Conf-9211139--1

REGIONAL DIFFERENCES IN THE POTENTIAL EXPOSURE OF U.S. MINORITY POPULATIONS TO HAZARDOUS FACILITIES

ANL/EAIS/CP--77888

DE93 004155

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Presented to the Annual Meeting of the Regional Science Association Meeting in Chicago, IL, November 15, 1992

ABSTRACT: In the literature that examines the distribution of environmental disamenities of various types, there is considerable documentation that minority groups and lower income groups are more likely to be exposed. Such differential exposure has been attributed to "environmental racism" by some authors, but there has been no systematic investigation of the factors and dynamics underlying this exposure pattern. This study examines regional differences in the proximity of African-Americans, Hispanics, Asians, and non-Hispanic Whites to a broad range of facility types and explores the degree to which this may be related to urban and income factors.

* Partial support for data base development was provided by the U.S. Department of Energy, Office of Minority Economic Impact, under contract W-31-109-Eng-38.

INTRODUCTION

Many types of municipal and industrial facilities make poor neighbors. These include facilities such as sewage treatment plants, airports, toxic waste disposal sites, and petrochemical refineries, that create unpleasant noises or odors or potential risks to life and health. While the value of having these facilities is widely recognized, most people prefer to live far enough from them to minimize personal impacts. Few communities actively seek the location of a noxious facility nearby. Indeed organized and highly visible opposition to the siting of new facilities is generally the rule.

Who, then, does live near noxious facilities? The least desirable occupations and locations are usually occupied by the poorest and the least powerful members of society. The idea that noxious facilities may be located near or in minority neighborhoods is not new but it has been raised again recently by the United Church of Christ Commission for Racial Justice study of toxic waste sites (UCC 1987). A number of minority organizations are beginning to address environmental issues (De La Pena 1991), and this activity led to the First National People of Color Environmental Leadership Summit, held in October 1991.

The past decade has witnessed the rise of terms like environmental racism (UCC, 1987), eco-racism (Rees, 1992), and environmental inequities (Bullard, 1987; Mohai and Bryant, 1992) to characterize the disproportional distribution of environmental hazards among minority communities. The issue surfaced earlier in the work of Berry (1977) on five types of urban hazards and in air pollution studies by Freeman (1972) and the Council on Environmental Quality (1971). Much of the literature supports the contention that racial and ethnic minorities and low-income groups bear a disproportionate burden of risk from hazardous activities and substances in the environment.

However, most studies addressing the distribution of disamenities across racial/ethnic or income groups are limited in scope, typically applying a case study approach to one environmental hazard, such as air pollution, in a limited geographical area. This provides depth, but does not develop findings that are generalizable to other areas or to the U. S. as a whole. For example, the U.S. Government Accounting Office (GAO) study (1983) examines the concentration of minority population at four hazardous waste facilities in the South (1983) and McCaull (1976) analyzes air pollution patterns in the Washington, D.C. area. These studies are typical, in that air pollution and, to a lesser extent, hazardous waste facilities have been the main focus of such studies since 1970.

Eleven of the fifteen studies that Mohai and Bryant (1992) summarize dealt only with air

pollution, (Council on Environmental Quality, 1971; Freeman, 1972; Harrison, 1975; Kruvant, 1975; Zupan, 1975; Burch, 1976; Handy, 1977; Asch and Seneca, 1978; Gianessi, et al., 1979; Gelobter, 1986, 1989), one dealt only with solid waste (Bullard, 1983) and two dealt only with hazardous waste (U.S. GAO, 1983; UCC, 1987). One of the studies dealt with toxic fish consumption (West et al., 1992) as a hazard and only one of the fifteen dealt with multiple hazards (Berry, et al., 1977). In the fifteen studies examined, Mohai and Bryant found that ten supported the contention that the burden of environmental hazards appeared inequitable across income groups. Similarly, eleven showed inequitable distribution by race. In addition, they found that race was more important than income in six of the nine studies where such a comparison is possible.

The United Church of Christ, Commission for Racial Justice commissioned the most comprehensive analysis of hazardous waste site locations to date (1987). It is national in scope, disaggregated to the zip code area, and covers 27 commercial hazardous waste facilities and about 10,000 uncontrolled hazardous waste sites. Though this study is more broadly-based, its conclusions with regard to the charge of racism have been contested because "of the twenty-seven areas with commercial hazardous waste landfills surveyed . . . twenty-one (78 percent) were populated by a greater percentage of whites than minorities" (Rees, 1992).

The GAO and UCC studies cited above were used as the basis for an article titled "Toxic Waste and the African American Community," (Bullard and Wright, 1989). In the GAO study, the percentage of African Americans in the host communities, located in North and South Carolina and Alabama, ranged from 38 to 90 percent. While African Americans comprised over 50 percent in 3 of the 4 communities, in absolute terms the total population of these communities was only 3,007. In the case of the UCC study sites discussed by Bullard and Wright, only 3 of the 9 sites had majority African American populations and one of the sites had a majority of Latino residents. The actual population numbers are not provided, with the exception of Emelle, AL with 626 residents (duplicated in the GAO study). Thus, the scope of the "African-American community" examined is actually very limited.

The argument is made that a majority of the hazardous landfill capacity of the South is represented by the "4 landfills in minority zip code areas." The implication seems to be that negative effects are restricted to narrow geographic (zip code) areas and thus minority populations bear a disparate burden. In reality, noxious facilities, including disposal sites, affect wider areas. This can occur physically through release of toxic substances or economically through stigmatization of the area. While serious equity issues are suggested by these findings, there is room for questions.

This study looks at whether minorities may have greater potential exposure to whatever risks are associated with a broad range of noxious facility types. It does not assess the actual risks or evaluate the evidence related to health effects but uses county-level data to examine the degree of association between the concentration of the facilities and the percentage of the population that is nonwhite.

THEORETICAL FRAMEWORK.

A framework for the analysis can be found within the broad literature of stratification, especially that relating to "structured social inequalities" (Heller, 1987). The phenomenon of residential differentiation or segregation is more narrowly applicable but still within this context of mainstream stratification literature. Kraus states that "underlying residential differentiation is the fact that grade of dwelling, meaning type and condition of lot, condition of structure, number of rooms, and the condition and use of adjoining properties generally rises with occupational rank" (1976, p. 169). That race and ethnicity are also linked with spatial distribution and residential segregation is seen clearly in works by Denton and Massey (1988). It seems clear that "residential location affects the cost and quality of housing" and "the level of exposure to unhealthy and unsanitary conditions," (Beeghley, 1989, p. 286).

Residential segregation addresses the issue of spatial distribution of populations and subgroups. From a regional perspective, it is reasonable to assume that rates of industrialization, and other factors which effect the economic and social well being of people will influence movement and migration. Roof (1972) goes so far as to suggest that the "urban containers of southern industrialization have been structured so as to institutionalize racial inequality" (in Elgie, 1980, 459). In addition, the link has been recognized between the "spatial structure of resources and opportunities" and "differential limits on the life chances of individuals" (cf Peet, 1975).

Spatial distribution of population subgroups is usually measured by such indicators as the index of dissimilarity. The black-white dissimilarity index, for example, represents the percentage of blacks who would have to move out of one tract in order for the tract to have a balanced, or even, black-white population mix, reflecting the subgroup proportions in the larger population. For this reason, the dimension measured by the index of dissimilarity is sometimes referred to as evenness (Denton and Massey, 1988). Since many MSAs containing the largest black populations are uneven (ibid), it follows logically that exposure to noxious facilities is also likely to be uneven.

If, as suggested by Streitwieser and Goodman, black mobility is severely limited by discrimination in the housing market (as well as by other factors, such as financial ability) it is clear that opportunities to relocate are limited and might explain their "concentration in the cities and near exclusion from the suburbs" (1983, 259). Similarly, these authors suggest that the black suburbanization process is different from the white experience. In fact, consistent with earlier work by Denton and Massey and others, Farley (1977, 1979) concluded that there is only "moderate residential segregation by socioeconomic status," (DI = .250) but Van Valey et al (1977) indicate there is a much higher level by race (DI = .700). Schnare (1977) further indicates that the segregation has its basis in race, not in class. This unevenness should then be reflected in the relationship between facility density and the local concentration of minorities given the proportion of minority group members within each region.

Additionally, there is room for consideration of the relationship of race/ethnicity and power (Weber, 1920; Lenski, 1966). Weber, in discussing class, status, and power also introduced the concept of "life chances" which incorporates a sense of the probabilistic nature of outcomes. Dahrendorf expanded on this notion, building on Weber's concepts of "future chances," and "preferential chances" toward the concept of "life chances" (Dahrendorf, 1979). Wilson concluded further that "class has become more important than race in determining black life chances in the modern industrial period" (Wilson, 1980). If the claims of environmental racism are true, then della Fave's argument that "The meek shall not inherit the earth" (1980, p.955) might more appropriately be restated as "The meek shall not inherit an unpolluted, non-toxic earth." At least one question that may legitimately be raised is whether or not the "meek" shall be defined in terms of class or race and ethnicity.

SCOPE OF THE STUDY

We propose to go beyond the scope of prior studies by employing county-level data for the entire nation and including a broad range of facility types representing environmental disamenities. In addition, we will address the issue of the distribution of noxious facilities among white and non-white populations in an attempt to determine the relative exposure to risk among different racial and ethnic groups, thus addressing the question of whether the data support the claims of environmental racism: ". . . minorities are shouldering an unequal share of the burdens of hazardous waste" (Godsil, 1991,

p.396). In addition, we will also explore the relative importance of nonurban versus urban residence.

In systematically approaching our task we will first describe the distribution of noxious facilities in the U.S. Second, we will present a summary of the distribution of racial and ethnic subgroups of the population. Third, we will examine the relationship of a standard measure of facility concentration to the proportion of the population comprised by racial and ethnic subgroups. Finally, we will attempt to isolate the role of race and ethnicity from the effects of region, urbanization, and income.

The unit of analysis for this study is the county. We include 3,109 counties and independent cities in the contiguous United States. One county is omitted because it is a new county for which some data items are not available.

Data Sources

This section presents a brief summary of the data and their origins. The facility types include manufacturing plants, hazardous waste sites, and electricity generating plants, among others, all of which are located in the 48 contiguous states. Information on the location of chemical manufacturing plants, petroleum production and petroleum refining facilities, plastics and rubber manufacturing plants, pulp mills, smelters, and incinerators is taken from the 1985 National Acid Precipitation Assessment Program Inventory. Chemical weapons storage site locations are from Rouse (1988) and locations of radiation-related research facilities, radioactive waste disposal and inactive industrial sites, and uranium mill tailings sites are from the U.S. Department of Energy 1991 annual report on environmental restoration activity. Electric generating plant locations are developed from various Energy Information Administration forms and documents, and liquefied natural gas storage sites and terminal locations are from an Institute of Gas Technology listing. Commercial hazardous waste disposal sites and National Priorities List/Superfund site locations are taken from U.S. Environmental Protection Agency listings. Demographic data used in our analysis are from the 1983 County and City Data Book which consists of data originally collected for the 1980 decennial census.

Variables

Facility Density. The number of facilities of a particular type per 100 square miles is used to standardize the facility measure since county size varies by several orders of magnitude. The

density measure is used for each facility type and for total facilities. Thus, for example, we examine the number of production facilities (DPROD), energy facilities (DENERGY) and disposal facilities (DDISP) and the sum of these three (DTOTFAC), each divided by the area and multiplied by 100, providing a density measure of facilities per 100 square miles.

Minority Concentrations. Minority concentrations are measured as the percentage of the total population of each county that are African American (PBLACK), Latino (PHISPAN), or Asian (PASIAN). Native Americans are not included because of the relatively small population size of this group.

MSA Status. Because of the potential influence of urban location we distinguish between counties which are located within the boundaries (INMSA = 1) of Metropolitan Statistical Areas (MSAs) and those that lie outside of any MSA. The MSA is a U.S. Bureau of the Census designation.

Population Density. This measure of population per square mile (POPDENS) is computed from total county population in 1980 divided by land area taken from the 1983 County and City Data Book.

Median Household Income. This measure (MDHSINC) is taken from the 1983 County and City Data Book and is the midpoint in the distribution of household incomes within each county.

Median Housing Value. Also taken from the 1983 County and City Data Book, this variable (MDHSVAL) is the midpoint of the distribution of owner-estimated values of owner-occupied housing.

Poverty Percentage. This measure (PCTPOV) is taken from the 1983 County and City Data Book and is the percentage of families with incomes below the poverty line.

Description of the Data

Descriptive Statistics. Each of the variables discussed in the preceding section is employed in the subsequent analysis. In order to provide the reader with adequate means of assessing these, the mean, minimum, and maximum values and the standard deviation for each variable, further partitioned by region, are provided in Table 1.

(Table 1 about here)

Distribution of Facilities. The numbers of facilities included in this analysis are listed by type in Table 2. The facilities are divided into three broad categories: production, energy, and disposal. The production category consists of facilities that typically contribute substantially to the economic base in their local area. Most are also major sources of emissions that reduce ambient air quality, contributing both to acid precipitation and exposure to airborne toxics. The energy category includes all types of electric generating plants, plus liquefied natural gas storage sites. These facilities represent a form of economic infrastructure, but most also generate emissions that diminish air quality. The third category, disposal, is composed of active facilities or inactive sites that contain or dispose of hazardous waste, including radioactive materials. These may pose risks to the public through either air- or water-borne contaminants. Of the 4,410 facilities, almost half are in the production category, with the remainder split about equally between energy and disposal facilities.

(Table 2 about here)

The distribution of these categories of facilities among the U.S. Bureau of Census Regions is also shown in Table 3. More than a third of the facilities are located in the South, which contains a high proportion of both the production and energy facilities. In the case of disposal facilities, the North East has the largest proportion of the total, and since it is the region with the smallest land area, the disposal category density is highest there. The distribution of facilities also varies considerably within regions and is weighted toward urban locations. Almost 66% of all facilities are located in MSAs, with urban concentration being highest for disposal facilities and lowest for the energy category. Among the regions, the urban concentration of facilities is greatest in the North East, which has 18.5% of all facilities with 87.6% of them in urban areas. Nationwide, 57% of counties do not have any facilities which means that all 4,410 facilities are located in just 1,336 counties. The majority of the counties with facilities have just one or two. Less than 2% of counties have ten or more facilities of all types combined, but some have more than 50.

(Table 3 about here)

Distribution of Minority Populations. Table 4 shows that minority populations are also distributed unequally among the Census Regions. More than half of the U.S. population of 26.5 million African Americans resided in the South in 1983. Only 8% were located in the West, with the

remainder of the population split between the North Central and North East regions. Hispanics, with a total population of 14.5 million in 1980, were concentrated in the West, where 42.5% lived, and to a lesser extent in the South with 30.8%. The North Central region contained the smallest proportion of the Hispanic population, 8.7%. Asians were also concentrated in the West where about half of the Asian population resided, and the rest of the over 3 million total Asian population was split nearly equally among the remaining three regions. Almost half of all Native Americans also lived in the West and only about 6% in the North East, giving that region the lowest percentage of the Native American population. Native Americans constitute the smallest of these population subgroups, with just over a million persons. For this reason, Native Americans are excluded, as a separate group, from the subsequent analysis.

(Table 4 about here)

In addition to the variation in minority populations as a percentage of the U.S. and regional totals discussed above, there are differences in the way minority subgroups are distributed as a percentage of each region's population and as a percentage of the populations of MSA counties. Table 5 presents the regional distribution of U.S. total and minority populations. It then presents the minority population as a percentage of the total for each region and the nation, and the minority population as a percentage of the urban population. The last column shows the percentage of the total minority population in each region that is urban. Over 98% of the minority population in the North East lives within an MSA, while only 72% of Southern minorities are urban.

(Table 5 about here)

Analysis

In order to discover the relationships that exist between race and potential exposure to the disamenities associated with noxious facilities, we proceeded systematically through various levels of analysis. The first of these involved the calculation of zero order correlations for facility density and minority subgroup proportions. Given the literature, cited above, on the state of residential segregation, we looked first at the U. S. as a whole and then at those counties located within MSAs. This was followed by a regional examination of zero order correlations for facility density and the

minority subgroup percentages for urban counties.

The next phase of the analysis involved the use of multiple regression to develop an exploratory model to predict the facility density for the U.S. as a whole, each region and all counties within MSAs. This analysis was further partitioned into a series of regressions relating the facility density for each facility type for the various geographic groupings. The regressions permit examination of the degree to which minority concentration is related to facility density when urban and economic factors are controlled.

Findings

Correlation Analysis of relationships between key variables. Our attempt to determine whether minorities experience a disproportional exposure to noxious facilities begins with an examination of the zero order correlations between facility density in each of the facility categories and the population percentage of whites and minority subgroups.

Table 6 presents the zero order correlations for all U.S. counties and also for all counties with a facility of any of the types studied. Examining the correlations for all counties first, we see that although the majority of the values for African Americans and Asian Americans are significant at $p < .01$, the magnitude of the correlation is generally small. However, the coefficients for the association of minority proportions with facility density are all positive indicating that these minority population percentages tend to increase with facility density. The correlations for White percentage are all negative and all significant at $p < .01$, indicating that the percentage of the population that is White tends to decline as facility density increases. Since more than half of all counties do not contain any of the facilities studied, the correlations are certainly depressed by the large number of cases for which facility density is zero.

In fact, about 66% of all facilities are located in urban areas (Table 3), as are over 84% of minorities (Table 5). Therefore, we turn our attention to urban counties. The bottom half of Table 6 shows the comparable correlation coefficients for the counties that are part of a metropolitan area. Except for Asians, the associations in the urban counties between facility density and minority concentration are twice as strong as when the country as a whole is considered. The coefficients are negative for the white majority and positive for each of the minority subgroups. Except for Asians, the associations in the urban counties between facility density and minority concentration are twice as strong as when the country as a whole is considered. It appears from the correlation coefficients that

there is a weak but clearly delineated tendency for minority population concentrations and noxious facility density to increase together.

In examining the distribution of facility types (Table 3) and of minority subgroups (Table 4) among regions, we found that both facilities and minorities were least concentrated in urban areas in the South. Therefore, we also correlated minority percentages with facility density by region, as shown in Table 7. At the regional level, we see an increase in the correlation for percent African American with every facility category, producing r values ranging from .15 in the South to .66 in the North Central region. This example, as is the case with the other minority groups, suggests that there is considerable regional variation in the relationship between race/ethnicity and facility density that is masked when measured at the national level.

(Table 7 about here)

On the regional level, we find moderate levels of direct association (significant at $p < .01$) between percentage African American and facility density in all regions but the South, where the relationship is weak. There is a moderate, direct association for Hispanics in the North East and a weaker one in the North Central region. For Asian Americans the association is moderate in the West and North East, and weak in the North Central region. The relationships in the South are weak for all of the subgroups, though they are highly significant for African Americans and in one case, energy facilities, for Asians. There is an inverse relationship between percent white and facility density in all regions that reaches moderate levels in the North East and Central regions and is generally significant at $p < .01$. The pattern within individual facility categories of relationships with population subgroups does not appear to be consistent.

Regression Analysis with Controls. Given the apparent relationship between the presence of minorities and the location of noxious and hazardous facilities, the question of causation arises. Consistent with Wilson's earlier work (1978) which suggests a "declining significance of race," some have asked whether the inequitable distribution of environmental disamenities or hazards is not more appropriately explained by economic factors such as poverty, income, wealth and property values. Therefore, we explore the regional relationships between facility category density and minority concentration further using regression analyses in which we control for intervening factors identified in the literature.

Economic studies, using hedonic estimation techniques that control for variation in labor and housing quality, have generally supported Roback's (1982) model of the complex interaction of local labor and land market prices. Roback found that environmental disamenities or hazards, that do not increase local productivity, increase local wage rates and decrease residential land values. As a result, local residents are compensated for disamenities by the net adjustment of the local economy, reducing the monetary cost of living there. A recent study by Nieves, Clark, and Hemphill (1992) confirmed this effect for several types of noxious facilities. Based on our understanding of the interaction of wage and housing value levels, we employ both simultaneously as controls. Since poverty has also been identified in the literature as a possible causal factor, we also control for the percent of families with income below the poverty line (PCTPOV).

In addition, the distribution of minorities and facilities suggests that locations of both may be related to degree of urbanization. Therefore, we include a dummy variable (INMSA) to indicate whether or not a county is part of an urban area and population density (POPDENS) to control for gradations in urban concentration.

The regression results for regions, urban counties, and all counties are presented in four similar tables for density of total facilities (Table 8), production facilities (Table 9), energy facilities (Table 10), and disposal facilities (Table 11). In all four sets of regression results, there is strong evidence of an urban effect in the location of facilities. The dummy for urban status (INMSA) is significant ($p < .01$) for total facilities, production, and disposal facilities when all counties with facilities are examined. It is negative, but nonsignificant, for the energy facility category which includes nuclear, geothermal, and large coal-fired plants that are generally located at some distance from urban areas. The other control for urban effects, population density, is almost always positively related to facility density and is generally significant at $p < .001$. Thus it appears that urban factors are important in explaining facility locations, and population density has a particularly strong effect.

The role of economic factors appears to be more complex. The coefficients for percent of families below the poverty line vary in sign and are only significantly different from zero in the South for production and total facilities. Thus, there does not appear to be much association between concentrations of poverty and facility locations. Median household income (MDHSINC) and median housing value (MDHSVAL) tend to be opposite in sign, as expected, with increments in income and decrements in housing value providing a form of compensation for proximity to noxious facilities. This pattern is not completely consistent across models, however, and is weakest in the case of energy facilities.

Control variables for region are employed in the regressions for urban counties and the whole U.S. These indicate that facility density is generally lower in the West and South than in the Central region and that it is significantly higher in the North East for disposal facilities and for all facilities combined.

After controlling for urban and economic effects, there are still significant positive relationships between minorities and facility density in some cases. At the national level the percent of African Americans is significantly (at least $p < .05$) positively related to production and disposal facility densities and total facility density. It is significantly ($p < .05$) negatively related to energy facilities when evaluated at the national level. At the regional level, percent African American is most consistently and significantly related directly to production and total facility density, except in the South. For energy facility density, the relationship of percent African American is negative and significant at $p < .05$ in the North East and South. Thus, for the South, there is no evidence of direct association between the concentration of African Americans and the density of any of the facility types. However, for disposal, production, and the total facility concentration, there is substantial evidence that the percentage African American and the facility density increase together.

At the national level of analysis, no significant effects remain for Hispanics after controlling for urban and economic effects. At the regional level, the percent Hispanic is significantly ($p < .01$) positively related only to disposal facilities ($p < .01$) in the North East, where the Hispanic population is mainly Puerto Rican. In the South the relationship is negative ($p < .01$) for production and for total facilities.

For Asians the coefficients are highly significant ($p < .01$) and positive for disposal facilities, and positive ($p < .05$) for total facilities, when evaluated at the national level. The regional results indicate that the main areas of association ($p < .01$) are with total and production facilities in the North East and disposal facilities in the North Central region. Negative relationships are found with production facilities in the North Central region, with energy and total facilities in the West, and disposal and total facilities in the South.

Conclusions

We have attempted to explore the issue of environmental inequity in this study, considering the major minority population subgroups, a broad range of hazardous facilities, and four U.S.

regions. The correlations between the facility-category densities and both percent African American and percent Asian American indicate a weak, but statistically significant, direct association when all U.S. counties and all urban counties are considered. In the same context, there is a consistent and highly significant inverse relationship between percent White and all facility-category densities. Analysis at the regional level reveals moderate to strong relationships between minority population concentration and most facility categories, with the exception of all subgroups in the South and Hispanics in the West. Inverse relationships for percent White are generally highly significant and are moderate in the North Central and North East regions; weak in the West and South. Based on these findings, we conclude that there is a pronounced tendency for minorities to be over-represented in counties with greater concentrations of noxious facilities. This implies that minorities are potentially disproportionately exposed to whatever health hazards are associated with the facilities. In addition, it appears that this tendency is most consistently the case for African Americans, regardless of region or facility type.

To the degree that an equitable distribution of societal risks among population subgroups is a goal, there are reasons for concern about the proximity of minority populations to noxious facilities. If these facilities present health and safety risks to the surrounding residents, they may contribute to differences in health status and life expectancy among demographic subgroups. There are many gaps in our knowledge of the linkages between environmental pollutants, population exposures, and health effects. However, differences in health status between minority and majority populations in the U.S. are relatively well documented. For example, asthma, lead poisoning and some types of cancer occur at a higher rate among African-Americans than in the rest of the population. While this may be partially due to poverty and inadequate medical care, it may also be caused by greater exposure to environmental hazards.

The literature, and our exploration of the data, suggest that possible explanations of the association between minorities and noxious facilities may lie in the structure of urban areas or in economic factors. To determine whether these factors are responsible for the association, we controlled for urban and economic effects in regressions for each facility-category density by region. The results suggest that urban effects play a stronger role in the facility densities than economic factors do. In the West, North Central and North East regions, it appears clear that the direct relationship between the proportion of African Americans and facility density is strong for production and total facilities in spite of the controls applied. However, in the North East and South, application of the controls changes the apparent association of African Americans with energy facilities to a

significant but negative one. For Hispanic Americans, there is a significant positive relationship only in the North East for disposal facilities. The relationship of percent Hispanic with production and total facility density is negative in the South. Asian Americans have a direct relationship to total and production facility densities in the North East and to disposal facilities in the North Central region. In the West the relationship is negative for energy facilities, as it also is in the North Central region for production facilities and in the South for disposal facilities. Thus, the picture that emerges is complex, with considerable regional variation in the direction and strength of the relationships between minority population percentages and facility-category densities.

The predominant pattern of decline in the strength of the relationships when urban and economic controls are applied is supportive of the previously noted suggestions (Wilson, 1978) that there is a declining salience of race and ethnicity. This would indicate that class is more important than race if the reductions moved the relationships from significant to non-significant, but in most cases they do not. Race, therefore, appears to be a major factor in these relationships.

While this study has examined the issue of racial inequities in potential exposure to environmental hazards on a national and regional basis, a number of questions remain. There are regional differences in the effects of the control variables and in analyzing the urban counties separately that are not explained within the study framework. Further exploration of these factors is recommended with a more complete and detailed set of economic controls. In addition, the use of county-level data leaves some questions unresolved. It is possible that a similar analysis of data for census tracts or zip codes might provide evidence of inequities in some of the regions where they are not apparent using county-level data. Such an analysis could shed additional light on the issues.

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Table 1. Variable Means and Standard Deviations by Region

Variable	Mean	Std Dev	Minimum	Maximum
ALL COUNTIES WITH FACILITIES N = 1336				
POPDENS	376.5306	2251.8838	0.4984	64922
PCTPOV	13.6901	6.3849	3.0000	46.0000
MDHSINC	15702	3330.8482	7406.0000	28987
MDHSVAL	39902	14819	11800	200001
PBLACK	9.2050	13.5609	0	77.9966
PHISPAN	4.3980	10.3772	0	91.5019
PASIAN	0.5553	1.0128	0	21.9845
DPROD	0.2932	0.9545	0	24.5614
DENERGY	0.1845	0.7590	0	22.7273
DDISP	0.1959	0.5803	0	8.6957
DTOTFAC	0.6735	1.6662	0.0103	31.5789
URBAN COUNTIES WITH FACILITIES N = 544				
POPDENS	849.4320	3476.3962	13.1062	64922
PCTPOV	11.1801	4.6704	3.0000	35.0000
MDHSINC	17709	3185.2830	11154	28987
MDHSVAL	47469	15066	23700	124400
PBLACK	9.7385	11.4021	0.0119	70.2408
PHISPAN	4.4152	9.6064	0.1833	91.5019
PASIAN	0.9010	1.4460	0	21.9845
DPROD	0.5272	1.4384	0	24.5614
DENERGY	0.3269	1.1610	0	22.7273
DDISP	0.3873	0.8599	0	8.6957
DTOTFAC	1.2414	2.4794	0.0251	31.5789
COUNTIES WITH FACILITIES IN THE WEST N = 190				
POPDENS	220.8386	1147.7589	0.4984	14760
PCTPOV	12.4895	5.4876	4.0000	40.0000
MDHSINC	16688	3117.7968	9062.0000	27901
MDHSVAL	56129	20643	12900	200001
PBLACK	1.5937	2.7359	0	18.4279
PHISPAN	10.7670	12.9762	0.0536	81.4206
PASIAN	1.3495	2.2248	0	21.9845
DPROD	0.1156	0.2776	0	2.0050
DENERGY	0.0637	0.3466	0	4.3478
DDISP	0.1308	0.4329	0	4.3478
DTOTFAC	0.3101	0.8500	0.0103	8.6957

Table 1. continued

Variable	Mean	Std Dev	Minimum	Maximum
COUNTIES WITH FACILITIES IN THE NORTH CENTRAL N = 407				
POPDENS	237.6812	629.1911	0.9878	7427.6230
PCTPOV	10.5799	3.8053	3.0000	27.0000
MDHSINC	16593	3055.2579	9423.0000	27509
MDHSVAL	38925	10062	15400	78100
PBLACK	2.8159	5.3837	0	45.5036
PHISPAN	1.2117	1.7640	0	15.9811
PASIAN	0.4020	0.4135	0	3.8389
DPROD	0.2613	0.7141	0	11.4754
DENERGY	0.1628	0.2495	0	2.0747
DDISP	0.1547	0.2794	0	2.0333
DTOTFAC	0.5787	0.8973	0.0322	11.4754
COUNTIES WITH FACILITIES IN THE NORTH EAST N = 161				
POPDENS	1478.4892	6029.4177	11.4575	64922
PCTPOV	10.3478	3.6474	4.0000	24.0000
MDHSINC	16973	3122.8713	10443	26626
MDHSVAL	43737	13726	22600	93000
PBLACK	4.1484	6.3552	0.0078	37.8382
PHISPAN	2.0622	3.5883	0.0756	26.0783
PASIAN	0.6490	0.7414	0.0234	5.2967
DPROD	0.4958	2.0610	0	24.5614
DENERGY	0.4993	1.9721	0	22.7273
DDISP	0.6275	1.1580	0	8.6957
DTOTFAC	1.6226	3.8560	0.0255	31.5789
COUNTIES WITH FACILITIES IN THE SOUTH N = 578				
POPDENS	218.5338	745.9266	0.6784	10132
PCTPOV	17.2059	6.9125	4.0000	46.0000
MDHSINC	14396	3189.7370	7406.0000	28987
MDHSVAL	34188	10993	11800	97400
PBLACK	17.6144	16.2970	0	77.9966
PHISPAN	5.1987	12.8668	0.0777	91.5019
PASIAN	0.3762	0.4697	0	4.1749
DPROD	0.3176	0.7229	0	12.5000
DENERGY	0.1517	0.3706	0	6.6667
DDISP	0.1261	0.4810	0	7.1429
DTOTFAC	0.5954	1.0906	0.0548	17.5000

TABLE 2. Number of U.S. Facilities by Category

FACILITY TYPE	NUMBER
Chemical manufacturing plants	609
Military chemical storage sites	7
Petroleum production	323
Petroleum refining	310
Plastics and rubber manufacturing	132
Pulp mills	272
Radiation-related research facilities	26
Smelters	382
TOTAL PRODUCTION:	2061
Coal-fired generating plants	458
Gas-fired generating plants	241
Geothermal generating plants	4
Liquefied natural gas storage sites	78
Nuclear generating plants	119
Other generating plants	13
Petroleum-fired generating plants	170
TOTAL ENERGY:	1083
Commercial hazardous waste disposal	27
Incinerators	53
National Priorities List/Superfund sites	1129
Radioactive waste disposal	7
Radioactively contaminated inactive industrial sites	29
Uranium mill tailings sites	21
TOTAL DISPOSAL:	1266
TOTAL FACILITIES:	4410

Table 3. Regional and Urban Distribution of Facilities by Facility Category (Percent)

REGION	REGIONAL PERCENT OF CATEGORY				URBAN PERCENT OF CATEGORY			
	PRODUCTION	ENERGY	DISPOSAL	TOTAL	PRODUCTION	ENERGY	DISPOSAL	TOTAL
West	17.6	12.6	18.9	16.7	63.6	57.1	68.8	64.1
N.Central	24.4	31.5	27.2	26.9	68.9	50.8	64.3	62.5
N.East	11.5	17.1	31.2	18.5	87.0	86.5	87.5	87.6
South	46.6	38.9	22.8	37.8	56.0	59.1	66.7	58.7
Total	100.1	100.1	100.1	99.9	64.1	60.9	73.1	65.9

Note: Percentages may not sum to 100 due to rounding.

Table 4. **Distribution of Minority Population Subgroups by U.S. Census Region, 1980** (Thousands of Persons and Percentage of Subgroup Population)

REGION	AFRICAN AMERICAN		HISPANIC		ASIAN		NATIVE AMERICAN	
	1000s	%	1000s	%	1000s	%	1000s	%
West	2229	8.4	6177	42.5	1580	50.5	699	47.7
N.Central	5333	20.2	1270	8.7	435	13.9	271	18.5
N.East	4850	18.3	2608	18.0	599	19.2	89	6.1
South	14039	53.1	4468	30.8	513	16.4	407	27.8
TOTAL	26451	100.0	14523	100.0	3127	100.0	1099	100.1

Note: Percentages may not sum to 100 due to rounding.

Source: 1983 County and City Data Book

Table 5. **Total and Minority Population Distribution by Region; Minority Population Percentage of Total and of Urban Regional Population; and Percentage of Minority Population that is Urban, 1980**

REGION	TOTAL POPULATION (1000s)	TOTAL MINORITY POPULATION (1000s)	MINORITY % OF		URBAN % OF MINORITY POPULATION
			REGION TOTAL	REGION URBAN	
West	41,805	10,684	25.6	27.3	89.4
N.Central	58,865	7,309	12.4	16.2	92.1
N.East	49,135	8,146	16.6	18.4	98.5
South	75,372	19,427	25.8	27.2	72.2
Total	225,179	45,568	20.3	22.3	84.1

Source: 1983 County and City Data Book

Table 6. **Zero Order Correlations for Facility Density and Racial/Ethnic Subgroup Proportions for All U.S. Counties and All Urban Counties**

REGION	FACILITY CATEGORY	% AF-AM	% HISPAN	% ASIAN	% WHITE
Total U.S.	Total	.0961 **	.0231	.2947 **	-.0944 **
Total U.S.	Product	.0986 **	.0045	.1270 **	-.0810 **
Total U.S.	Energy	.0566 **	.0372 *	.2761 **	-.0737 **
Total U.S.	Disposal	.0454 *	.0119	.2938 **	-.0473 **
All MSA	Total	.2063 **	.0750 *	.2361 **	-.2299 **
All MSA	Product	.2051 **	.0099	.0621	-.1752 **
All MSA	Energy	.1247 **	.1112 **	.2587 **	-.1889 **
All MSA	Disposal	.0929 **	.0534	.2383 **	-.1252 **

* $p < 0.05$ level ** $p < 0.01$ level

Table 7. **Zero Order Correlations for Facility Density and Racial/Ethnic Subgroup Proportions by Regions for All Urban Counties**

REGION	FACILITY CATEGORY	% AF-AM	% HISPAN	% ASIAN	% WHITE
West	Total	.5081 **	.0308	.6573 **	-.3025 **
West	Product	.3637 **	.0338	.2046	-.1628
West	Energy	.4317 **	.0436	.6630 **	-.2978 **
West	Disposal	.4125 **	.0031	.6139 **	-.2455 *
N.Central	Total	.6601 **	.2508 **	.2432 **	-.6502 **
N.Central	Product	.6536 **	.1554 *	.1314	-.6184 **
N.Central	Energy	.3211 **	.2467 **	.1310	-.3414 **
N.Central	Disposal	.1703 *	.2082 **	.3476 **	-.2145 **
N.East	Total	.5137 **	.4884 **	.6652 **	-.5693 **
N.East	Product	.3396 **	.1292	.2695 **	-.2841 **
N.East	Energy	.4125 **	.5531 **	.7110 **	-.5363 **
N.East	Disposal	.3917 **	.4452 **	.5093 **	-.4642 **
South	Total	.2428 **	-.0143	.0928	-.1998 **
South	Product	.1941 **	-.0062	.0280	-.1609 **
South	Energy	.1503 **	.0135	.2225 **	-.1455 **
South	Disposal	.1545 **	-.0335	.0042	-.1091 *

* $p < 0.05$ level ** $p < 0.01$ level

Table 8. Total Facility Density Regression Coefficients for the U.S. and Regions (All Counties with Facilities)

VARIABLE	WEST (n=190)	N.CENTRAL (n=407)	N.EAST (n=161)	SOUTH (n=578)	MSA (n=544)	TOTAL (n=1336)
Intercept	-0.7612 **	0.7691 *	-1.6121	-1.1335 **	-0.8705	-0.4001
INMSA	0.1556 *	0.1967 **	0.4779	0.2145 *	--	0.3833 **
POPDENS	0.0007 **	0.0012 **	0.0002 **	0.0010 **	0.0005 **	0.0005 **
PCTPOV	0.0079	-0.0184	0.0805	0.0228 *	0.0195	0.0010
MDHSINC	0.00005 **	-0.00001	0.00008	0.0001 **	0.0001 *	0.00006 **
MDHSVAL	-0.0000002	-0.000004	-0.00002	-0.00002 **	-0.00002 *	-0.00001 **
West	--	--	--	--	-0.0516	-0.1541
N.East	--	--	--	--	0.6065 **	0.3297 **
South	--	--	--	--	-0.3327	-0.0723
% AF-AM	0.0537 **	0.0145 *	0.0979 *	-0.0015	0.0362 **	0.0124 **
% Hispan	-0.0007	-0.0100	0.0537	-0.0093 **	0.0012	-0.0009
% Asian	-0.0691 **	-0.1322	1.3741 **	-0.1742 *	0.1411 *	0.0925 *
Adj. R^2	.8379	.7658	.5583	.5070	.5052	.5241

* $p < 0.05$ level ** $p < 0.01$ level

Table 9. Production Facility Density Regression Coefficients for the U.S. and Regions (All Counties with Facilities)

VARIABLE	WEST (n=190)	N.CENTRAL (n=407)	N.EAST (n=161)	SOUTH (n=578)	MSA (n=544)	TOTAL (n=1336)
Intercept	-0.6177 **	0.7825 **	-0.0143	-1.0616 **	-0.6729	-0.0907
INMSA	0.0764	0.0872	0.3224	0.1394 *	--	0.2922 **
POPDENS	0.00002	0.0009 **	0.00005 **	0.0005 **	0.00007 **	0.00009 **
PCTPOV	0.0066	-0.0111	0.0563	0.0225 *	0.0324	-0.0011
MDHSINC	0.00003 **	-0.00003 *	-0.00003	0.0001 **	0.00008	0.00003 *
MDHSVAL	0.0000008	-0.000001	-0.00001	-0.00003 **	-0.00002 *	-0.000009 **
West	--	--	--	--	0.1394	0.0208
N.East	--	--	--	--	0.1355	0.0484
South	--	--	--	--	-0.3826 *	-0.0728
% AF-AM	0.03912 **	0.0140 *	0.1209 **	-0.0012	0.0307 **	0.0112 **
% Hispan	-0.00007	-0.0051	-0.1387	-0.0071 **	-0.0027	0.00002
% Asian	-0.0171	-0.2479 **	1.0545 **	-0.0935	0.0426	0.0174
Adj. R^2	.2805	.7178	.1641	.2777	.1042	.1075

* $p < 0.05$ level ** $p < 0.01$ level

Table 10. Energy Facility Density Regression Coefficients for the U.S. and Regions (All Counties with Facilities)

VARIABLE	WEST (n=190)	N.CENTRAL (n=407)	N.EAST (n=161)	SOUTH (n=578)	MSA (n=544)	TOTAL (n=1336)
Intercept	0.0840	0.2226	0.4719	-0.3318 *	0.1251	-0.0556
INMSA	-0.0076	0.0515	0.0782	-0.0382	--	-0.0128
POPDENS	0.0003 **	0.0001 **	0.0003 **	0.0003 **	0.0003 **	0.0003 **
PCTPOV	-0.0006	-0.0083	-0.0155	0.0080	-0.0058	0.0023
MDHSINC	-0.000003	0.0000001	-0.000007	0.000009	-0.0000004	0.000007
MDHSVAL	0.000000	-0.000001	-0.000005	0.000006 **	0.000001	0.0000007
West	--	--	--	--	-0.1339	-0.0944 *
N.East	--	--	--	--	-0.0263	-0.0332
South	--	--	--	--	0.1245	0.0437
% AF-AM	0.0071	0.0043	-0.0353 *	-0.0023 *	-0.0062 *	-0.0028 *
% Hispan	-0.00007	0.0022	0.0186	-0.0015	0.0003	-0.0012
% Asian	-0.0370 **	-0.0082	0.1963	0.0241	-0.0042	-0.0082
Adj. R^2	.9308	.1300	.8670	.3761	.8004	.7867

* $p < 0.05$ level ** $p < 0.01$ level

Table 11. Disposal Facility Density Regression Coefficients for the U.S. and Regions (All Counties with Facilities)

VARIABLE	WEST (n=190)	N.CENTRAL (n=407)	N.EAST (n=161)	SOUTH (n=578)	MSA (n=544)	TOTAL (n=1336)
Intercept	-0.2274	-0.2361	-2.0670	0.2599	-0.3227	-0.2537
INMSA	0.0867	0.0580	0.0773	0.1133 *	--	0.1039 **
POPDENS	0.0003 **	0.0001 **	-0.00002	0.0003 **	0.00007 **	0.00008 **
PCTPOV	0.0019	0.0010	0.0396	-0.0077	-0.0071	-0.0002
MDHSINC	0.00002 *	0.00002 *	0.0001	0.000005	0.00004	0.00002 *
MDHSVAL	-0.000001	-0.000001	-0.000006	-0.000005	-0.000005	-0.000001
West	--	--	--	--	-0.0571	-0.0805
N.East	--	--	--	--	0.4972 **	0.3144 **
South	--	--	--	--	-0.0745	-0.0432
% AF-AM	0.0075	-0.0037	0.0123	0.0020	0.0117 *	0.0039 *
% Hispan	-0.0006	-0.0071	0.1738 **	-0.0007	0.0037	0.0003
% Asian	0.0151	0.1239 **	0.1232	-0.1048 *	0.1026 **	0.0833 **
Adj. R^2	.7165	.2203	.4096	.1757	.2360	.2695

* $p < 0.05$ level ** $p < 0.01$ level

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