Is There Environmental Racism? The Demographics of Hazardous Waste in Los Angeles County*

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Objective. The "environmental justice" movement has suggested that demographic inequities characterize the location of hazardous waste treatment, storage, and disposal facilities (TSDFs). While some researchers have found evidence that TSDFs are disproportionately located in minority areas, others attribute TSDF location to nonracial factors such as income and industrial employment. *Methods.* We used both univariate and multivariate techniques to analyze the location of TSDFs in Los Angeles County, California; the focus on one county allowed us to overcome the problem of "false" addresses for TSDF sites and to introduce specific land use/zoning variables that are not used in the other studies. *Results.* In our univariate results and the multivariate model, we find that (1) industrial land use and manufacturing employment do matter, as suggested by critics of environmental justice; (2) income has first a positive, then a negative effect on TSDF location, a pattern that likely reflects the fact that the poorest communities have little economic activity while wealthier communities have the economic and political power to resist negative environmental externalities; and (3) race and ethnicity are still significantly associated with TSDF location, even when percentage African American and percentage Latino are evaluated as separate groupings. Taken together, the results suggest that communities most affected by TSDFs in the Los Angeles area are working-class communities of color located near industrial areas.

* Direct all correspondence to James L. Sadd, Environmental Science and Studies Program, Occidental College, 1600 Campus Road, Los Angeles, CA 90041 (e-mail: jsadd@oxy.edu). Most of the data used in this study are in the public domain, and all data sources are listed in Table 1. Two proprietary data sets (GIS coverages of 1990 land use and point locations of TSDFs) were made available to the authors for the purpose of this research by the Southern California Association of Governments and Environmental Data Resources, Inc., and we gratefully acknowledge their support. We also thank the *SSQ* manuscript reviewers for their helpful comments. Editor's note: Reviewers were Douglas L. Anderton, Dennis Ehrhardt, Roger G. Noll, and Phillip H. Pollock III.

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Introduction

For more than a decade, community based environmental and social justice organizations nationwide have expressed concerns about disproportionate environmental risk and equity under the banner of "environmental justice" (Capek, 1993; Bullard, 1996). The environmental justice concept and the emergent political movement supporting it suggest that the potential health risks associated with exposure to hazardous materials, polluted air, and contaminated water are greater for racial and ethnic minorities and/or the poor because they represent a disproportionate fraction of residents living in communities located near potential hazards; indeed, the environmental justice concept asserts that demography can be used to predict the location of environmental hazards, with nonminority, affluent residents living in areas far from these potential threats. In urban Los Angeles, groups such as the Mothers of East L.A., Concerned Citizens of South Los Angeles, the Labor/Community Strategy Center, and Communities for a Better Environment have been the local face of this developing national movement and have, for example, challenged the location of municipal incinerators in minority neighborhoods as well as the allocation of public transportation dollars away from modes (such as buses) more heavily used by minorities.

But is there, in fact, environmental "injustice" of the type these groups claim? We address this question by evaluating disproportionate exposure to hazardous waste treatment, storage, and disposal facilities (TSDFs) in Los Angeles County. We focus on TSDFs for several reasons. First, this type of facility does pose some additional risk to nearby residents, particularly in case of fire, earthquake, accidental explosion or release, or illegal discharge and, therefore, represents a potentially significant health hazard. Second, unlike many other categories of environmental hazard, TSDFs also require an extensive government permitting process for siting and operation, which yields a relatively good record of site location.[1] Third, TSDFs and related hazardous waste sites have been the focus of similar studies, which offer some methodological examples of how to evaluate the validity of environmental justice (see GAO, 1983; UCC, 1987; Lavelle and Coyle, 1992; Mohai and Bryant, 1992; Anderton et al., 1994a, 1994b; Coursey et al., 1994; Been, 1995; Pollock and Vittes, 1995; Mohai, 1996; Yandle and Burton, 1996).

In looking for evidence of "environmental injustice," this study addresses three primary questions: (1) What is the geographic distribution of TSDFs in Los Angeles County? (2) Does the geographic distribution of TSDFs correlate with such demographic characteristics as race, economic status, and land use? (3) Of these demographic characteristics, which are statistically significant when considered in the context of a multivariate model?

[1] Been (1995) discusses the problems with verifying location accuracy, a subject we discuss later.

Our study reveals that a simple comparison of tracts with and without TSDFs reveals statistically significant differences by race and economic status along the lines suggested by the environmental justice proponents, as well as significant differences by industrial land use and manufacturing employment along the lines suggested by critics of the environmental justice concept (Anderton et al., 1994a, 1994b). In our multivariate model, race, along with industrial land use and employment in manufacturing, remains a factor; rising income, on the other hand, has a positive then a negative effect on the probability of TSDF location.

While this last finding may seem anomalous to those who have thought income, not race, was the driving force behind the location of environmental hazards, the relationship squares with the results in Been (1995) and makes sense on reflection: some areas are too poor to have any economic activity, even a TSDF, while others are wealthy enough to resist TSDFs' being sited nearby. In short, the most "at-risk" and impacted communities are working class, heavily minority neighborhoods located near industrial activity—exactly the sorts of communities being organized by the aforementioned Los Angeles–based groups.

This study is limited in intent and scope, in part because of the analytical design and, in part, because of limitations inherent in the available data. First, we focus only on Los Angeles County and thus can draw no sweeping conclusions with regard to environmental justice issues elsewhere; this is, in short, a case study.[2] Second, we consider only properly permitted TSDFs; an analysis that includes illegal sites would be complicated by poor data quality but could yield equally interesting results in terms of demographic patterns. Third, we did not study the history of the siting process for the various TSDFs used in this study and, consequently, do not have information on particular incidents of explicit income or ethnic discrimination in site decision making; we merely demonstrate a pattern that could be consistent with discrimination or with other factors. Finally, we did not conduct a time-series analysis and so do not know whether the affected communities changed demographically (e.g., became more "minority" in their residential population) *after* a TSDF was sited, a trend that might suggest market dynamics in residential movement rather than discrimination in siting.[3]

[2] The focus on Los Angeles County was driven by our desire to look at the patterns in our place of residence as well as by the research design; in particular, our geographic focus also allowed us to overcome the problem of "false" tract locations (such as headquarters addresses instead of actual processing sites) by visiting certain questionable sites and taking positioning data. Other geographically focused studies include Coursey et al. (1994), Mohai and Bryant (1992), and Pollock and Vittes (1995).

[3] Lambert and Boerner (1994) have suggested that the siting of a TSDF may cause a decrease in property value and a resulting shift toward a higher proportion of low-income and minority residents. Been (1994a) explores this issue and finds mixed evidence. It is difficult to accurately perform such "before and after" comparisons on a broad scale, in part because the U.S. census tract boundaries are relocated and the format of the census questionnaire, especially with

Despite the aforementioned limitations—many of which are characteristic of other studies in this field—this research makes a useful contribution by providing new evidence that race matters in the location of certain environmental risks in at least one important urban area.

Data and Methodology

All eighty-two Los Angeles County TSDFs currently listed by the California State Department of Toxic Substances Control (DTSC; Tanner, 1993 data set) were used in this analysis. According to this data set, forty-three of these facilities processed less than 50 tons in 1993, thirteen processed between 50 and 1,000 tons, and twenty-six processed more than 1,000 tons during that year; the largest facility processed 141,230 tons in 1993. Geographic coordinates and other data pertaining to these facilities were provided by Environmental Data Resources, Inc., and differentially corrected global positioning systems data were used to confirm correct location; such positioning was especially useful in overcoming the address error problem (Been, 1995: 11). We employed the census tract as the unit of geographic analysis, a more compact and homogeneous analytical unit than the zip code polygons used in the path-breaking study done by the United Church of Christ's Commission for Racial Justice (UCC, 1987). The tracts were matched with demographic data drawn primarily from the 1990 U.S. Census Summary Tape Files (STF-1 and STF-3) and augmented by land use and other data from other public and commercial data sources (see Table 1). Of the 1,652 census tracts in Los Angeles County, 12 had either no land area (they were generally yacht or navy harbors) or no residents and were therefore eliminated from analysis, yielding a usable county total of 1,640 census tracts.[4]

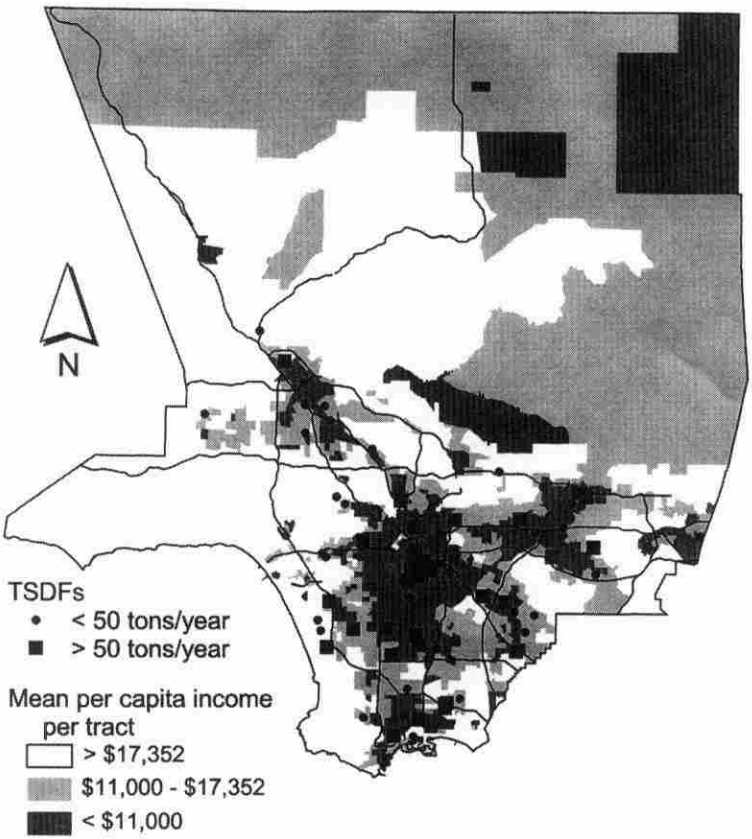
Qualitative Geographic and Univariate Comparisons. An initial qualitative analysis was accomplished by employing a Geographic Information System (GIS—Arc/Info) to visually compare the spatial distribution of TSDFs within Los Angeles County with the geographic distribution of various demographic characteristics using overlay maps (Figures 1 and 2). Figure 1 shows the locations of hazardous waste TSDFs, categorized by tonnage of waste processed per year. Large facilities—those that processed over fifty tons in 1993—are primarily concentrated in the area located just

regard to identifying ethnicity, has changed from decade to decade (see also Anderton, 1996; Mohai, 1996; Yandle and Burton, 1996b).

[4] None of these 12 excluded tracts contain a TSDF (although some do fall within a one-mile radius of a TSDF). For certain variables, however, the range of available tracts was even less than 1,640. For example, tracts where no one was employed generated a missing value for a measure of percentage of employment in manufacturing; as we will see in the regression analysis, this forced out 4 additional tracts, one of which contains a large-capacity TSDF.

FIGURE 1

TSDFs and Mean Per Capita Income, Los Angeles County, 1990

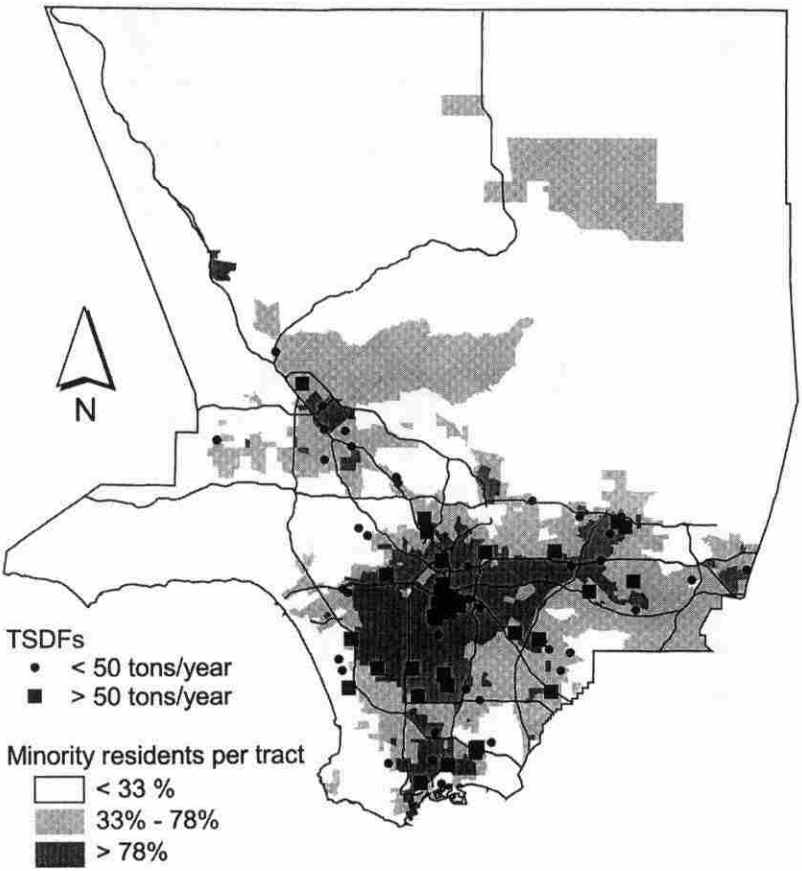


south of downtown Los Angeles; the remaining sites are located throughout southern and West-Central Los Angeles County, usually along freeway routes. These locations are overlaid on a breakdown of very low income tracts (>$11,000 per capita), low-income tracts ($11,000–$17,352 per capita), and tracts where per capita income exceeds the county tract average (for all tracts in our sample) of $17,352 a year. Figure 1 suggests that most of the TSDF tracts are located in the very low income and low-income areas of South-Central and East Los Angeles, the Long Beach/Los Angeles Harbor area, and portions of the central San Gabriel and San Fernando valleys.

Overlaying TSDF location on the percentage of minority residents (Figure 2) is similarly illustrative. There appears to be a geographic correlation between race and TSDFs.

FIGURE 2

TSDFs and % Minority Residents, Los Angeles County, 1990



To investigate the relationships in a more systematic way, we used GIS analytical routines to construct three dummy variables to distinguish various subsamples of Los Angeles tracts. The first, *TSD,* is equal to one for all census tracts that contain at least one TSDF, regardless of capacity; since some tracts have more than one TSDF, this gave us a total of sixty-six tracts with a TSDF. *TSD>50* is equal to one for all tracts containing a large-capacity TSDF, one that processed over fifty tons during 1993 and that may, therefore, pose a higher level of risk; the thirty-nine facilities that meet this criterion are located in thirty-one tracts.

A third dummy variable, *TSD>50/1.0,* expands the potentially exposed community by including all tracts with a boundary within a one-mile radius

of a large-capacity TSDF, yielding a tract total of 262.[5] Defining the neighborhood potentially affected by TSDF location by a radius of this general magnitude has been employed in several other studies (Mohai and Bryant, 1992; Anderton et al. 1994b; Pollock and Vittes, 1995) and reflects the assumption that the increased risk and potential damage caused by a TSDF is not constrained to U.S. Census boundaries, but, instead, affects residents of the area surrounding the facility. We considered a one-mile radius surrounding sites to be appropriate for this analysis. Pollock and Vittes (1995) report patterns of significant demographic inequity present within a much larger geographic range.

We then collected twelve different demographic variables for each tract, including (1) percentage minority residents (all but non-Latino whites; see Been, 1995: 5); (2) percentage African American; (3) percentage Latino; (4) per capita income; (5) median household income; (6) percentage employed in manufacturing; (7) percentage of land zoned for residential use; (8) percentage of land zoned for industrial use; (9) median house value; (10) median rent; (11) percentage registered to vote; and (12) population density (see Table 1). We calculated tract means and medians for the different variables, then compared the tracts with and without TSDFs (*TSD, TSD>50*), and the tracts located within versus those outside of our one-mile radius (*TSD>50/1.0*) to the overall means for Los Angeles County. Comparisons took two forms: a simple *t*-test of the sample means and a Wilcoxon procedure that is nonparametric and yields a *Z*-statistic for the difference in ranked sums.[6] The results are reported in simplified fashion in Table 2. To conserve space, we report only the county means and then the tract means for each subsample, where *TSD, TSD>50,* or *TSD>50/1.0* equals one; we do not report the means for the "companion" tracts with no TSDF exposure. Of course, if the means for TSDF tracts is above the county average, the mean for the companion tracts is below the average. The *t*-value and *Z*-statistics are, however, based on the appropriate comparison between tracts with and without TSD exposure.

The pattern that emerges generally squares with the priors of environmental justice advocates, but there are some interesting and important subpatterns. In all subsamples, the percentage minority (i.e., all those who are not "Anglo") is significantly greater in the tracts with TSDFs or within a one-mile radius of large-capacity TSDFs; however, the percentage African American is actually lower for tracts with any sort of TSD (albeit insignificantly) and becomes significantly higher only when we raise the exposure

[5] Analysis using a fourth dummy variable—all tracts within one-half mile of a large-capacity TSDF—yielded results similar to those for *TSD>50/1.0*. To conserve space, we do not report the results.

[6] The *t*-test can be performed under the assumption of either an equal or an unequal variance in the split samples; when the probability of an equal variance (as given by the *F*-statistic from a Levene test) was below .05, we opted for the unequal variance assumption. The Wilcoxon ranked-sum test is also used in Anderton et al. (1994b).

TABLE 1

Variable Names and Data Sources used in Analysis

TSDF	Hazardous waste treatment, storage, and disposal facilities registered with the California State Department of Toxics (Tanner, 1993 data set)
% minority	% of nonwhite residents in a census tract. Calculated by subtracting non-Hispanic whites from total persons and dividing by total persons (from 1990 Census, STF1)
% African American	% of tract residents identified as non-Hispanic black in 1990 STF1
% Latino	% of tract residents identified as Hispanic-1990 STF1
Per capita income	Per capita income by tract, as reported in 1990 STF3
Household income	Median household income by tract, as reported in 1990 STF3
% manufacturing employment	Ratio of residents employed in nondurable manufacturing to all tract residents employed, as reported in 1990 STF3
% residential land	% land in a tract devoted to residential housing and schools. Computed at the tract level using GIS from 1990 land use GIS coverage (2.5 acre resolution) (provided by Southern California Assn. of Governments)
% industrial land	% of land in a tract devoted to industry, transportation, communications, and utilities. Computed at the tract level using GIS from 1990 SCAG land use GIS coverage
Median house value	Median home value; self-reported, as taken from 1990 STF3
Median rent	Median rent; self-reported, as reported in 1990 STF3
% registered voters	Ratio of registered voters (for November 1994 election) to total number of persons in a tract over age 18. Voting data from Los Angeles County Registrar/Recorder Office; population from the 1990 Census, STF1
Population density	Total population divided by area of census tract. Population data from 1990 STF1; tract area calculated from 1992 Census TIGER data files

radius to one mile (*TSD>50/1.0*). The percentage Latino, on the other hand, is greater in those tracts containing or proximate to TSDFs across all subsamples, a pattern that squares with the findings in Anderton et al. (1994a, 1994b).[7] Per capita and household income are significantly and (nearly) uniformly lower across the subsamples, as is the percentage of registered voters; manufacturing employment is significantly and uniformly lower across the subsamples.

[7]The finding of significance for Latinos in Anderton et al. (1994b) seems to be driven by the pattern in the Southwest, in which Los Angeles County is located.

TABLE 2

Univariate Statistics on Differences between Tracts with and without TSDFs

Variable	L.A. County	*TSD*	*t*-value	*Z*-stat	*TSD*>50	*t*-value	*Z*-stat	*TSD*>50/1.0	*t*-value	*Z*-stat
% minority	56.3	69.2	3.96***	−3.10***	77.1	4.94***	−3.47***	78.2	15.40***	−12.25***
% African American	11.0	9.8	−0.54	−0.42	14.0	0.85	−0.44	16.8	4.67***	− 3.52***
% Latino	34.7	50.3	4.84***	−4.76***	53.5	3.93***	−3.89***	50.1	10.38***	−10.39***
Per capita income	$17,352	$12,730	−4.88***	−3.60***	$11,045	−7.38***	−3.39***	$11,202	−15.15***	−10.79***
Household income	$38,369	$32,170	−4.63***	−2.50**	$29,253	−2.76***	−2.99***	$30,298	−10.75***	−8.31***
% manufacturing employment	20.4	25.7	4.69***	−5.14***	26.6	3.74***	−3.98***	25.9	10.75***	−10.38***
% residential land	64.9	39.5	−9.00***	−7.76***	34.0	−7.36***	−6.16***	57.5	−5.15***	−5.48***
% industrial land	10.8	42.1	9.87***	−9.74***	49.5	8.18***	−7.61***	22.7	9.30***	−10.16***
Median house value	$243,026	$195,434	−4.68***	−3.54***	$186,070	−4.37***	−2.83***	$183,894	−12.46***	−9.64***
Median rent	$683	$623	−3.60***	−2.58***	$583	−3.29***	−3.33***	$598	−9.88***	−9.15***
% registered voters	34.1	28.6	−2.86***	−3.09***	28.2	−1.98**	−2.41**	26.2	−9.03***	−8.74***
Population density	11,044	7,032	−5.15***	−4.54***	6,909	−2.56***	−3.30***	11,838	1.54#	−2.73***

NOTES: ***Significant at the 0.01 level.

**Significant at the 0.05 level.

*Significant at the 0.10 level.

#Significant at the 0.20 level.

The land use mix changes across the subsamples. Whereas for *TSD>50/1.0*, TSDF-exposed tracts do have a pattern of lower residential and higher industrial use, this is less pronounced than for tracts where *TSD* and *TSD>50* equal one, a result that squares with the general supposition that TSDFs are located in the most industrial areas. Median housing values and rents are lower in all exposed tracts, but the tracts means fall most dramatically when we consider large-capacity sites (i.e., *TSD>50* and *TSD>50/1.0*).[8]

Finally, population density is lower in tracts with TSDFs (*TSD* and *TSD>50*), a result that is consistent with the aforementioned pattern of land use. On the other hand, population density is actually higher for those tracts falling in a one-mile radius of a large-capacity TSDF (*TSD>50/1.0*), although the difference is significant only in the Wilcoxon test. Note, however, the lower percentage of land devoted to residential areas in the *TSD>50/1.0* sample, a fact that implies that these "affected" individuals are especially crowded on the available land.[9]

The results do suggest a racial differential in TSDF exposure. For example, while the total number of people living in a census tract containing a TSDF represents 4.2 percent of the entire county population, this subpopulation represents 5.2 percent of all minorities and only 2.9 percent of the Anglo residents; meanwhile, more than one in five minorities live in a census tract located within one mile of a large-capacity hazardous waste TSDF in Los Angeles County, compared with fewer than one in ten Anglos living in similar circumstances. Whether this differential is a function of other variables (such as income or employment type) rather than ethnicity per se remains an open question, however. If, for example, the effects of race/ethnicity disappear once we control for, say, income, land use, and manufacturing employment, then the minority presence in TSDF tracts may be simply an unfortunate result of the strong correlation between percentage minority and these other variables.[10] To separate out the impacts, we follow the procedure of other authors and, in the next section, construct and test a multivariate logit regression of TSDF location.

Multivariate Logit Analysis. The base equation to be tested in our multivariate analysis was as follows:

[8]This result could suggest either siting of TSDFs in areas with lower property values or indicate a postlocation decline in values. See the discussion in Been (1994a).

[9]Following Anderton et al. (1994b), we also divided the tracts within our radius sample (i.e., all tracts where *TSD>50/1.0* = 1) into those with and without an actual large-capacity TSDF. The resulting *t*- and *Z*-statistics were nearly all highly insignificant, in contrast to Anderton's conclusions (which, we should note, were based on a much larger sample and a wider radius). The only significant differences—higher industrial land use and lower residential land use and population density—were unsurprising in light of our findings.

[10]This is generally what Anderton et al. (1994b) find. Been (1995) criticizes these results on methodological grounds and reruns various statistical tests with outcomes more conducive to the perspective that alleges some degree of environmental inequity.

$$\text{TSDF} = \text{f}\,[\textit{MINORITY}(+), \textit{PERCAPIN}(+), \textit{PERCAPIN2}(-), \textit{INDLAND}(+), \textit{EMPMAN}(+), \textit{POPDEN}(-)],$$

where the signs in parentheses indicate the manner in which each variable was expected to influence prediction of TSDF location. *MINORITY* refers to percentage minority in a particular tract, *INDLAND* refers to the percentage of tract land zoned for industrial use, *EMPMAN* is the ratio of manufacturing employees to all employed individuals in a tract, and *POPDEN* is the tract's population density (normalized to 100 when density is equivalent to the tract mean reported in Table 2). As will be seen, we also enter *AFAMPCT* and *LATINPCT*, the percentage of tract residents who are African American or Latino; runs using other variables are discussed below.

The last key variable in the base equation is *PERCAPIN*, defined as the ratio of per capita tract income to the tract mean reported in Table 2 (normalized, as with *POPDEN*, to 100). Note, however, that *PERCAPIN* is positively signed and that we have introduced a new variable, *PERCAPIN2* (the square of per capita income), for which we predict a negative sign; this functional specification gives us an inverted U-shaped curve in which the probability of a TSDF first increases, then decreases with increasing income. This curvilinear shape reflects the notion that extremely poor census tracts might not contain enough industry to warrant locating a TSDF in that area, even if the low level of income translates into a low level of potential political resistance to such a facility; on the other hand, wealthier residents might have a greater capacity to avoid living near potentially hazardous facilities and/or resist the location of such facilities nearby, implying that the best odds for location of a TSDF would be in tracts within an income range that would not be the lowest in the county. Such a supposition also squares with the pattern reported by Been (1995: 18–19). She breaks up neighborhoods by income and finds that both the poorest and the richest areas bear a disproportionately low burden of TSDFs, with a disproportionately high concentration of such facilities in areas with median family incomes ranging from $10,000 to $40,000.

The actual regressions were performed using as the dependent variable the various TSDF tract designations reviewed in Tables 2 and 3. Reported here are the results for two dummy variables associated with large-capacity TSDFs (*TSD>50* and *TSD>50/1.0*), in part, because large-capacity plants may pose a greater potential hazard and, in part, simply to conserve space; the pattern was similar for the *TSD* variable (which equals one for a tract with any sort of TSDF), but the statistical significance of those runs was generally lower, a result in keeping with the smaller difference between TSDF and non-TSDF tracts evident in Table 2. With each dependent variable, we tried three basic specifications: the first set uses the base regression outlined

earlier; the second drops *POPDEN;* and the third drops *MINORITY* and enters separate variables for the two major minority groups.

The results, reported in Table 3, tend to be consistent with both the environmental justice framework and Anderton et al.'s (1994a, 1994b) stress on the importance of industrial employment.[11] Note first that our specification of the income relationship generally works well and that both *MINORITY* and *INDLAND* are quite significant and robust across the specifications. Manufacturing employment is incorrectly signed but insignificant for *TSD>50*; on the other hand, it is positive and significant for the one-mile radius, a pattern that squares with Anderson's assertion that TSDFs may be located near the appropriate workers (or vice versa). Finally, both *AFAMPCT* and *LATINPCT* are positive and significant in the same regression, seeming to challenge the conclusion in Anderton et al. (1994b) that environmental hazards might be more correlated with Latinos than with African Americans.

As can be seen, *POPDEN* is highly insignificant and was therefore dropped. While this is contrary to the findings in Been (1995), in which population density is negatively signed and significant in a logistic regression, the insignificance actually results from our use of a superior measure, *INDLAND*, which has not been available for researchers casting a broader geographic net than we did. If we, for example, drop *INDLAND*, *POPDEN* becomes significantly negative and the other variables follow the same general pattern of signs and significance with one telling exception: *EMPMAN* becomes positive and significant in the *TSD>50* sample. In our view, this suggests that population density has been a stand-in for industrial land use in previous studies. If we calculate a density measure that divides population by only the residential land, it is actually positive but not significant in a regression that includes *INDLAND*.

What about other possible specifications? Using median household rather than per capita income yields essentially the same results. Median house value and median rent fare poorly, an expected result, since both are problematic variables and it is unclear how each should be weighted in determining land values.[12] Percentage of registered voters is insignificant, perhaps because we are already controlling for variables (race, income, and

[11] Indeed, Anderton et al. (1994b) find percentage minority to be generally insignificant in their logistic regressions and argue that this is because they have controlled for the locational decisions of minority residents by including an industrial-employment variable. As noted in the text, our results are different for this case study.

[12] Because of coding limits, for example, a full 10 percent of median rents and 7.3 percent of median household values share the same maximum value. Meanwhile, there is likely to be significant error in the self-reported house value, and upward bias may have been quite possible in the overheated California real estate market extant at the time of the U.S. Census. Weighting house values and rents is also quite difficult; although we know how many units fall in each category, there are computational difficulties in transforming house values in rent-type flows, and the possibility of high-end houses coexisting in the same tract with low-income rental units makes normalization of each sort of value or flow particularly challenging.

TABLE 3

Logit results for TSDF Presence as a Function of Various Demographic Variables

Independent Variable	Dependent Variable					
	TSD>50 (a)	*TSD*>50/1.0 (b)	*TSD*>50 (c)	*TSD*>50/1.0 (d)	*TSD*>50 (e)	*TSD*>50/1.0 (f)
MINORITY	0.030	0.033	0.030	0.033		
	(1.965)**	(6.318)***	(1.967)**	(6.332)***		
PERCAPIN	0.056	0.027	0.056	0.026	0.062	0.009
	(1.692)*	(2.589)***	(1.752)*	(2.726)***	(1.771)*	(.829)
PERCAPIN2	0.000	−0.000	−0.000	−0.000	−0.000	−0.000
	(−1.39)	(−2.451)**	(−1.404)#	(−2.515)***	(−1.588)*	(−1.647)*
INDLAND	0.064	0.033	0.063	0.032	0.063	0.033
	(5.981)***	(7.304)***	(8.02)***	(8.106)***	(7.971)***	(8.261)***
EMPMAN	−0.012	0.020	−0.012	0.022	−0.018	0.025
	(−.542)	(2.216)**	(−.542)	(2.213)**	(−.736)	(2.283)**
POPDEN	0.000	0.000				
	(.020)	(.153)				
AFAMPCT					0.019	0.018
					(1.476)#	(4.010)***
LATINPCT					0.026	0.010
					(1.489)#	(1.677)*
Usable observations	1,636	1,636	1,636	1,636	1,636	1,636
Log likelihood	−102.6	−583.5	−102.6	−583.5	−103.3	−596.1
% cases correct	98.2	85.3	98.2	85.3	98.2	85.1
Pseudo R^2	0.146	0.167	0.146	0.167	0.150	0.154

NOTES: ***Significant at the 0.01 level.

**Significant at the 0.05 level.

*Significant at the 0.10 level.

#Significant at the 0.20 level.

working-class status) often associated with low political participation. Finally, a linear specification of an income variable, as suggested by one anonymous referee, yields a negative but insignificant coefficient, with all other variables retaining their sign and significance pattern; we therefore stick with our preferred specification.[13]

While signs and significance are important, it would also be interesting to know the magnitude of the impacts of different variables. Unfortunately, coefficients in logit regressions are difficult to interpret, primarily because they are telling us the impact on the log of the odds. One way to determine the effect on the more commonly used notion of probability is to transform these coefficients at the mean of the dependent variable; however, the mean for the dependent variable therefore affects the coefficient value, and this can be especially problematical when the mean value for dependent value is quite low, as it is for *TSD>50*. An alternative is to conduct sensitivity analysis, "calibrating" the regression at the tract mean for all the relevant independent variables. We follow the latter procedure here.

Taking as our "best" regressions those reported in columns (c) and (d) of Table 3, we first determined the income "peaks" below and above which the likelihood of being located near a TSDF decreases. For *TSD>50*, this was 99 percent of the mean tract; for *TSD>50/1.0*, it was approximately 125 percent of the mean tract.[14] An increase in per capita income of 10 percent from the peak would decrease the probability of a tract's having a boundary within a one-mile radius of a large-capacity TSDF by 0.002. Meanwhile, a 10 percent increase in minority residents would raise this probability by 0.045, a 10 percent increase in industrial land would raise the probability by 0.043, and a 10 percent increase in manufacturing employment would raise probability by 0.029.[15] Of course, one must recall that the random chance of a given tract's being in the *TSD>50/1.0* subsample is the county incidence rate of 0.159; thus, the aforementioned shifts in minority population, land use, and employment would raise a tract's chance of being located in the TSDF radius by 28 percent, 27 percent, and 18 percent, respectively, while change in probability associated with increasing the peak per capita income by ten percentage points would lower the chance by 1.3 percent.

In the real world, these critical race, income, employment, and land use variables move in parallel and simultaneous fashion. We therefore constructed two "tract profiles," which we consider to be typical of several

[13] A linear specification of income is highly significant only when we drop race; of course, given that the debate is about whether the location of TSDFs reflects racial disparities or simply market forces, this is a highly academic exercise.

[14] "Peaks" of income relative to the mean are similar if median household income is used.

[15] These are estimates from the tract means, but the actual effect on probability is nonlinear. For example, moving from 0 to 10 percent minority raises probability of being located in the *TSD>50/1.0* radius by 0.009; moving from 90 to 100 percent minority raises the probability by 0.077.

Los Angeles County cities and neighborhoods. Each tract profile is defined by a range of model variables: Profile A is characterized by 0 to 20 percent minority residents, a per capita income range of twenty-five thousand dollars to thirty-five thousand, 2.5 to 7.5 percent industrial land use, and 5 to 20 percentage employment in manufacturing. Profile B is 80 to 100 percent minority, per capita income from five thousand dollars to fifteen thousand, percentage industrial use from 20 to 30 percent, and percentage employed in manufacturing between 30 and 45. Twenty tracts in Los Angeles County fit profile A and twenty-three fit profile B. For the profile A tracts, the predicted probability from our regression of a *TSD>50/1.0* is 2.0 percent and the actual incidence is 5 percent; for profile B, the predicted probability of a *TSD>50/1.0* is 43.1 percent and the actual incidence is 34.8 percent. In our view, this suggests a reasonable fit between our regression and the data.

Summary

This article has tried to examine the issue of "environmental justice" by examining the pattern of one potential hazard, TSDFs, in one geographic area, Los Angeles County. The results of univariate analysis suggest a substantial difference between tracts with and without (or close to and far from) such hazards by race/ethnicity, income, land use, employment patterns, political participation, and population density. One key subpattern squares with the analysis in Anderton et al. (1994b); breaking the category "minority" into African Americans and Latinos suggests that the latter may be much more likely than the former to be living in the closest proximity to such TSDFs. Multivariate analysis of the type suggested by Anderton et al. (1994b), Been (1995), and others indicates that (1) even controlling for income, industrial land use, and manufacturing employment, race/ethnicity correlates with the location of TSDFs, and this holds for both African Americans and Latinos; (2) income bears a complicated relationship to the likelihood of TSDF location, with the latter first rising, then falling as income increases (see also Been, 1995); and (3) as suggested by Anderton et al. (1994a, 1994b), TSDF location and the proximity of a manufacturing labor force are significantly correlated in a multivariate analysis (and industrial land use, not tested in Anderton et al. [1994a, 1994b], is even more significant).

While the latter results on the significance of manufacturing employment do support the claims of those arguing that the strength of the minority–TSDF correlation is partially driven by other forces, the persistence of race across our tests suggests that environmental justice proponents may have real cause for their concerns, at least in the Los Angeles area. Most important, the overall pattern we find suggests that the communities most likely to "host" a TSDF are industrial areas with a

large concentration of working-class people of color—exactly the group that has been the focus of Los Angeles–based advocates of environmental justice.

This study, of course, leaves open a set of questions that should be the target of future research. As noted in the introduction, we have not conducted a historical analysis of siting and have no evidence of actual discrimination in permit decisions. Moreover, we have not examined whether areas surrounding Los Angeles County TSDFs changed demographically (e.g., became more minority in their residential population) during the period after the facility was sited.[16] Been's (1994a) exploration of this issue is inconclusive. Yandle and Burton (1996a) attempted such a study for hazardous waste landfills in metropolitan areas of Texas and found no evidence for siting bias against racial and ethnic minorities but did detect a bias toward siting these facilities in low-income communities. Their study, however, has received pointed criticism on both contextual and methodological grounds (Anderton, 1996; Bullard, 1996; Mohai, 1996; see also Barkenbus, Peretz, and Rubin, 1996; Yandle and Burton, 1996b). If there is any racial pattern of movement into an area of environmental risk, that is, if more minorities move into areas with potential hazards than do Anglos of similar income levels, we believe this suggests a lack of choice over a broader residential market, and the explanation for the present pattern of environmental inequity based on race and ethnicity would then differ only in its historical details (Andeola, 1994).

In terms of policy, we suggest that TSDFs be seen as a necessary part of the urban economic landscape; any attempt to ban such sites might actually pose even greater and more inequitable hazards by creating incentives for illegal dumping.[17] Still, better zoning separation between industrial and residential land might be a useful policy direction, and serious thought should be given to compensation schemes designed to offset the costs of potential risk (Kunruether et al., 1987; O'Sullivan, 1993; Been, 1994b). In the meantime, policymakers should pay more attention to the demographics of the communities surrounding any proposed new sites and recognize that the opinions of community groups that have raised the charges of environmental injustice are not unreasonable based on the current existing evidence.

[16] Such a pattern, if it exists, might weaken the environmental justice notion and, in turn, raise interesting questions about minority preferences: since we are controlling for income and employment, why would we find more non-Anglos than Anglos of similar income and occupation "choosing" to move to potential hazard areas?

[17] Local governments cannot place an outright ban on hazardous waste facilities; such action, whether the ban be expressly stated or obtained by use of excessive regulation, has been ruled by the U.S. Supreme Court to violate the commerce clause of the Constitution (Shortlidge and White, 1993).

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