Environmental justice: an analysis of superfund sites in Florida.

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In this study we investigate the spatial relationship between Superfund sites and the racial, ethnic, and economic characteristics of the areas surrounding those sites in the state of Florida. Unlike many previous environmental justice studies, we examine census tracts rather than larger aggregates such as counties or zip codes. We also look at the problem of environmental injustice longitudinally by analyzing Census data from 1970, I980, and 1990. Such an analysis not only allows us to detect potential environmental inequality, but also to postulate on the nature and origins of this injustice. Overall, our findings indicate that Blacks and Hispanics are more likely to live near Superfund hazardous waste sites, but income and poverty indicators do not predict the location of sites. The spatial association between race, ethnicity, and Superfund sites is increasing over time, leading us to conclude that the likely cause of much of the recent environmental injustice uncovered in our results stems from indirect, rather than direct, forms of discrimination.

Environmental justice (EJ) researchers have focused much of their research on the spatial relationship between race, ethnicity, economics and hazardous waste facilities.(1) However, the study of EJ encompasses more than the analysis of the placement of active waste facilities in minority and poor areas (Bullard 1996). It is also concerned with the social and economic processes that shape racial, ethnic, and economic demographic patterns around existing hazardous waste sites. For this reason, we have chosen to examine the issue of environmental justice by looking at the spatial distribution of Superfund sites. Such an endeavor contributes to the body of EJ research in three ways. First, our analysis helps shed some light on the recent debate concerning the existence of environmental injustice. This debate is most often framed in terms of the presence or absence of a statistical association between race, ethnicity, income, and hazardous waste. For instance, several studies provide evidence that demonstrates that nonWhites and the poor are more likely to live near hazardous waste than are Whites and the more affluent (e.g., Adeola 1994; Bullard 1983, 1990; Gould 1986; Mohai and Bryant 1992; Pollock and Vittas 1995; United Church of Christ 1987; U.S. General Accounting Office 1983; White 1992). Other research, however, suggests that the spatial association between race, ethnicity, and hazardous waste is weak at best (Anderton et al. 1994a, 1994b; Anderton et al. 1997; Bowen et al. 1995; and Yandle and Burton 1996).(2) It is clear, then, that more research needs to be done in the area of EJ.

Second, if our data support the contention that environmental injustice does exist, we should be able to determine whether that injustice is more a matter of racial or economic inequalities. While it is certainly plausible that both race and economics matter, past literature has generally suggested that race may be the more salient factor when determining the location of hazardous waste (cf. Mohai and Bryant 1992; United Church of Christ [UCC] 1987).

Third, assuming evidence of environmental injustice exists with respect to race and ethnicity, we believe that it is important to discover the modus operandi of this form of injustice. As we will argue, discrimination may be direct or indirect. While direct discrimination may be overt or institutionalized, indirect discrimination is, by-and-large institutionalized and can be related to larger structural inequalities and market forces (Feagin 1977). Understanding how, and to what extent, both forms of discrimination contribute to the problem of environmental injustice is important because social policy aimed at eliminating one form of discrimination may not be effective at combating other forms of discrimination. To this end, we examine the concept of discrimination as it relates to the issue of "structured choice" to explain the possible existence of environmental injustice. This is important as a large portion of past EJ research has been empirically or theoretically focused on direct and overt forms of discrimination (Bullard 1990; Bullard and Wright 1987; Goldman 1996; and UCC 1987 are examples that look beyond overt discrimination). A cross-sectional examination of the problem cannot provide enough information to help us distinguish between direct and indirect types of discrimination. Consequently, we have analyzed the problem of environmental injustice both longitudinally and cross-sectionally. Specifically, we look at changing racial, ethnic, and economic characteristics in areas containing Superfund sites over a twenty-year time period. Before we begin our analysis, we feel that a brief overview of past research is necessary. Following our review of the literature we discuss some relevant methodological and theoretical issues that should be taken into account when examining EJ issues.

Prior Research

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Several researchers have studied EJ issues by examining the geographical association between race, ethnicity, economic indicators, and areas that contain hazardous substances in the form of inactive, uncontrolled, or abandoned disposal sites. Data on the location of these sites are recorded and made available to the public through the Environmental Protection Agency's (EPA's) Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS). The most hazardous CERCLIS sites are those that the EPA has determined pose a "substantial health threat" to people residing nearby.(3) These CERCLIS sites, also known as "Superfund" sites, are placed on the National Priority List (NPL) so that federal funding can be allocated to aid in cleaning them up.

In 1987 the United Church of Christ (UCC) published the results of research that looked at all uncontrolled toxic waste sites in the United States. They found that CERCLIS sites were most often located in zip codes where the population was disproportionately Black and poor. Using multivariate discriminant analysis, the UCC determined that race was more strongly related to the location of CERCLIS sites than income. Kreig (1995) studied the distribution of Superfund sites in the greater Boston area and replicated the UCC's results. However, he found that race was more strongly related to Superfund sites in older industrial areas, while income was more strongly related to Superfund sites in newer industrial areas. Kreig coneluded that new industrial growth attracted many workers from inner city areas where old industrial jobs were declining. Those individuals who were able to take advantage of more technical and high paying jobs were also able to make the move with industry. Since many poor Blacks were unable to move or were unqualified for these jobs, they remained in the older industrial areas where jobs were scarce and income relatively low (see also Wilson 1987). As Kreig explains, urbanization may be the cause of hazardous waste, but structural inequalities account for variation in organization, which would impact the relationship between race and hazardous waste within any given area.

Other studies examining the relationship between race, economic indicators, and Superfund sires have not been so definitive. For example, Zimmerman (1993) looked at the distribution of Superfund sites across designated Census Places and Minor Civil Divisions (MCDs).(4) Zimmerman's results were inconclusive as they varied by the type of statistic used in her analysis. In Zimmerman's study, weighted averages produced results indicating the presence of environmental injustice while unweighted averages did not. We should note that Zimmerman compared racial and ethnic demographics of Census Places and MCDs containing one or more NPL sites to racial and ethnic demographics of geographic regions of the nation (e.g., northeast, midwest, south, and west) in which those Census Places were located.

Hird (1994) also used census data to examine the residential, political, and economic characteristics of areas surrounding NPL sites. Hird suggests that Superfund sites are more likely to be found in counties that are more affluent rather than economically disadvantaged ones. Hird also found, however, that NPL sites are more likely to be located in counties with a higher percentage of nonWhites. These results do provide evidence in support of the position that environmental injustice is more a matter of race and ethnicity than economics.

Recently, Anderton et al. (1997) examined the spatial distribution of CERCLIS sites (including a separate comparison for NPL sites) across 1990 census tracts. In order to draw conclusions about EJ, Anderton and his colleagues used two different comparison groups in their study. First, they compared CERCLIS tracts to all other non-CERCLIS tracts within the metropolitan area containing the CERCLIS site(s). Next, they compared CERCLIS tracts to all other tracts in the United States. Both comparisons yielded similar results in that Anderton et al. found the percentage of Blacks and Hispanics to be significantly lower in tracts containing CERCLIS sites when compared to tracts containing no site. These comparisons were roughly the same for NPL and non-NPL CERCLIS tracts. Their multivariate analysis of CERCLIS sites provided results that varied by type of site. When variables such as population density, percentage of industrial employment, and average value of owner-occupied housing were controlled, an increase in the percentage of Blacks, Hispanics, or families below the poverty line in any given tract decreased the incidence of NPL sites in that tract. These multivariate results were markedly different for non-NPL CERCLIS sites, as both the percentage of Blacks and Hispanics increased the incidence of those sites in that tract. As Anderton et al. (1997:17) note, however, "none of these effects is so large to be considered strong evidence of substantive inequality."

Taken together, these studies offer mixed evidence as to the spatial relationship between race, ethnicity, economic status, and Superfund sites. Because several methodological concerns have been raised with respect to various EJ studies, we feel that an extended discussion of those concerns is necessary. Such a discussion also provides readers with an overview of the more salient methodological issues that surround the study of EJ. We note here, however, that many such criticisms stem from analyses that have focused on hazardous waste sources other than those used in this study (e.g., data on Treatment, Storage and Disposal Facilities [TSDFs] as well as data on Toxic Release Inventory [TRI] sites).

Methodological Concerns

In general, three relevant methodological concerns impinge upon the empirical examination of EJ, regardless of the type of environmental hazard examined (see Anderton et al. 1997; Clark et al. 1995). These concerns center on: (1) the choice of units of analysis; (2) the appropriateness of controls; and, (3) the issue of causal order.

Units of Analysis

Units of analysis may be problematic in the study of EJ because of a tendency toward aggregation bias. For example, Anderton et al. (1994) found that race and ethnicity were statistically related to the location of Treatment, Storage, and Disposal Facilities (TSDFs) across the United States at the aggregated census tract level. However, this relationship was not replicated at the census tract level of analysis. These results led Anderton et al. (1994:135) to conclude that "the appearance of equity in the location of TSDFs depends heavily on how areas of potential impact or interest are defined" (see also Anderton 1997). Using Toxic Release Inventory (TRI) data, Bowen et al. (1995) had similar findings when studying the amount of toxins released into the environment by chemical manufacturers in Ohio. At the county level Bowen et al. found that there was a positive association between percentage of Blacks in an area and the amount of toxins released, while at the census tract level this same association did not exist. Similar trends are likely to be observed nationally with respect to the location of CERCLIS sites. For instance, the UCC's study of abandoned hazardous waste facilities found pervasive evidence of environmental injustice at the zip code level while Anderton et al.'s (1997) study of CERCLIS sites found no such association at the census tract level of analysis. Clearly, studying smaller units of analysis is methodologically better. For instance, Anderton (1997:511) has argued that "prior uses of zip code areas have aggregated across meaningful community differences revealed by the use of census tracts." For this reason some care must be taken when choosing which units of analysis to use in the study of the spatial association between race, ethnicity, economic status, and environmental hazards.

Urbanization

Jay Gould (1986) was the first researcher to point out that it may be urbanization and not race, ethnicity, or median family income causing the distribution of hazardous waste. Although Gould (1986:25) never directly tested this assertion he pointed out, "that urban areas have more industrial activity [and therefore produce and harbor more toxic waste] than rural areas . . . so it does become important to find ways of isolating the differential impact of toxic waste and urbanization." Anderton (1997) more clearly spelled out this concern by pointing out that any racial, ethnic, or economic demographic comparisons between urban and nonurban areas are likely to produce results that are confounded by the geographic nature and the average size of nonmetropolitan census tracts. To solve this problem Anderton calls for controlled comparisons, such as those used in multivariate analyses (Anderton 1997: 513). It seems important, then, to control for urban/rural differences using a variety of indicators that get at the fundamental underlying differences between those areas. For example, a measure of population density is a function of both area size and population and therefore would take into account census variations across urban and rural tracts.

While urban/rural indicators can certainly be valuable in understanding the means by which environmental injustice operates, researchers must be careful that they do not interpret such results as given facts that exist apart from the social and economic structures that aid in their production. For example, it is important to recognize the connection between urban development and larger structural issues relating to race, ethnicity, and class. Global economic changes are ultimately related to racial and ethnic demographics in urban areas because of the changing nature of physical capital and the segmentation of the U.S. labor market (see Wilson 1987). Goldman (1996) emphasizes this global economic/urban connection and maintains that EJ issues cannot be understood by excluding nonurban areas from statistical analyses; such an exclusion may artificially create comparison groups that are disproportionately nonWhite.

Property Values

Another criticism of EJ research is that a large portion of the studies on the topic fail to control for property values in areas surrounding hazardous waste (see Clark, Lab and Stoddard 1995). The argument is that hazardous waste creates low property values which then serve to lure nonWhites and the poor into areas containing that waste. Empirical evidence suggests that even the rumor of potential hazardous waste facilities serves to reduce the residential property values of that area (Ketkar 1992; Nelson, Genereux and Genereux 1997). In addition, several researchers have reported that the

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value of residential housing is considerably lower in areas containing hazardous waste facilities when compared to areas containing no waste facilities (see Anderton et al. 1994a; Pollock and Vittas 1995). Vicki Been (1994:42) argues that the reason that the poor and nonWhites are situated near hazardous waste is because market forces drive the "poor, regardless of their race, to five in neighborhoods that offer cheaper housing." This, she claims, is beneficial because it provides affordable residences to those who could otherwise not afford such residences (see also Clark, Lab and Stoddard 1995). We contend that the reduction of housing choices for many minorities is, on its face, a form of indirect discrimination and therefore contributes to the problem of environmental injustice. From this perspective we assert that market forces provide a means to oppress minorities and the poor, as their decisions about where to live and work are constrained by a set of limited opportunities (see also Bullard and Wright 1987; Foster 1993; UCC 1987).

Causal Order

Causal order is an important issue in the examination of EJ because some researchers have argued that for environmental injustice to exist, hazardous waste must be placed in areas that are predominately poor and nonwhite (see Been 1994; Clark et al. 1995). Such a contention assumes that racism can be understood mainly as a product of individuals and their choices. In contrast, we will offer an alternative to the individual choice model of behavior when explaining the demographic patterns around Superfund sites. Our model is based on a broader interpretation of the meaning of discrimination - one that considers how racism is produced and reproduced within social institutions (see Blauner 1972). Such an interpretation is important as it directly relates to the issue of causal order. For instance, we will provide a theoretical basis for the assertion that environmental injustice exists when nonWhites and the poor follow hazardous waste or when they fail to move from areas containing such waste.

Theoretical Issues

In this section we will attempt to bring the issue of structured choice into the realm of EJ by addressing the concepts of direct and indirect discrimination. To accomplish this task, however, we must be clear about our meaning of discrimination. From our point of view, the concept of discrimination is multidimensional and therefore covers a broad range of situations and behaviors. This perspective is not unique. For instance, over thirty years ago Ture and Hamilton (1992:4) wrote:

Racism is both overt and covert. It takes two, closely related forms: individual Whites acting against individual Blacks and the total White community acting against the Black community. We call these individual racism and institutional racism. The first consists of overt acts by individuals, which cause death, injury or the violent destruction of property. . . . The second type originates in the operation of established and respected forces in society, and thus receives far less public condemnation than the first type.

More recently Feagin and Feagin (1980:112) report that discrimination "refers to actions or practices carried out by members of a dominant group, or their representatives, that have a disproportionate and harmful impact on members of a subordinate group." According to this definition intention need not be present for discrimination to occur. Discrimination may be direct and carried out with intent to harm others, or indirect in that discriminatory consequences result whether intention is present or not. As we will demonstrate, it makes sense to examine the problem of environmental injustice within the context of Feagin and Feagin’s (1980) definition of discrimination. Many empirical studies of environmental justice are sensitive to the problem of direct discrimination, although often at the cost of ignoring indirect forms of discrimination (Bullard 1996). However, indirect processes may in fact be more widespread and consequential. It is important, then, to establish the means by which direct and indirect discrimination may contribute to the existence of environmental injustice.

Direct Discrimination

Direct discrimination is a form of discrimination that is based strictly on a "prejudice [right arrow] discrimination" model (Feagin 1977:184). Often times this type of discrimination is carried out with the intent to deny or harm another individual or group based on some characteristic that the targeted individual or group possesses. Forms of direct discrimination may persist despite the fact that legislation is aimed at preventing it and social norms frown upon it. Direct discrimination may also be found within the normal operation of institutions where it is likely to be supported by social norms. In this sense, direct discrimination may operate overtly as well as institutionally (Feagin 1977).

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According to Feagin (1977) overt forms of direct discrimination occur when bigoted beliefs promote actions that harm members of subordinate social groups. If overt discrimination were alone responsible for producing conditions of environmental injustice, then we would only be concerned with identifying bigoted beliefs and motivations that lead to discriminatory behaviors. For instance, a researcher studying workplace exposure to environmental hazards might seek to identify situations where the actions of an employer who, because of bigoted beliefs that Blacks are inferior to Whites, assigned a Black person to work with dangerous chemicals instead of a White worker. Likewise, we might be concerned with identifying instances where corporate elites make a decision to situate a production facility in a poor and minority neighborhood rather than a White neighborhood because "those" individuals do not care about their health and safety. The following example provides a more specific demonstration of how this might occur. In 1984 the State of California received the following advice about the siting of waste-to-energy facilities from Cerrell Associated (1984:117):

A great deal of time, resources, and planning could be saved and political problems avoided, if people who are resentful and people who are amenable to waste-to-energy projects could be identified before selecting a site. If this information was available, facilities could be placed in areas, if technically feasible, where people do not find them so offensive. [Thus], officials and companies should look for lower socioeconomic neighborhoods that are also in a heavy industrial area with little, if any, commercial activity. (emphasis added)

An entity (such as the State of California) following Cerrell's recommendation would intend to place an environmental hazard near individuals who live in lower socioeconomic neighborhoods. According to Cerrell, this placement is justified because the people in those areas do not find that environmental hazard so "offensive." American history is filled with many other examples of direct discrimination - and many of those are related to environmental injustice. For instance, during the California gold rush era Chinese workers were extensively used to carry out manual labor associated with health risks considered to be too burdensome for Whites (Flowers 1990).

Indirect Discrimination and Structured Choice

While direct and overt forms of discrimination certainly give rise to environmental injustice, alone they cannot adequately describe the processes facilitating such inequity. We can gain important additional understanding by studying how indirect forms of discrimination relate to the spatial distribution of environmental hazards across diverse racial, ethnic, and economic groups. To this end we examine some of the more relevant connections between indirect discrimination and environmental injustice.

According to Feagin (1977:186) "indirect forms of discrimination occur through practices that result in a negative and differential impact on minorities even though the policies or regulations guiding those actions were established, and carried out, with no intent to harm." For instance, economic and social forces may serve to constrain the choices of Blacks, Hispanics, and the poor when compared to the choices available to Whites and the affluent.

Groves and Frank (1986:72) state that structured choice means some people are freer than others because individual choices cannot be made independent of one's social situation (see also Mills 1959). Simply put, an individual's social position may limit one's freedom and compel one to act in a certain way, accept a certain job, attend a certain school, or live in a certain area. In our society one's race, ethnicity, or economic status serve to limit choices. Limited choices may be related to forms of direct or indirect discrimination, and environmental injustice may occur when those constraints are responsible for the geographic association between race, ethnicity, or economic position and the location of hazardous waste. For instance, it is well documented in the literature that patterns of residential segregation are influenced by housing discrimination (Bullard 1995; Darden 1994; Denton 1994; Denton and Massey 1988; Farley et al. 1994; Massey and Denton 1993; Rosenbaum 1994; South and Deane 1993; Yinger 1995). Housing discrimination is likely to influence the racial and ethnic demographic patterns around existing hazardous waste sites when minorities are denied, because of bigoted beliefs, residences in areas that contain little or no hazardous waste. While such instances provide examples of direct and overt housing discrimination, they also depict indirect forms of discrimination when considered within the context of environmental injustice.

Economic forces, in conjunction with past and present employment and housing discrimination, may also affect racial segregation and in doing so be related to environmental justice. For instance, the early 1970s accumulation crisis faced by U.S. corporations prompted a radical economic shift. This "great U-Turn" created a society where corporations have "merged and acquired, downsized, deindustrialized, multinationalized, automated, streamlined, and restructured"

(Harrison and Bluestone 1988:19). Ultimately, many American workers felt the impact of the economic changes brought on by increased global competition. Especially hard hit by these trying times were BLack workers whose lives, because of past employment discrimination, were closely tied to manufacturing and entry level jobs in many American inner cities (C. Wilson 1996). This fact, combined with the out migration of a number of successful and upwardly mobile inner-city residents, contributed to pockets of concentrated and isolated poverty that ultimately served to disrupt family and community structures (W. Wilson 1987). Given those conditions it should come as no surprise that many Blacks, because of their race, face an additional set of economic and cultural constraints that act to decrease social mobility.

If the social and economic conditions of many urban Blacks are indirect products of past racism, environmental injustice may be one byproduct of this discrimination: as current demographic changes can be seen, at least in part, as related to the unequal distribution of environmental hazards across diverse racial and ethnic groups) We contend that these larger economic forces must not be ignored and that they are likely, when accounted for, to have a strong impact on the inequitable distribution of environmental hazards.

Ultimately, we believe that there is strong support for the position that many individuals, because of their race, ethnicity, or economic status, have limited choices when choosing where they will reside. Because Blacks, Hispanics, and the poor face an additional set of social constraints, indirect forms of discrimination are likely to affect racial, ethnic, and economic demographic patterns in areas already containing environmental hazards, To uncover these problems, however, environmental justice researchers must be sensitive to the broader meaning of discrimination.

While we do not have the data to demonstrate that past or present discrimination in housing, education, income, or employment has directly or indirectly shaped the racial, ethnic, and economic demographics of areas surrounding sources of hazardous waste, we believe that there is strong reason to suspect that this is the case. Simply put, those individuals with the fewest life choices are the most likely to reside in undesirable locations such as those areas adjacent to hazardous waste facilities. For this reason, we have designed our analysis to be sensitive to forms of indirect discrimination. It is to that task that we now turn.

Data and Methods

The purpose of this study is to discern if the racial, ethnic, and economic make up of a census tract will predict whether it is more likely to contain a hazardous waste site. In choosing our dependent variable we had several options. We could have examined the location of hazardous waste using any number of indicators. Ideally, however, we would pick an indicator where no assumptions about the extent of chemical exposure to surrounding communities are necessary. For example, if we used data on the production and use of hazardous chemicals then we must assume that each facility containing hazardous substances exposes the surrounding population equally (see Pollock and Villas 1995 for elaboration of these issues). Of course, this ignores chemical use and chemical disposal. This means that it is hard to separate the communities exposed to chemical waste from those that are not exposed. Because we were concerned that such an indicator of hazardous waste may be misleading, we decided instead to choose an indicator of hazardous waste where chemical exposure to surrounding areas and people was highly likely in every case. While not perfect, as some variation in exposure is still likely, the Environmental Protection Agency’s (EPA’s) National Priority List (NPL) provided such an opportunity because many of these sites are known to be exposing those residents living nearby.(6)

One problem with using Superfund site data, however, is that there may be potential Superfund sites that have not yet been identified as such by the EPA. We have no way of determining whether these undisclosed sites are due to random variation or if they reflect some type of hidden bias in site discovery. We do know that if a pattern exists in the undetected sites not included in our analysis that may potentially affect our results in two different ways. If the sites unknown to us are located in predominately White or affluent areas then our findings exaggerate the effects of race, ethnicity, and economic indicators. On the other hand, if these unknown sites are located in Black, Hispanic, or poor areas, our findings will underestimate the effect of race, ethnicity, and economic indicators.

We were able to obtain a list of fifty-three Superfund sites located in Florida, including the latitude and longitude of those sites as well as some limited information on the history of the sites, from the Florida Department of Environmental Protection (FDEP). Most of the hazardous waste sites on the list that we received became Superfund sites in the late 1980s and early 1990s. However, as EPA records indicated, polluting at these sites began long before the sites were identified as hazardous. We have strong reason to suspect that some areas were singled out for waste disposal as they were largely nonwhite and poor, however, we also believe that indirect forms of discrimination may be responsible for any racial, ethnic, or economic demographic changes that occurred after site placement.

The information we received from the FDEP allowed us to match each Superfund site (via latitude and longitude bearings) to Florida demographic data made available through the U.S. Bureau of the Census (1990) STF 3a data. Our first decision was to choose a level of analysis. According to Clark, Lab and Stoddard (1995), units of analysis are problematic because researchers assume that the population within a given unit is homogenous (see also Anderson, Anderton and Oakes 1994). As we pointed out in the literature review, the larger the unit of analysis, the more likely the chance of confounded results. We decided to use census tracts as our unit of analysis as this provided a relatively small aggregation of people. In addition, studying census tracts still allowed us to collect the other variables in which we are interested. Bogue (1985) noted that census tracts provided an additional advantage over larger units of analysis in that they are constructed based on population homogeneity and may be, at least in some loose sense, an indicator of community boundaries. One problem, however, does arise when studying census tracts. As Anderton, Oakes and Egan (1997) note, the mean size of nonurban census tracts is relatively large (when compared to urban tracts) so that the physical boundaries of nonurban tracts obscure community differences rather than reflect those differences. For reasons previously stated, we felt that it was important to include nonurban areas in our analysis while simultaneously acknowledging that some data limitations do exist.

Because it is possible that the impact of hazardous waste in a NPL tract may often exceed the boundaries of that tract, we used two different census tract groupings. The first group consists of tracts that contain at least one Superfund site. The second group consists of tracts containing at least one site and those tracts contiguous to the tracts containing at least one site. Because four census tracts contained more than one Superfund site, we ended with a total of 49 site tracts in group one and 276 site tracts in group two. Our comparison groups consisted of all of the census tracts in Florida where no Superfund sites were found. Comparison group one contained 2356 census tracts, and comparison group two contained all tracts that were not Superfund tracts and also did not lie next to a Superfund tract (2129 tracts).

Independent Variables

We chose several independent variables, based on past EJ research, that we believed would be good indicators of the presence or absence of a Superfund site in any given census tract. In our analysis PCTBLACK and PCTHISP correspond to the percent of Blacks and the percent of persons of Hispanic origin living in a particular census tract. We also selected three economic indicators: (1) median household income (MED_INC); (2) percent of individuals living below the poverty level (POVERTY); and, (3) the percent of unemployed individuals (UNEMPLOY).

To address the suggestion by Clark, Lab and Stoddard (1995) and others that past studies have failed to consider sources of spuriousness such as urbanization and property values, we included five additional variables. First, URBAN is a dichotomous variable (coded "1" for urban and "0" for nonurban). In addition, we included an indicator of population density (DENSITY). DENSITY is measured as the number of individuals per square mile of land in any given census tract. We also collected information on the percent of employed individuals working in manufacturing jobs that produces both durable and non-durable goods (MANUFACT). Finally, we included two property value indicators; MED_RENT indicates the median rent paid in a census tract, and MED_HOUSE indicates the median value of owner occupied housing in a census tract. In addition to identifying possible sources of spuriousness, these variables might also serve to specify more adequately the relationship between race, ethnicity, income, and hazardous waste location.

Analyses and Results

The first step in our analysis was to compare the social and economic variables of census tracts containing Superfund sites to the census tracts in our control group (those tracts that did not contain a Superfund site). To decide if the observed differences between the two groups were meaningful or simply due to chance, we conducted t-tests for independent samples on each variable. Our results are displayed in Table 1.

As Table 1 indicates, a higher percentage of Blacks (22.0% vs. 15.0%, p [less than] 0.10), Hispanics (16.9% vs. 9.3%, p [less than] 0.05), the poor (16.5% vs. 12.3%, p [less than] 0.05), and lower income households ($25,571 vs. $28,127, p [less than] 0.10) are located in census tracts containing Superfund sites than are located in tracts without such sites. These results were duplicated in the second comparison group that labeled Superfund tracts as well as those tracts contiguous to Superfund tracts as potentially contaminated by hazardous waste. In addition, UNEMPLOY (5.0 vs. 4.2, p [less than] 0.01) was also a significant discriminator in the second case as Superfund and contiguous tracts had a significantly larger percentage of unemployed persons. While these results are compatible with the CERCLIS research conducted by the UCC and Kreig (1995), they substantially depart from Anderton et al.'s (1997) bivariate findings. As noted in our literature review, Anderton, Oakes, and Egan found that Blacks, Hispanics, and the poor were more likely to live in areas that did not contain a Superfund site. Our results offer both support and opposition to Hird's (1994) research on NPL sites. On the one hand, our findings regarding race and ethnicity are comparable with Hird's, and on the other hand our findings regarding median income and poverty are not.

As we also pointed out in our literature review, hazardous waste should be related to urbanization. Surprisingly, our bivariate results do not replicate those findings as convincingly as we expected. On average, the census tracts containing a NPL site were about as likely to be urban as rural. These results may be partially due to the fact that we are examining abandoned waste sites and not hazardous waste facilities (such as TRI facilities or TSDFs). It is possible that the areas where industry disposes of hazardous waste (e.g., chemical dumps) may be located some distance from the place where that waste was produced. While the urban indicator did not seem to be a significant bivariate predictor of the location of NPL sites, the percent of individuals employed in manufacturing was somewhat higher in areas containing a Superfund site (8.1% vs. 7.2%, p [less than] 0.01) for the second group. These results do seem to be consistent with past research using that variable (see Anderton, Oakes and Egan 1997; Hird 1994).

In their literature review, Clark, Lab and Stoddard (1995) argue that more densely populated areas are also likely to be the most polluted because of their location in relation to industry within urban areas. Our analysis seems to contradict that assertion as the difference in population density between Superfund and control tracts is the opposite of what Clark et al. would predict (1,780 people per square mile in Superfund tracts vs. 2,945 people per square mile in all other tracts p [less than] 0.01). We would further note that these findings are consistent with Anderton et al.'s (1997) research that found the population density in Superfund tracts to be lower than the population density in tracts that did not contain Superfund sites. One notable difference, however, exists with respect to DENSITY when considering our group two comparison. In the second case the variable DENSITY was not significant. In addition, [TABULAR DATA FOR TABLE 1 OMITTED] in Hird's (1994) county level analysis population density was positively associated to the number of census tracts in a county. After we reviewed the records of several Superfund sites in Florida, we were able to make some sense out of these conflicting observations. Occasionally, massive land areas within site tracts may be blocked off from public access in an effort to prevent people from coming into contact with hazardous chemicals. For example, hundreds of Pensacola residents living near an area that is highly contaminated with the chemical dioxin are currently being relocated by the federal government. Once the move is complete, the area will remain inaccessible to the public and all of the residential structures in the area will be demolished in an effort to clean the area (EPA 1996). Also, waste dumps, which characteristically take up large amounts of uninhabited land, make up a portion of Superfund sites.

As we surmised, both of our indicators of property values were statistically significant and indicated that property values are, in general, lower in areas containing Superfund sites. Again these results are compatible with Hird's (1994) analysis. On average, owner occupied houses in census tracts with Superfund sites were worth less ($67,381 vs. $86,082, p [less than] 0.01) and rental units generally rented for less in those areas ($357 vs. $397, p [less than] 0.05).

In sum, our bivariate results seem to point to the existence of environmental injustice. The pattern clearly points to greater proximity to hazardous waste sites for racial and ethnic minorities and the poor. These results imply that injustice may be the result of economic as well as racial and ethnic inequality, given that income, race, and ethnicity variables were significantly associated with the location of waste sites.

Multivariate Findings

According to Clark et al. (1995) many studies have failed to examine the independent effects of race, ethnicity, poverty, and income level while controlling for other variables. To examine simultaneously the impact of several independent variables on a dichotomous dependent variable we used logistic regression analysis to address two questions. First, we controlled for urbanization and property values to see if they diminished or eliminated the effects of race, ethnicity, poverty, or income. Second, we attempted to identify which variables more strongly predicted the location of Superfund sites in Florida - race and ethnicity or income and poverty.

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Because Florida only contains four census tracts with more than one Superfund site, we decided to use logistic regression rather than some other multivariate technique. For example, had Florida contained several census tracts with more than one Superfund site located within its boundaries Poisson regression would have been more appropriate; that technique would have taken the variation within those tracts into account. On the other hand, logistic regression is a useful statistical procedure in our case because it will allow us to determine which variables most strongly predict whether a census tract will contain a Superfund site in general (see Norusis 1990:45); this latter issue may actually be more relevant to EJ concerns. The results of this regression are presented in Table 2.

We regressed the dependent variable against race, ethnicity, economic indicators, and control variables. A variety of diagnostics were performed to check for multicollinearity, however, no problems were identified in any model run. As Table 2 indicates, the multivariate results go a long way toward helping us answer our previously stated questions. First, although URBAN, DENSITY, MED_HOUSE, and MED_RENT were all controlled for in the analysis, PCTBLACK and PCTHISP were still significant predictors of the location of Superfund sites. This is true for both Superfund tracts and the combination of Superfund and contiguous tracts. As shown in Table 2, census tracts that are largely Black also have a greater probability of containing a hazardous waste site. For example, when the mean values of all the variables in our multivariate analysis are used to compute the probability that any given tract will contain a Superfund site, we find that there is a .01 probability that any given tract will contain a site and .12 probability that a tract will contain a site or be situated next to a tract that contains a Superfund site.(7) If no Blacks live in a census tract the probability that the tract contains a Superfund site is slightly less than .01. Also, if no Blacks live in a census tract then the probability that a tract contains or is contiguous to a Superfund site is .08. However, if a tract is 55% Black (2 standard deviations above the mean of PCTBLACK for all tracts) then the probability that a tract contains a Superfund site increases to .03 and the probability that a tract contains or is situated next to a tract that contains a site increases to .30. This change in probabilities is dramatic, and we view the increase as substantively significant.

Table 2

Logistic Regression Predicting the Presence or Absence of Superfund Sites in 1990 Census Tract Areas

Variable	Group 1		Group 2 (includes contiguous tracts)	
	b	(S.E.)	b	(S.E.)
PCTBLACK	.0233	(.0081)(**)	.0190	(.0038)(***)
PCTHISP	.0499	(.0081)(***)	.0344	(.0041)(***)
MED_INC	-1.9E-5	(2.8E-5)	3.3E-5	(1.1E-5)(**)
POVERTY	-.0088	(.0216)	.0061	(.0107)
UNEMPLOY	-.1593	(.0814)(*)	-.0259	(.0362)
URBAN	1.0064	(.4298)(**)	.4190	(.2003)(**)
DENSITY	-.0005	(.0001)(***)	-.0001	(3.2E-5)(***)
MED_RENT	-.0005	(.0020)	-.0017	(.0008)(**)
MED_HOUSE	-7.9E-6	(6.3E-6)	-5.3E-6	(2.4E-6)(**)
MANUFAC	.0495	(.0337)	.0425	(.0171)(**)
CONSTANT	-2.8080		-2.8429	
[R.sup.2]	.13		.09	
N	2,405		2,405	

*** p [less than] 0.10 ** p [less than] 0.05 *** p [less than] 0.01**

Our findings concerning Hispanics also indicate that this group has a greater probability of living close to a Superfund site. Again, we find that when no Hispanics live in a census tract there is a .01 probability that the tract will contain a Superfund site. If no Hispanics live in or next to a site census tract there is a .09 probability that the tract will contain a Superfund site. However, when a census tract is 45% Hispanic (2 standard deviations above the mean of PCTHISP) these probabilities increase to .06 and .39, respectively. Again we must conclude that these multivariate results provide evidence supporting the position that environmental injustice exists.

Our multivariate results also seem to indicate that race and ethnicity are more predominant factors in explaining the location of Superfund sites in Florida than poverty, unemployment, or median family income. For example, in group 1 only

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UNEMPLOY is significant (p [less than] 0.10). However, the direction of the relationship is not what we expected. Our results indicate that unemployment is inversely related to the probability that a tract will contain a Superfund site. That is, a highly employed tract is more likely to have a Superfund site located within its boundaries than a highly unemployed tract. These results are somewhat similar for group 2 in that only MED_INC is significant (p [less than] 0.05). Like UNEMPLOY in group 1, MED_INC also displays a relationship opposite of what we would predict. These results suggest that higher income census tracts have a greater probability of containing a Superfund site. While our bivariate results stand in sharp contrast to Hird's (1994) findings, our multivariate results are consistent with his results. Our results concerning MED_INC also are more in line with Anderton, Oakes, and Egan's (1997) findings. These results suggest to us that economic discrimination may not exist with respect to the location of Superfund sites in Florida. If anything, our data would lead us to conclude that when other factors are controlled for, the more affluent are more likely to live near Superfund sites. Overall, then, when controlling for other variables, evidence of economic discrimination seems nonexistent, and perhaps even opposite of what we would have expected, while evidence of racial and ethnic discrimination is strong and pervasive.

By and large, our multivariate results concerning race and ethnicity are also comparable to those of the UCC (1987). Still, the UCC studied zip codes and not census tracts so comparisons between our study and the UCC study should be viewed with caution. One possible reason that our results concerning race and ethnicity differ from Anderton, Oakes, and Egan's (1997), who also study census tracts, is that we studied only one geographic region of the country. Anderton et al. (1994) maintain that studies examining areas that contain a large percentage of African Americans (such as the EPA's Region 4 which includes Florida) are more likely to find a pattern of racial discrimination. We accept Anderton et al.'s assertion and add to that argument by noting that Florida also has a history of legal racial segregation. Comparative research in other geographical areas is necessary to establish empirical support for such an assertion.

Longitudinal Analysis

One problem with our analysis to this point is that it does not allow us to distinguish what type of discrimination, direct or indirect, may be responsible for the racial and ethnic distribution of Superfund sites. That is, we cannot conclude, based on our results, that Blacks and Hispanics were forced because of institutional forms of discrimination to live disproportionately close to Superfund sites, or whether polluting facilities were overtly placed in these areas. We note here that it is impossible to answer this question definitively because the required census data are not available during the siting stage of many facilities that created the waste sites used in our analysis. Still, by examining fairly recent census data and the extent to which racial and ethnic demographic patterns in these tracts change over time, we may be able to offer a limited explanation of the way that environmental injustice is created around Superfund sites in Florida.

In Table 3 we have presented a longitudinal comparison of census data at the tract level of analysis. This comparison covers a twenty-year time period and includes data on the racial and ethnic composition of Superfund tracts for the years 1970, 1980, and 1990. Because tract level data are not available for all Superfund sites for all years we had to drop four (4) sites from the 1980/1990 comparison and an additional four (4) sites from the 1970/1980 comparison. To interpret the statistical significance of the changes in PCTBLACK and PCTHISP over each tenyear time period, we used matched sample t-tests. We also reported overall state averages and changes for both race and ethnicity.

As Table 3 indicates, the variable PCTBLACK changed very little for census tracts containing Superfund sites between the years 1970 and 1980. For instance, in 1970 Superfund tracts in Florida were approximately 14.8 percent Black. In 1980 this percentage increased to 15.4, a rather small and statistically insignificant change. There was, however, a drastic change in such tracts between the years 1980 and 1990 as the percentage of Blacks in Superfund tracts increased from 14.7 percent to 19.7 percent (p [less than] 0.10). This increase in the percentage of Blacks living in Superfund tracts occurred despite the fact that the overall percentage of Blacks residing in Florida decreased slightly between 1980 and 1990. These data suggest that over time Blacks are becoming increasingly located in census tracts containing Superfund sites. From our point of view, these results imply that in 1990 Blacks have fewer choices in deciding where they will live than in 1980 (see Denton 1994). As we have argued, these limited choices may be due, in part, to present discrimination in housing and employment. In addition, these results may be due to the fact that many minorities are traditionally employed in industries that are adversely impacted by shifts in the global economy. In short, our analysis supports our earlier suggestion that indirect forms of discrimination play an important role in the creation of environmental injustice.

Table 3

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Racial and Ethnic Trends in Census Tracts Containing Superfund Sites for the Years 1970, 1980, and 1990

Variable	N	1970	1980	Change in %	t-score
PCTBLACK	41	14.8	15.4	.6	.38
PCTHISP	41	6.9	17.8	10.9	4.19(*)
PCTBLACK	STATE	13.8	13.8	0.0	
PCTHISP	STATE	7.0	8.8	1.8	
	N	1980	1990	Change in %	t-score
PCTBLACK	45	14.7	19.7	5.0	3.02(*)
PCTHISP	45	13.4	16.3	2.9	2.58(*)
PCTBLACK	STATE	13.8	13.6	-.2	
PCTHISP	STATE	8.8	12.2	3.4	

Notes:

Matched Sample t-test used to determine whether changes were statistically significant. Differences in averages between the same years are due to the fact that four tracts had to be dropped from the 1970/1980 comparison and four tracts had to be dropped from the 1980/1990 comparison. This occurred because census data on those tracts were not available for both census years. The Census Bureau has changed the way it measures ethnicity over the past 20 years and those figures may not be comparable over time. For example, in 1970 about 93 percent of all persons of Hispanic origin were counted as "White." In 1980 about 56 percent of all persons of Hispanic origin were counted as "White." In 1990 all persons of Hispanic origin are counted as "White" or "Black" but may still be distinguished as a subcategory of each of those categories.

* p [less than] 0.10

Our results for Hispanics living in Superfund census tracts in Florida are more difficult to interpret than our results for Blacks. First, the Census Bureau has radically changed the way it collects information on ethnicity between the years of 1970 and 1990. Nonetheless, we observe a large increase in PCTHISP between the years 1970 and 1980 (over 10%). This increase is over five times that in the state as a whole. While much of the increase observed in Table 3 may be due to the definitional changes in ethnicity, it seems likely that this change also reflects the actual changes in the Hispanic population between 1970 and 1980. Again, we believe that these results provide some evidence of the existence of indirect discrimination and its relationship to environmental injustice as Hispanics are becoming increasingly located near Superfund sites in Florida.

In an effort to provide additional support for our supposition that institutional discrimination is largely responsible for environmental injustice, we conducted another multivariate analysis using the 1980 census data. If the changes we observed for PCTBLACK and PCTHISP between 1980 and 1990 were responsible for all of the effects of PCTBLACK and PCTHISP uncovered in our 1990 analysis, we would expect that they would not be significant predictors of the location of Superfund sites in 1980. The results of our analysis are presented in Table 4.

As Table 4 suggests, PCTBLACK is not a significant predictor of the location of Superfund sites when these tracts are compared with all other tracts in Florida. However, when census tracts containing Superfund sites and tracts contiguous to those tracts are compared to all other tracts, the regression results again indicate that PCTBLACK statistically predicts the location of Superfund sites. The 1980 results for PCTHISP appear to mimic the 1990 results for that variable.

When examining the theoretical power of these variables, however, in the 1980 model the variables PCTBLACK and PCTHISP have much less predictive power than in the 1990 model. For instance, when the mean values of all the variables in our multivariate analysis are used to compute the probability that any given tract will contain a Superfund site, we find that there is a .02 probability that any given tract will contain a site and .05 probability that a tract will contain a site

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or be situated next to a tract that contains a Superfund site (see footnote 6). These probabilities are somewhat similar to the ones we obtained for the 1990 census data. If no Hispanics live in a census tract, then the probability that the tract contains a Superfund site decreases to approximately .01 and the probability that a tract contains or is adjacent to a Superfund site decreases to .04. On the other hand, if PCTHISP in a tract is 38 percent (approximately two standard deviations above the mean of PCTHISP for all 1980 tracts) then that probability increases to .04 and .08 respectively. This is an increase, but not as large as that found in 1990. Since PCTBLACK is not statistically significant, we made no interpretations concerning the probabilities for that variable for tracts only containing Superfund sites. However, for tracts containing and located next to Superfund sites, these probabilities could be computed. If a tract is 0% Black then the probability that tract contains a Superfund site or is next to a Superfund site decreases to .04. In contrast, if a tract is 64% Black (two standard deviations above the mean of PCTBLACK for all tracts in 1980) then the probability that the tract contains or is situated next to a tract that contains a site increases to .08. Again the differences in these 1980 probabilities are not as substantial as the 1990 probability differences.

Table 4

Logistic Regression Predicting the Presence or Absence of Superfund Sites in 1980 Census Tract Areas

Variable	Group 1		Group 2 (includes contiguous tracts)	
	b	(S.E.)	b	(S.E.)
PCTBLACK	.0021	(.0085)	.0122	(.0038)(***)
PCTHISP	.0148	(.0074)(**)	.0169	(.0041)(***)
MED_INC	2.8E-5	(5.3E-5)	8.2E-5	(2.2E-5)
POVERTY	-.0002	(.0254)	.0028	(.0119)
UNEMPLOY	.0196	(.0542)	-.2071	(.0290)
URBAN	.0469	(.4289)	.2808	(.2148)
MED_RENT	.0011	(.0031)	3.9E-5	(.0014)
MED_HOUSE	-1.7E-5	(9.8E-6)(**)	-1.6E-5	(4.4E-6)(***)
MANUFAC	.0483	(.0218)(**)	.0369	(.0116)(**)
CONSTANT	-4.5442		-3.3719	
[R.sup.2]	.11		.11	
N	1,832		1,832	

* p [less than] 0.10 ** p [less than] 0.05 *** p [less than] 0.01

Overall, these results seem to provide us with evidence that indirect discrimination may be largely responsible for the environmental injustice observed in our 1990 analysis. While this explanation does not appear to explain the entire problem, it does seem to suggest the extent of indirect forms of racism regarding Superfund sites in Florida between the years 1980 and 1990. Still, we note that our 1980 multivariate results do not rule out the possibility that direct racial and ethnic discrimination have played a role in the location of the Superfund hazardous waste sites. In fact, we might suppose that direct discrimination causes some inequality identified in the 1980 model. This contention, however, is not readily testable given the limitations and changing nature of past census data.(8)

Conclusion

Several important findings come out of our research. First, our results demonstrate that Blacks and Hispanics are more likely than Whites to live near Superfund sites in Florida. Second, these patterns persist despite the fact that we controlled for other variables such as housing values, income, the percentage of manufacturing employment, and urbanization. Third, our analysis supports the results of earlier studies such as those conducted by Mohai and Bryant (1992) and the UCC (1987) that show that race and ethnicity are the most salient factors in predicting the location of hazardous waste sites. Fourth, the problem of environmental injustice does not appear to be abating. Instead, we find evidence that suggests that this form of injustice may be intensifying. For example, in Florida census tracts containing Superfund sites the percentage of Blacks and Hispanics has increased between 1970 and 1990. In addition, race and ethnicity are much stronger predictors of the location of Superfund sites in 1990. These findings suggest to us that environment injustice is more than just the direct placement of hazards into minority communities. Even without evidence for direct discrimination, clearly, social processes beyond the siting decisions themselves are furthering such inequality.

Besides our general findings, an important policy question arises from our analysis. To what extent can the problem of environmental injustice be solved by current legislation aimed at preventing the disproportionate distribution of hazardous waste across diverse racial and ethnic groups in our society? Our longitudinal analysis seems to indicate that if environmental injustice does exist, it is more than the result of bigoted individuals and their choices. If that is the case then any equity policies adopted by the EPA may be largely ineffective as those policies do not deal with larger social-structural issues that may influence racial demographic patterns around established Superfund sites. In the end the EPA and state environmental agencies may need to look beyond direct forms of discrimination as the cause of environmental injustice and focus their policies on larger social justice issues.

In general, our analysis suffers from one major drawback. Like Anderton, Oakes, and Egan's (1997) study we were unable to account for undiscovered and underclassified sites in our investigation. This measurement problem distorts our results to the extent that undiscovered associations depart significantly from the ones presented here. Because it is difficult, if not impossible, to determine the magnitude or direction of these undiscovered associations, we cannot generalize our findings beyond known Superfund sites. Additional research focusing on the processes of site identification and classification as it relates to race, ethnicity, and economic status may prove to be useful in that it may provide a basis for extending the generalizability of our conclusions.

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1. Environmental justice means two things. First, it means that environmental hazards should be distributed equally across society and that no individual, group, or community should bear a disproportionate burden from this type of health threat. Second, and more ideally, it means that no one should be forced to suffer from the adverse effects of environmental hazards.

2. Anderton et al. (1994a) maintain that if environmental injustice does exist it is most likely found in the EPA's region IV (the region containing Florida). In that region, census tracts containing Treatment Storage Disposal Facilities (TSDFs) were more likely to contain a higher percentage of Blacks and a lower percentage of Hispanics. It is not clear, however, if these trends can be generalized to Superfund sites, which are the focus of this analysis.

3. A Hazardous Ranking System (HRS) is used to determine the overall health threat of a site. Site assessments are made after the EPA investigates actual and potential chemical exposure according to each of three chemical pathways: air, soil, and water. If the HRS score of any site is equal to or greater than 28.5 out of a possible 100, that site is labeled a serious health threat and placed on the NPL list (EPA 1992).

4. Zimmerman (1993) used Census places as her unit of analysis. Census Places are typically densely populated areas that encompass incorporated and, in some cases, unincorporated areas. When data on Census Places were not available, MCD data was substituted. Minor Civil Divisions represent primary legal subdivisions with a given county. In Zimmerman's (1993:658) analysis the typical Census Place and MCD contained approximately 88,000 individuals.

5. Some of the same processes that operate in urban areas today also operate in rural ones. For instance, the rise of agribusiness and the industrialization of the agricultural market are well documented in the literature (Gottdiener 1985:223). With a focus on productivity and efficiency, the farming system can easily be viewed as industry dominated by and sensitive to global economics. Shifts in the economy, then, may contribute to racial segregation and pockets of poverty in rural areas.

6. Barry Johnson (1995) maintains that approximately 40 percent of all sites on the Superfund list have complete exposure pathways to surrounding communities, meaning exposure to dangerous chemicals is occurring.

7. The probability that any given census tract or group of census tracts will contain a Superfund site can be computed

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using the following equation:

P(Y = 1) = [e.sup.a + [b.sub.1]PCTBLACK + [b.sub.2]PCTHISP + [b.sup.3]MED_INC + [b.sup.4]POVERTY + [b.sup.5]UNEMPLOY + [b.sub.6]URBAN + [b.sub.7]DENSITY + [b.sub.8]MED_RENT + [b.sub.9]MED_HOUSE + [b.sub.10]MANFAC] / 1 + [e.sup.a + [b.sub.1]PCTBLACK + [b.sub.2]PCTHISP + [b.sup.3]MED_INC + [b.sup.4]POVERTY + [b.sup.5]UNEMPLOY + [b.sub.6]URBAN + [b.sub.7]DENSITY + [b.sub.8]MED_RENT + [b.sub.9]MED_HOUSE + [b.sub.10]MANFAC]

By substituting the coefficients (found in Tables 3 and 4) and mean of each variable into the equation we were able to obtain a statistic indicating the probability that the average census tract (or tract and contiguous tracts as in Group 2) contains a Superfund site. To compute the probability that any given Black or non-Black tract were likely to contain a Superfund site we simply substituted the values "0%" and "55%" (two standard deviations above the mean) for PCTBLACK in the 1990 model and "0%" and "64%" for PCTBLACK in the 1980 model. These computations were carried out while substituting the mean values of all the other variables into the equation. The same procedure was used to compute the probabilities for Hispanic and non-Hispanic tracts. In that case the values substituted for the variable PCTHISP were "0%" and "45%" (two standard deviations above the mean) for 1990 model and "0%" and "38%" for 1980 model. For more information on interpreting logistic regression coefficients, see Menard (1995:37-57).

8. For example, running a similar model for 1970 would force us to remove yet another four Superfund sites from the analysis because data on those sites were not available in 1970. In addition, the area covered by 1970 census data is limited even more so than in the 1980 census data. This would severely limit any longitudinal comparisons as all nonmetropolitan areas would be excluded from such an analysis.

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