%	2.7%
Percent Native American	0.6%	0.6%	0.5%	0.8%
Socioeconomic Characteristics				
Poverty Rate	20.1%	18.3%	16.9%	12.7%
Mean Household Income	$31,192	$33,318	$36,920	$38,745
Mean Housing Value	$93,985	$102,594	$111,915	$111,956

The estimated percentages of people of color near hazardous waste facilities appear much less if the unit-hazard coincidence method is employed. Figure 3.3 displays the results of the past studies that have used this approach (see Appendix 3.1 for exact values). Columns A, B and C show the results of the studies that have used zip code areas to identify the areas containing ("hosting") or not containing hazardous waste facilities. Columns D, E, F and G show the results of studies that have used census tracts to identify host and non-host areas. Generally, studies using zip code areas have found bigger differences in the people of color percentages between host and non-host areas than the studies using census tracts. For example, the 1987 United Church of Christ study, using 1980 census data, found that the average people of color percentage in zip code areas containing a hazardous waste facility to be 23.7% compared to only 12.3% for zip code areas not containing a facility (Column A). In their update to the UCC study, Goldman and Fitton (1994) used 1990 census data and found that the average people of color percentages for host and non-host zip code areas were 30.8% vs. 14.4% (Column B). In summing (aggregating) populations in zip code areas, instead of averaging them, Goldman and Fitton found the people of color percentages in host and non-host zip code areas were 34.0% and 24.7%, respectively (Column C).

As mentioned, estimated disparities using the unit-hazard coincidence method have been even less when census tracts instead of zip code areas have been used. For example, Anderton et al. (1994) using the 1980 census data found the average people of color percentages in host and non-host tracts to be 24.0% vs. 23.0%, respectively (Column D). Oakes et al. (1996) using 1990 census data found these percentages to be 28.0% vs. 26.0%, respectively (Column F).[5] However, both Anderton et al. and Oakes et al. omitted rural areas and some metropolitan areas from their analyses, and thus did not design their studies similarly to the UCC and Goldman and Fitton studies. However, even when the study designs are constructed similarly to that of the UCC, the differences in the average people of color percentages between host and non-host census tracts, although somewhat bigger, are still relatively small. For example, Been (1995) using 1990 census data found these to be 27.2% vs. 24.2%, respectively (Column E), while applying the unit-hazard coincidence method and 1990 census to the current universe of 413 hazardous waste facilities leads to similar results (27.9% vs. 24.4%; see Column G).

Figure 3.3 – Comparing Results of Past Studies Using Unit-Hazard Coincidence Method with Results Using Distance-Based Methods



As indicated in Figure 3.3, the newer, distance-based methods, which better match where people and environmentally hazardous sites are located, reveal much larger racial disparities in the distribution of hazardous waste facilities. In order to make a more direct comparison with the earlier studies, Columns H, I and J in Figure 3.3 (see also Appendix 3.1) display the people of color percentages within and beyond three kilometers of the nation's hazardous waste TSDFs using 50% areal containment and areal apportionment methods. Column H shows differences in the people of color percentages applying the 50% areal containment method in which percentages for census tracts have been averaged. Column I also shows differences in the people of color percentages applying the 50% areal containment method, but in which the populations of the tracts have first been aggregated (summed).

Column J shows differences in the people of color percentages applying the areal apportionment method, and here also the percentages are for the aggregate populations within and beyond the three-kilometer distances.

As can be seen, regardless of which distance-based method is applied (and regardless of whether populations are averaged or summed), the proportion of people of color estimated to be within three kilometers of a hazardous waste facility is between 46% and 48%, while the proportion of people of color estimated to be beyond this distance is between 23% and 24%. Thus, both the concentration of people of color around the nation's hazardous waste facilities (about 46%) and disparities between host and non-host areas (over 20%) are far greater when distance-based (Columns H to J), as opposed to unit-hazard coincidence (Columns A to G), methods are applied.

Newer methods which better match where people and environmentally hazardous sites are located reveal much larger racial disparities in the distribution of hazardous waste facilities than previously reported.

Conclusions

The 1987 UCC Report has had a major impact in the U.S. and worldwide in raising public awareness about the issues of environmental injustice. It has spurred academic researchers to take a close look at the extent, causes and consequences of disproportionate environmental burdens in poor and people of color communities, fueled public policy debates about how environmental injustices should be remedied, and further stimulated the environmental justice movement. The number of research studies has grown steadily and dramatically over the past 20 years. The majority of these have found significant racial and socioeconomic disparities in how environmental hazards of a wide variety are distributed. Nevertheless, newer methods that better match where people and environmental hazards are located indicate that such disparities are even greater than what these previous studies have shown. Given the attention to environmental injustice fueled by the evidence of the 1987 UCC Report and other prior studies, a finding that racial and socioeconomic disparities around hazardous sites are even greater than previously reported when these methods are applied underscores the urgency of finding solutions to this problem.

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In the next chapter, the newer methods are applied to the most recent data on hazardous waste facility location and the 2000 census in order to make a more detailed and up-to-date assessment of the current extent of racial and socioeconomic disparities in the distribution of the nation's hazardous waste facilities.

Endnotes

[1] The Conference Proceedings were subsequently edited and published in 1992 by Westview Press under the title, *Race and the Incidence of Environmental Hazards: A Time for Discourse*, Bunyan Bryant and Paul Mohai, editors.
[2] Representatives of the Michigan Conference were invited to meet with EPA Administrator William Reilly in September 1990 to talk about the disproportionate environmental burdens in people of color and poor communities and what steps EPA could take to address this issue. These representatives were dubbed the "Michigan Coalition" by

EPA and included Bunyan Bryant, Robert D. Bullard, Ben Chavis, Michel Gelobter, David Hahn-Baker, Charles Lee, Paul Mohai and Beverly Wright.

[3] Zip code areas are geographic areas consisting of "a section of a street, a collection of streets, an establishment, structure or group of post office boxes" assigned a five- to eleven-digit code by the U.S. Postal Service for the purpose of delivering mail. Census tracts are small geographic subdivisions of counties drawn "by a local committee of census data users for the purpose of presenting data." Averaging about 4,000 inhabitants, tracts are "designed to be relatively homogeneous units with respect to population characteristics, economic status and living conditions" (http://www.census.gov/main/www/cen2000.html).

[4] These are available, respectively, from: 1) U.S. Environmental Protection Agency (2003); 2) U.S. Bureau of the Census (1993); 3) U.S. Environmental Protection Agency 2001/2002; and 4) Environmental Information Ltd. (2001/2002). See "References."

[5] Neither Anderton et al. (1994) nor Oakes et al. (1996) presented the overall people of color percentages as did the UCC (1987), Goldman and Fitton (1994) and Been (1995) studies. Instead, they presented percentages for African Americans and Latinos separately. In order to more easily compare the results of the two former studies with those of the latter, the African American and Hispanic percentages were summed to produce an overall people of color percentage. As Mohai (1995) points out, such summing is a reasonable approximation of the overall people of color percentages in the U.S. since the proportion of other racial and ethnic groups other than African Americans and Latinos is in comparison small. The overlap between the African American and Latino percentages is likewise very small. For example, in the 1980 census African Americans and Latinos made up 97.7% of all racial and ethnic minorities while the overlap between these two categories was less than 1.0%.

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Appendix 3.1 - People of Color Percentages in Host and Non-Host Areas Estimated from Distance-Based versus Unit-Hazard Coincidence Methods

	Unit-Hazard Coincidence Studies Using Zip Code Areas			Unit-Hazard Coincidence Studies Using Census Tracts				Distance-Based Analyses		
	A	B	C	D	E	F	G	H	I	J
	UCC (1987)	Goldman & Fitton (1994)	Goldman & Fitton (1994)	Anderton et al. (1994)	Been (1995)	Oakes et al. (1996)	For current facilities	Tracts 50% within vs. beyond 3 km	Tracts 50% within vs. beyond 3 km	Circular areas within vs. beyond 3 km
	(Mean)	(Mean)	(Aggregate)	(Mean)	(Mean)	(Mean)	(Mean)	(Mean)	(Aggregate)	(Aggregate)
Percent People of Color in Host Areas	23.7%	30.8%	34.0%	24.0%	27.2%	28.0%	27.9%	46.5%	47.7%	46.2%
Percent People of Color in Non-host Areas	12.3%	14.4%	24.7%	23.0%	24.2%	26.0%	24.4%	23.6%	23.5%	23.4%