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An Investigation of Environmental Racism Claims: Testing Environmental Management Approaches with a Geographic Information System

GREGG P. MACEY*
Department of Urban Studies and Planning,
Massachusetts Institute of Technology, Room 9-316,
77 Massachusetts Avenue
Cambridge, Massachusetts 02139, USA

XEE HER
ELLEN THOMAS REIBLING
JONATHON ERICSON
Department of Environmental Analysis and Design,
University of California at Irvine,
Irvine, California 92697-7070, USA

ABSTRACT / The purpose of this research was to explore the concept of an environmental racism claim through the use of several environmental management tools. The EPAs Toxics Release Inventory, Cumulative Exposure Project, and the Los Angeles County Department of Health Services' Hot Zone Census Tract Assessment were combined with racial and socioeconomic data to test claims that minorities in South Central Los Angeles are disproportionately exposed to environmental lead. Multivariate analysis indicated that race is strongly associated with the number of cases of elevated blood lead levels in South Central, irrespective of poverty status. Proximity to point sources, a common focal point for studies of environmental racism, was not a contributing factor to health outcomes. Proximity to transportation corridors was consistently the strongest indicator of environmental lead exposure, while median home values were significantly and positively related to elevated blood lead levels. Implications for environmental justice advocates and social and environmental scientists are discussed.

Young children are particularly vulnerable to the effects of environmental lead poisoning, defined as a blood lead level (BLL) of 10 μg/dl or higher. Elevated blood lead levels in children have been associated with slower cognitive development (Tong 1998, Winneke and Kreamer 1997), decreases in somatic growth (Frisancho and Ryan 1991), increased social and behavioral problems (Wasserman and others 1998), permanent nervous system damage, and even increased mortality (Brown and others 1999). Tong's (1998) examination of longitudinal prospective studies supports the notion that the effects of early lead exposure persist into later childhood.

Common exposure pathways include in utero (Rothenberg and others 1999, Farias and others 1998), postnatally inhaling or consuming lead dust from housing painted before 1978 (National Academy of Sciences 1993), inhaling or consuming lead-contaminated soil, common in industrial and urban areas (Mielke and Reagan, 1998), or drinking water either contaminated by lead particles or drawn from older piping systems containing lead solder. Although the elimination of lead in gasoline has contributed to observed decreases in blood lead levels nationwide (Needleman 1998), an estimated four to five million metric tons of lead remain in soil near heavily traveled highways (Xintaras 1992). Soils constitute a particularly significant exposure pathway, as they reflect the historic deposition of metal dust from gasoline, lead-based paint, and industrial activities (Mielke and others 1999).

Evidence of disproportionate exposure to environmental lead within urban areas such as South Central Los Angeles and West Dallas abounds within the literature (Rothenberg and others 1996, Lanphear, and others 1996, Jacobs and Papanek 1995, Bullard 1994). The effects of environmental exposure to lead on the predominantly minority inhabitants of urban areas as well as smaller towns adjacent to industrial corridors was noted by the Agency for Toxic Substances and Disease Registry (1988). Lead poisoning affects nearly one million children nationally, the majority of whom are black or Latino children residing in urban centers (Centers for Disease Control and Prevention 2000). Among urban children 5 years old and younger, the disproportionate impact of lead on minority groups has also been disaggregated from the effects of income. For families with incomes less than $6000, 68% of black children have elevated blood lead levels, compared to

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*Author to whom correspondence should be addressed; e-mail: gmacey@MIT.edu

36% of white children (US EPA 1992). The effect remains for families earning more than $15,000 (38% compared to 12%).

Increasingly, such data are utilized for the advancement of claims of environmental racism. These claims maintain that people of color, broadly defined, are exposed to greater quantities of toxins due to racial discrimination in policy-making, the unequal enforcement of environmental regulations and laws, and the deliberate targeting of communities of color for toxic waste facilities. The term "environmental racism" emerged following an incident in Warren County, North Carolina, where in 1982, the governor agreed to bury 6000 truckloads of polychlorinated biphenyl (PCB) within the community of Afton. At the time, Afton had the highest percentage of African-Americans in the state, and later the township was determined geologically unsuitable for the burial of hazardous waste (Bullard 1984, Geiser and Wanock 1994). The civil disobedience that followed formed the impetus for various studies administered by the US General Accounting Office (1983) (within EPA Region IV, communities surrounding hazardous waste sites were 69–92% black), the National Law Journal (Lavelle and Coyle 1992) (a national data set of civil penalty cases between 1985 and 1991 revealed that violations of the Resource Conservation and Recovery Act (RCRA) within minority communities were assessed for significantly lower fines), and the United Church of Christ Commission for Racial Justice (1987) (a study of all 415 commercial hazardous waste sites in the contiguous United States which found that race, not income, was the predominant factor in site placement).

Environmental management provides a useful approach for sifting through this complex set of claims. At the very foundation of environmental management are obligations undertaken by a community or set of communities to attain, protect, enhance, and allocate natural resources. The intersection of environmental management and the environmental justice movement occurs when a governing body fails to manage resources effectively, resulting in all or part of a community unable to attain a minimum environmental quality. Moreover, an environmental racism claim suggests a pattern of environmental management that must be evaluated for its perceived discriminatory intent, actions, and effects. The inability of national uniform regulations such as the Clean Air Act to address localized concentrations of toxins, known as hotspots, further suggests that any solution to environmental racism claims must involve the resources and coordination of multiple levels of governance whose jurisdictions intersect within a specific geographic area.

The search for an environmental management solution to environmental racism claims has proceeded along two primary trajectories. One path incorporates efforts at different levels of government to include analyses of disparate impacts in future siting, monitoring, and cleanup efforts. In 1994, the Clinton Administration issued Executive Order 12,898, instructing federal agencies to identify any disproportionate effects of agency programs and policies on minority and low-income communities. Further legislative attempts to incorporate demographic analyses in environmental management decisions have appeared at both the national and state levels. The Environmental Equal Rights Act of 1993 (H. R. 1924, 103rd Congress, 1993) would have required that specific criteria be met for a siting approval to avoid challenge. Proposed facilities within two miles of an existing waste facility, within communities with a higher than average percentage of minority residents, and shown to adversely affect human health or environmental quality would have been vulnerable to challenge (Kevin 1997). California Assembly Bill 2212 (1993) would have prohibited California agency approval of hazardous waste and nonhazardous solid waste facilities should a permit application fail to include census tract data such as race, ethnicity, poverty rates, and the percentage of the population below age 5 and above age 65. Although these initiatives have proven unsuccessful to date, the EPA has committed regional and state agencies to conducting environmental justice pilot projects within high-priority permitting areas (Forrest and Mays 1997). Through evaluation of population demographics at RCRA facilities and by conducting public health assessments, the EPA intends to gain a better understanding of permit conditions that lead to claims of discriminatory intent.

A second, complementary approach to more responsible environmental management of toxic substances involves the use of social science research, which is often helpful in the adjudication of legal claims. Advocates of environmental justice have focused on the act of siting locally undesirable land uses (LULUs, such as hazardous waste facilities) in order to prove discriminatory intent. There is a burgeoning literature that analyzes the correlation between the placement of LULUs and the demographics of a given area, using a number of environmental management tools as data sources. For example, in 1996, Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA), or Title III of the Superfund Amendments and Reuthorization Act (SARA). Section 313 of SARA required the EPA to develop an inventory of routine toxic chemical emissions, now known as the Toxics Release Inventory (TRI). Owners and operators

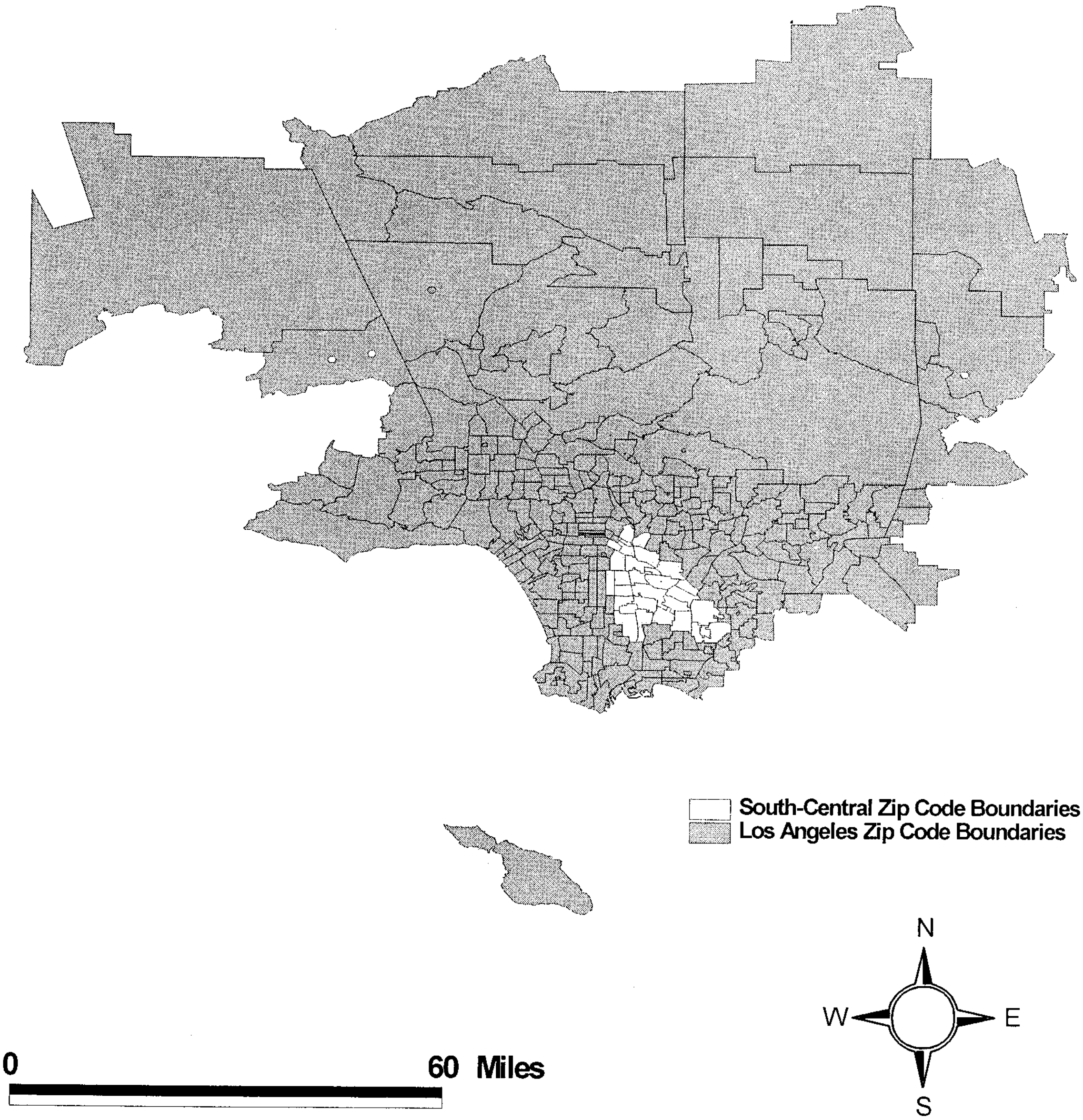

Figure 1. South Central Los Angeles location within Los Angeles County.

of facilities with ten or more full-time employees that manufacture, process, or use any of the more than 600 listed chemicals are required to submit forms on an annual basis that provide estimates of the total amount of chemicals released into the environment through a variety of media. In 1993, the EPA issued an investigation of environmental racism claims along the Lower Mississippi River Industrial Corridor using TRI data. It was found that within two miles of TRI facilities releasing roughly 90% of the corridor's total air emissions there were higher proportions of minorities than either the state average or the industrial corridor's average. Although the report avoided a common fallacy within the literature of equating the siting of facilities with toxic releases, it continued a trend begun in the initial investigative studies by equating toxic release and facility siting with actual health impacts.

As both the top-down (i.e., government agency activity) and bottom-up (i.e., civil actions and grassroots mobilization) approaches to environmental management solutions continue, they begin to evidence similar informational needs. First, the gathering, analyzing, and presenting of large amounts of environmental and social data in a spatial context has limited the ability of advocates and government officials to effectively monitor and remediate cases of discriminatory environmen-

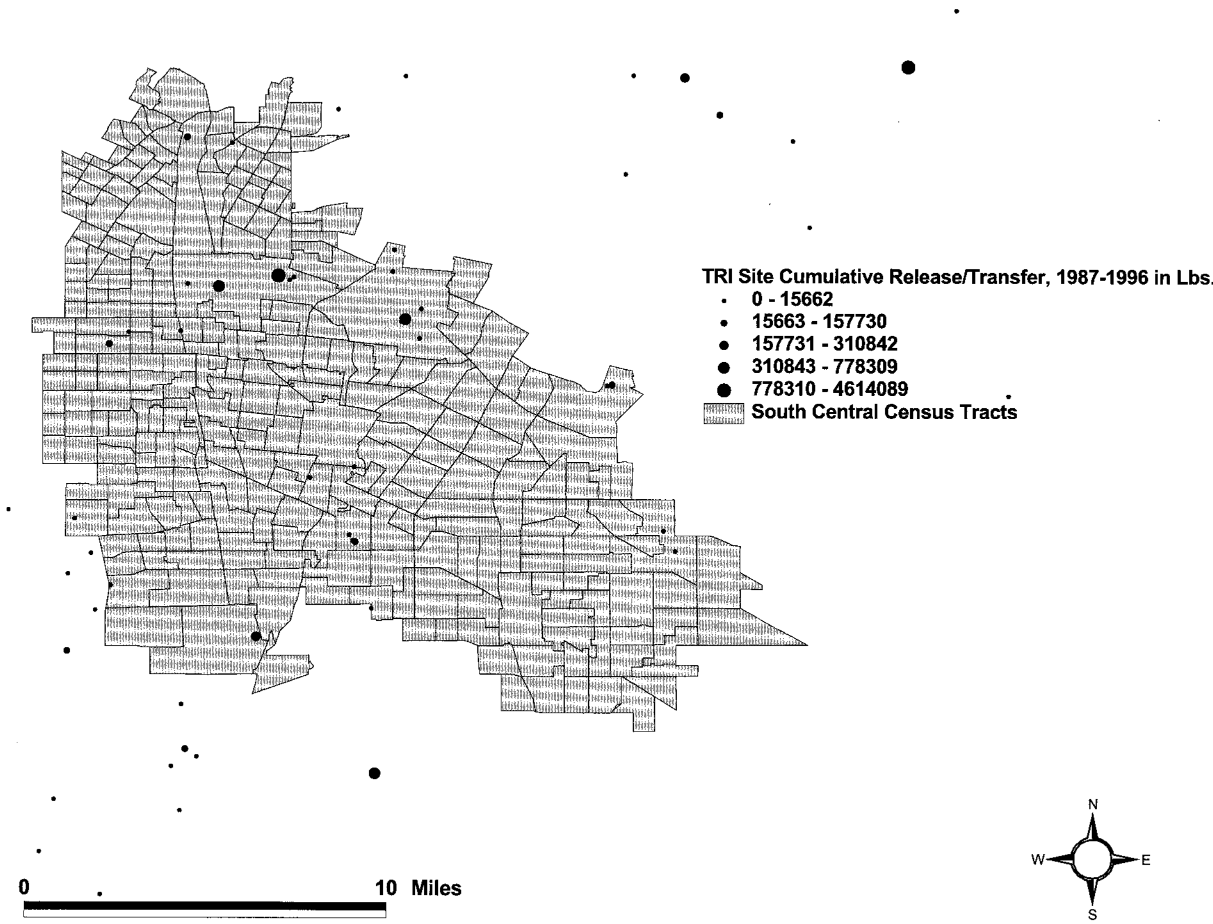

Figure 2. Location of Toxics Release Inventory sites and cumulative release/transfer of lead in pounds, 1987–1996.

tal harm. Second, the presence of multiple environmental pathways inhibits claims against specific corporate enterprises and government agencies when an environmental harm is presented. Finally, the cumulative exposure of residents to environmental toxicants adds a level of complexity to the spatial problem, although it is increasingly salient for toxic tort adjudication (Northern 1997).

Computer-aided analysis, facilitated by software packages known as geographic information systems, provides an appropriate tool for addressing each of these challenges. Geographic information systems allow for the acquisition, storage, analysis, and presentation of large amounts of spatial resource management data (Dueker 1987). They store land use and socioeconomic data in information layers, or themes, each of which represents the spatial distribution of a desired attribute (such as jurisdictional boundaries, land use, or soil type). These layers can be aggregated to produce maps applicable to the issue at hand. For example, Bocco and Sanchez (1997) developed a model for the potential impact of lead contamination from point sources. Through a series of cartographic overlays of spatial themes, the authors were able to provide a narrowed universe of potential pollution sources in Tijuana, Mexico.

The present analysis makes use of geographic information systems (GIS) science to evaluate different environmental management tools available for the analysis of environmental racism claims. It employs a variety of environmental management tools, including the EPA's Toxics Release Inventory (fixed sources), the EPA's Cumulative Exposure Project (Axelrod 1999) (a model of the impacts of fixed emissions), and the Los Angeles County Department of Health Services' Hot Zone Census Tract Assessment (Los Angeles County Department of Health Childhood Lead Poisoning Prevention Program, personal communication, February 1999). In order to evaluate the effectiveness of each model in predicting health outcomes from environmental exposure, the above inventories are evaluated along with proxies for other sources of environmental

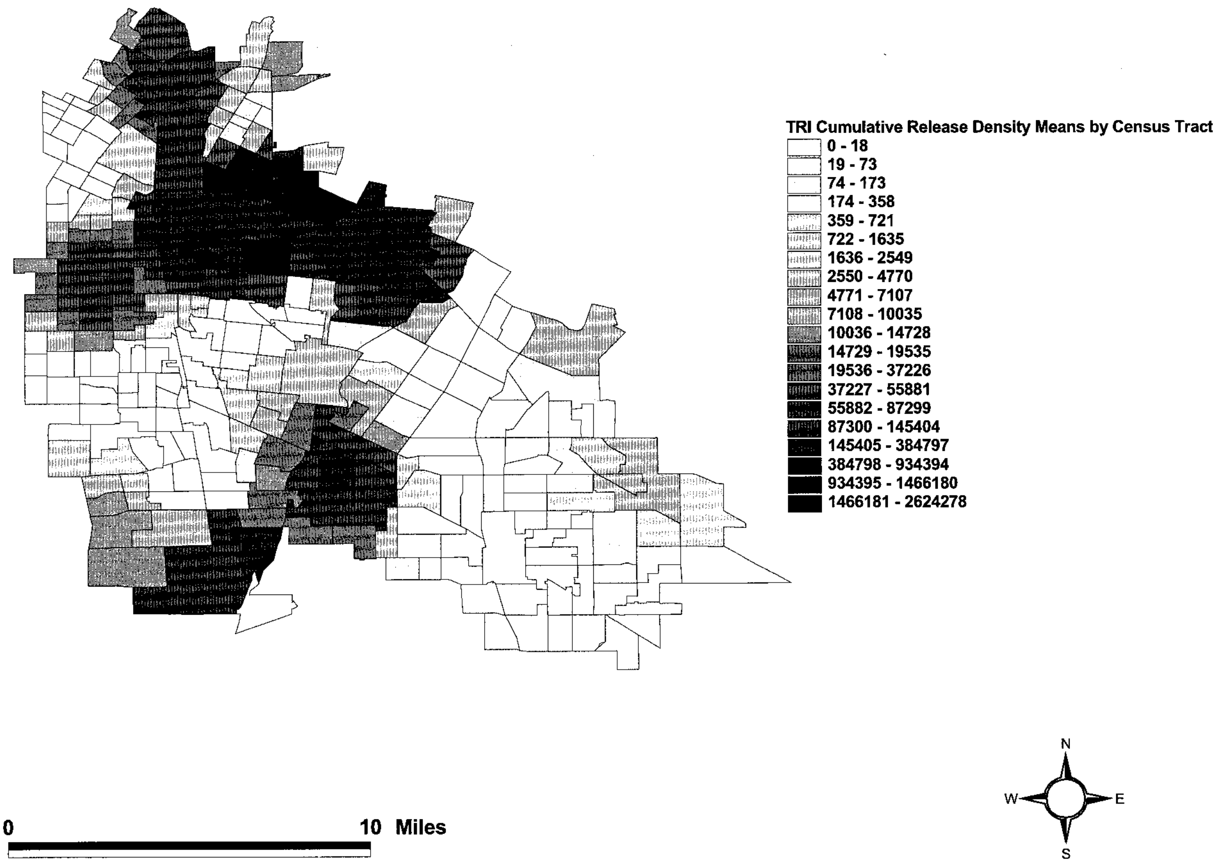

Figure 3. Density Means for TRI Cumulative Release/Transfer of Lead, 1987–1996.

lead: a model of roadside emissions (a major source of environmental lead until its elimination from gasoline) and data pertaining to age of housing stock (a proxy for the use of lead-based paint). The racial breakdown of a geographic area from which environmental racism claims originate, South Central Los Angeles, is also utilized. Through use of GIS and environmental lead as a case study, the study attempts to encourage further discussion of environmental racism claims within the context of environmental exposure, exposure pathways, and health outcomes.

Methods

The boundaries of South Central Los Angeles used for this study are defined by the Los Angeles County Department of Health Childhood Lead Poisoning Prevention Program (personal communication, 22 January 1999) (Figure 1). The project area encompasses the communities and cities of Bell, Bellflower, Bell Gardens, Cerritos (partially), Commerce, Compton, Cudahy, Downey, Huntington Park, Los Angeles (partially), Lynwood, Maywood, Norwalk, Paramount, South Gate, and Vernon. Census tracts ($N = 273$) were used to take advantage of the relative uniformity of socioeconomic indicators within their boundaries. Previous studies have made use of zip codes in their investigation of socioeconomic factors (United Church of Christ Commission for Racial Justice 1987). Larger in scale, zip codes were designed to facilitate transportation efficiency and, by design, are not homogenous. Census tracts, on the other hand, are small units of analysis and are designed to be homogenous regarding population characteristics and economic status (US Department of Commerce 1994).

Within the boundaries of the project area, potential environmental lead exposure pathways were identified and incorporated within a GIS database. First, in order to model the cumulative impacts of lead emissions and transfers, TRI sites were mapped according to latitude and longitude. Release and transfer data for 1987–1996 were used to calculate the potentially impacted area within South Central. Using Spatial Analyst, an extension to ArcView GIS (Environmental Systems Research

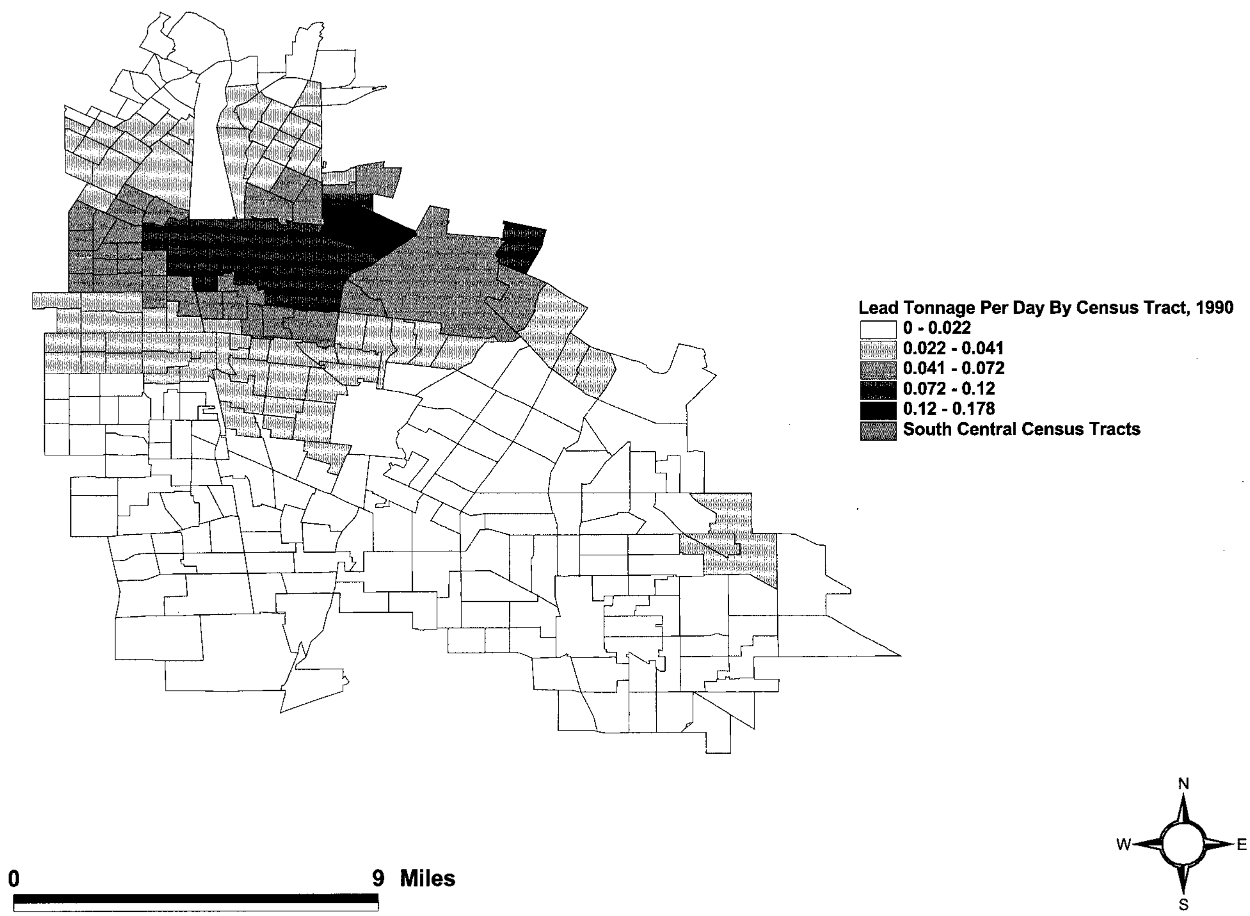

Figure 4. Spatial distribution of cumulative exposure project model for lead tonnage per day, as reported by Axelrod (1999).

Institute 1999), the total release of each point source was distributed throughout the project area as a linear function of distance, the position of each TRI site in relation to other points, and the quantity of emissions from these points. In keeping with previous research, the cumulative impacts of TRI sites were restricted to distributions within two miles of each point source (US EPA 1993). Figure 2 shows project area and neighboring TRI sites, while Figure 3 provides the mean density for TRI releases within the project area by census tract.

TRI data were compared with the EPA's Cumulative Exposure Project data as well as the Los Angeles County Department of Health's Hot Zone Census Tract Assessment. The exposure project uses information on concentrations of air toxins to assess potential health impacts. Using a dispersion model, the EPA estimates pollutant emissions and uses a computer model to simulate the impacts of winds and other atmospheric processes upon emitted pollutants. This variable represents an estimate of total lead (in tons) deposited per day in each census tract in 1990 (Figure 4). Hot zone census tracts are identified through analysis of demographic data, including the percentage of children in poverty living in housing constructed prior to the banning of lead-based paint. The assessment differs from continuous demographic data used in the present study in that it chooses an arbitrary cutoff of socioeconomic indicators in distinguishing the location of hot zones (Figure 5).

A second source of environmental lead consists of roadside emissions from leaded gasoline. An ESRI database of interstates, freeways, and major roadways and streets was overlaid with the project area to yield a second potentially impacted universe. Lead concentrations in dust near busy motorways have been shown to be 6 mg/m^2/day at the end of the right-of-way, falling by roughly 50% to 3 mg/m^2/day at 30 m (taking into account wind direction) (Chamberlain and others 1978). A buffer zone was drawn to reflect this area of significant lead deposits and their distribution according to wind direction. The area of the buffer zone was calculated as a proportion of total surface area within

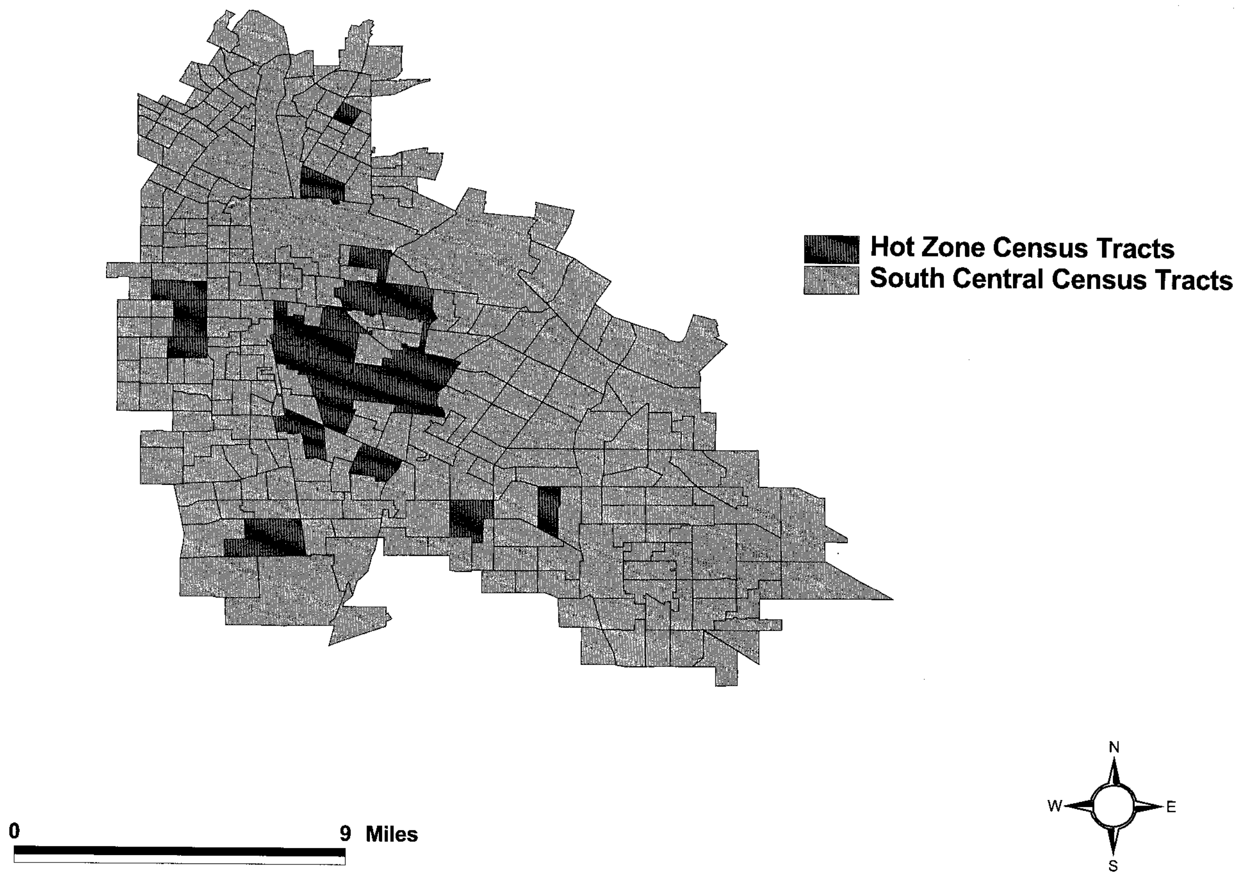

Figure 5. Location of hot zone census tracts within South Central Los Angeles, according to Los Angeles County Department of Health Childhood Lead Poisoning Prevention Program (personal communication 1999).

each census tract, as an indicator of relative lead deposit (Figure 6).

The inhalation or consumption of lead dust from housing painted before 1978 marks a third exposure pathway, especially among children. This indicator can be exacerbated by low socioeconomic status (SES), which can divert funds needed for removal, repainting, or repair of chipped surfaces to other necessities. It has been estimated that nationwide, lead-based paint can be found in 99% of homes constructed prior to 1940. The number decreases to 70% for homes built from 1940 to 1960, and to 20% for homes built from 1960 to 1974 (Jacobs and Papanek 1995). The percentage of housing built before 1969 was calculated for each tract using US census data for 1990. The SES variable of the percentage of children living below the poverty line was also included in the database. Ethnicity variables were also used in model construction. Figures 7 and 8 illustrate the distribution of Hispanic and black populations throughout South Central Los Angeles, compared with the location of TRI sites in the study area.

Ordinary least-squares regression was used to test claims of disproportionate exposure to environmental lead within South Central Los Angeles. The dependent variable represents the number of children reported to have elevated blood lead levels of 10 μg/dl or higher between 1991 and 1998 by the County of Los Angeles Department of Health Childhood Lead Poisoning Prevention Program (personal communication 22 February 1999). This figure is given as a number per thousand children living in each census tract (Figure 9). For the number of elevated blood lead level cases per thousand children, the equation is:

$$Y_i = a + b_1X_1 + b_2X_2 \ldots + b_iX_i + e_i \qquad (1)$$

where Y_i represents elevated blood lead level (BLL) per thousand children for the ith census tract, as a linear function of the following independent variables: cumulative lead concentration as a function of TRI site, roadway buffer zone as a proportion of total tract surface area, percentage of housing built before 1969, median home value, percentage of children living be-

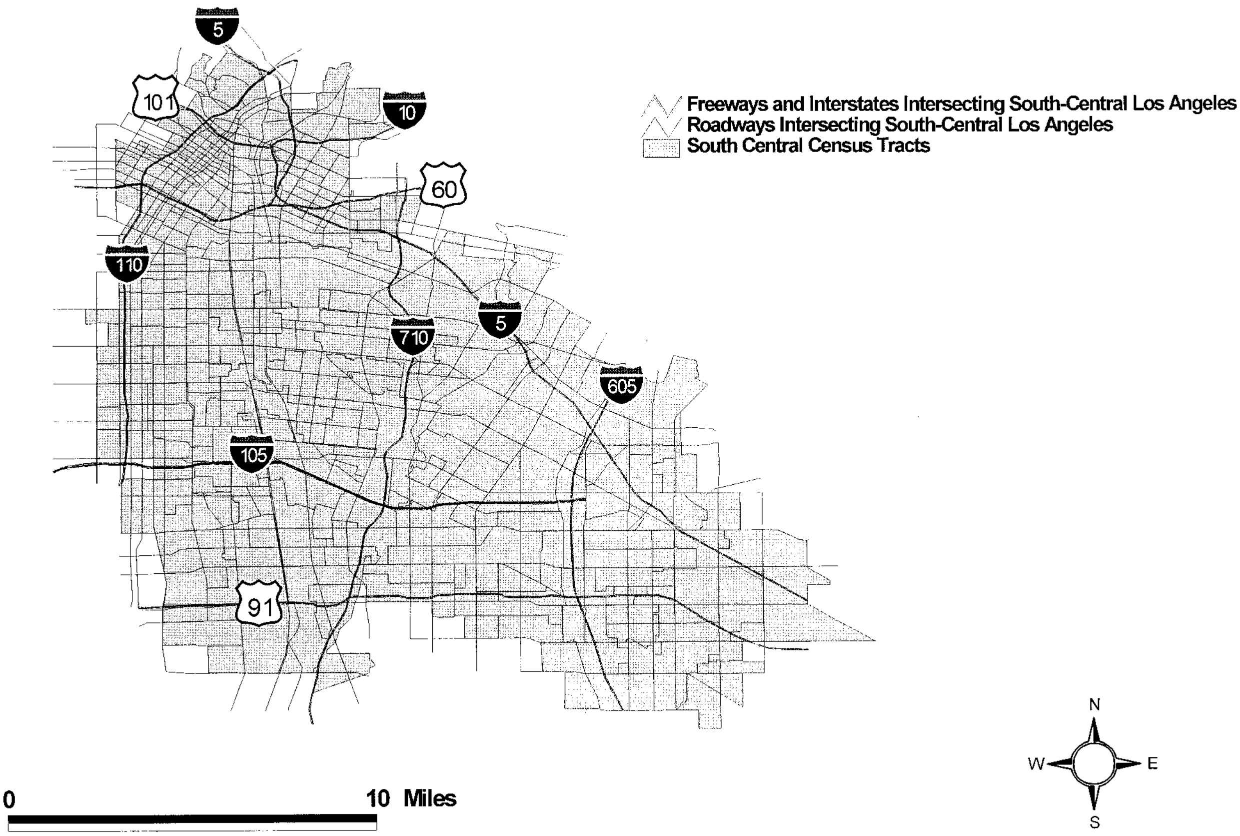

Figure 6. Roadside buffer zone in South Central Los Angeles.

low the poverty line, percentage black, percentage Hispanic, and percentage Asian. The error term, e_i, acknowledges that the equation by itself will not perfectly predict the dependent variable or the number of elevated BLL cases per thousand. Linear regression provides an approximation of a phenomenon given knowledge of a number of independent variables. A number of steps were taken while determining the coefficients (i.e., b_1, b_2) of equation 1 to ensure that the error term was minimized and that resulting models did not violate any of the assumptions underlying a linear statistical model. Potential model violations were detected for the TRI variable, including heteroscadasticity. Data for the TRI variable were transformed (log base 2 was taken) in order to spread out clustered values and pull in larger values in the skewed distribution. All variables are represented as continuous variables.

A series of multiple regression models for the dependent variable were fitted in order to explore the relationship between covariates (other than the environmental management variables) and elevated BLLs. Variables were added to test how well they explain the variation in elevated BLLs per thousand across census tracts in South Central Los Angeles. Two types of hypothesis testing were employed for each model: the omnibus test, which concerns the combined effects of each of the predictor variables, and a subsequent test of each of the variable coefficients. Table 2 (below) compares the results for each model. For each of the models presented, we can reject the null hypothesis for the omnibus test and declare that the relationship between at least one predictor and the dependent variable is not equal to zero. We are left to look more closely at the covariates within each model and to compare the direction and magnitude of their relationship to elevated BLLs.

A second series of multiple regression models were fitted in order to explore the effects of environmental management variables after controlling statistically for other effects (Table 3 below). The first includes cumulative TRI exposure (LNTRI). The second regression model substitutes the EPA's Cumulative Exposure Project data for TRI data. The third and fourth models, used to test the Los Angeles County Department of Health's Hot Zone Census Tracts, substitute a binary variable coded 1 for hot zone and 0 for otherwise for

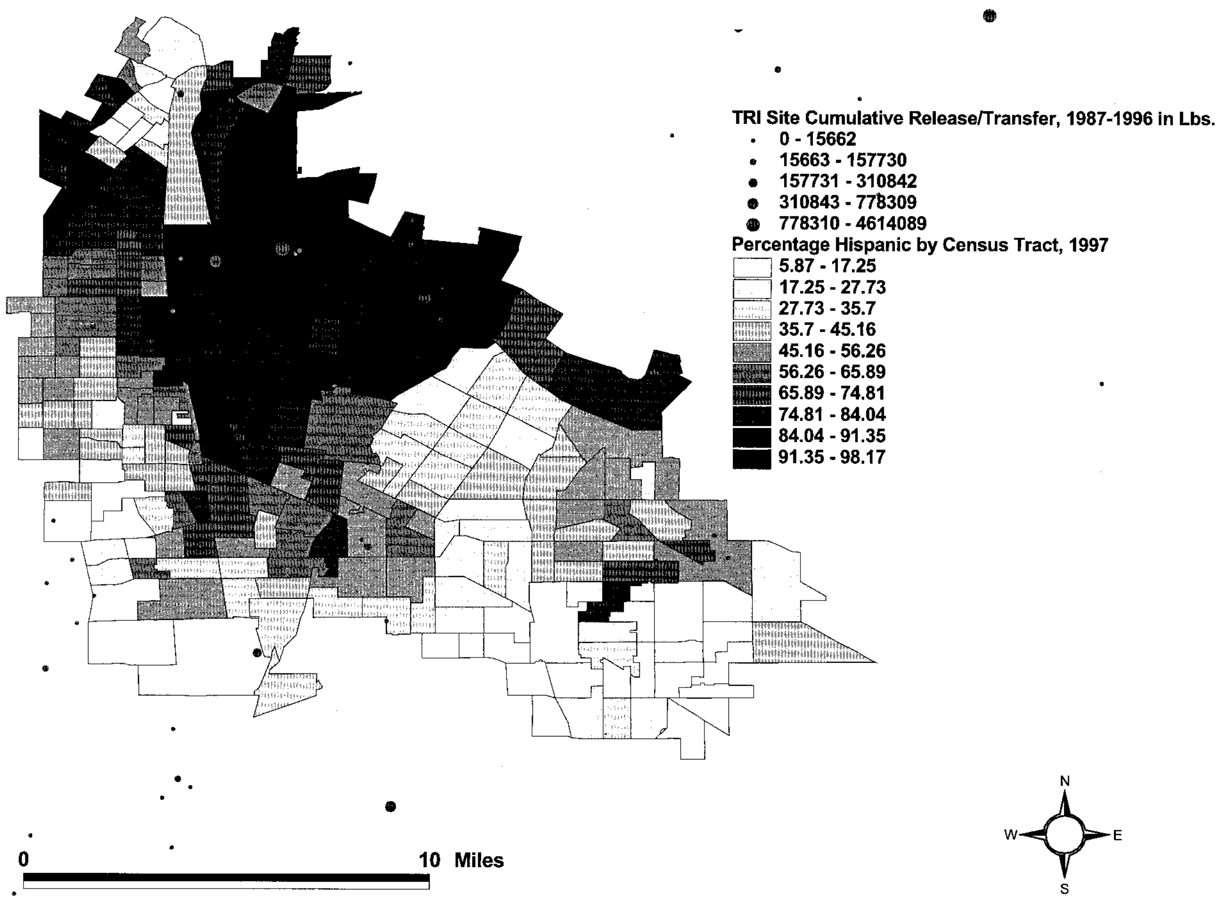

Figure 7. Distribution of Hispanic population in South Central Los Angeles compared with TRI site locations.

associated SES data. This was done to account for the use of similar demographic variables (percentage of children in poverty living in housing constructed prior to the banning of lead-based paint) in the Hot Zone Census Tract Assessment.

Results

Descriptive statistics for each independent variable are reported in Table 1. The average census tract was 57% Hispanic, 19% black, and 0.5% Asian. Mean housing value was $153,806, and 60% of housing was built prior to 1969. Roughly 30% of children lived in a household considered below the poverty line. TRI exposure averaged 36 tons of lead across the project area over a 10 year period, while estimated cumulative exposure averaged 0.028 tons per census tract per day. An average of 9.78% of the total surface area of census tracts within the project area was covered by the roadside buffer zone.

Table 2 compares the results for models constructed using demographic variables and proximity to transportation corridors. Model 1 shows a statistically significant relationship between roadside buffer zones and elevated BLLs ($t = 6.74$, $P < 0.001$). Models 2–4 add the variables housing age, child poverty, and home value. Model 4 suggests statistically significant relationships between all three demographic variables and elevated BLLs, when controlling for road buffer. Ethnicity variables (percentage black, Hispanic, and Asian by census tract) were added to the model, increasing the percentage of the variance in the dependent variable explained from 25% to 31%. Model 5 shows significant relationships between the percentage black and the percentage Hispanic variables and elevated BLLs ($t = 4.60$, $P < 0.001$; $t = 4.42$, $P < 0.001$), while an insignificant relationship between percentage Asian and the dependent variable was recorded ($t = -0.70$). Interestingly, the latter relationship was negative.

Table 3 represents the ordinary least-squares regression coefficients for each independent variable when environmental management variables are included.

Figure 8. Distribution of black population in South Central Los Angeles compared with TRI site locations.

Model 1 includes TRI exposure, model 2 substitutes a Cumulative Exposure Project variable for the TRI variable, and models 3 and 4 substitute a Hot Zone Census Tract variable for associated demographic variables, housing age, and proportion of children living in poverty.

In model 1, standardized (beta) coefficients suggest that the number of cases of elevated BLLs reported within South Central Los Angeles is associated (in order of relative influence) with median home value ($t = 7.48$, $P < 0.001$; $\beta = 0.65$), percentage black ($t = 4.55$, $P < 0.001$; $\beta = 0.46$), percentage Hispanic ($t = 3.67$, $P < 0.001$; $\beta = 0.36$), roadside buffer zone ($t = 4.52$, $P < 0.001$; $\beta = 0.28$), and age of housing ($t = 3.61$, $P < 0.001$; $\beta = 0.23$). TRI exposure, percentage Asian, and the percentage of children in poverty were not significantly related to the number of cases of elevated BLLs per thousand children. When cumulative exposure estimates were substituted for TRI totals, the order of influence remained essentially unchanged, although the difference between roadside buffer zone and age of housing increased ($\beta = 0.32$ and 0.24, respectively). Cumulative exposure was significantly related to elevated BLLs ($t = 2.42$, $P < 0.05$) although it explained only about one fifth the amount of variance that was accounted for by median home value. The progression from median home value to race and then roadside buffer zone and cumulative exposure continued when the Hot Zone Census Tract variable was introduced. The latter was found to be insignificant and negative in its relationship with the dependent variable when considered with either TRI or cumulative exposure variables.

Discussion

In February 1995, Jacobs and Papanek (1995, p. 14) declared that "the epidemiology of pediatric lead poisoning in Los Angeles County must be better understood." The authors were alarmed at the high percentages of elevated lead cases found among Hispanic and black children in the county, and posited that the most

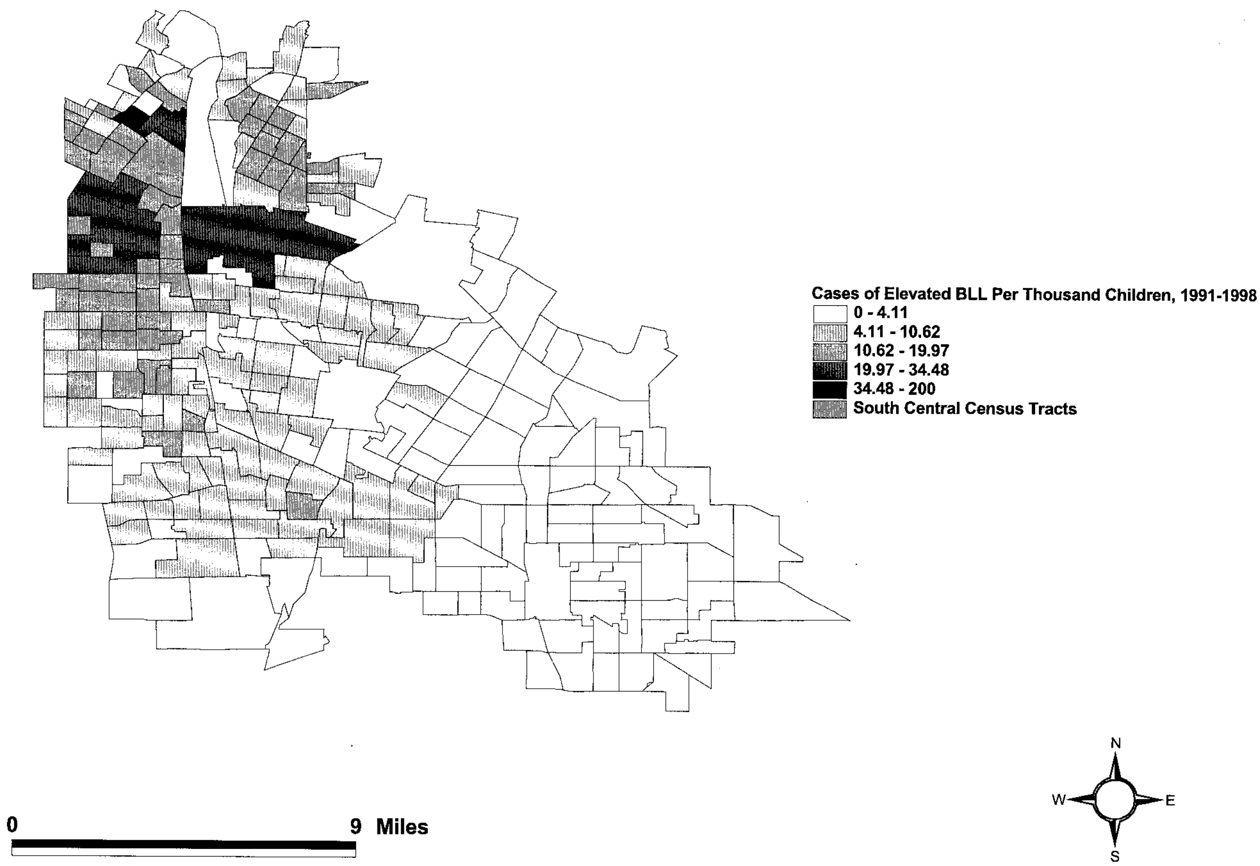

Figure 9. Cases of elevated blood lead levels per thousand children, 1991–1998, as reported by Los Angeles County Department of Health Childhood Lead Poisoning Prevention Program (personal communication 1999).

Table 1. Descriptive statistics for dependent and independent variables by census tract

	Percentile						
	Min	10th	25th	50th	75th	90th	Max
Elevated BLL per thousand children (cases)	0	0	1.94	5.71	10.93	17.64	200
L2TRI exposure (log base 2 of cumulative lbs.)	0	1.25	2.50	3.89	4.78	5.19	6.42
Roadside buffer zone (% of tract surface area)	0	0.04	0.06	0.09	0.12	0.16	0.63
Age of housing (% of housing)	0	0.34	0.51	0.64	0.74	0.83	1.00
Children in poverty (%)	0	0.05	0.14	0.30	0.43	0.51	1.00
Median home value (1990 dollars)	0	96,080	107,425	148,700	175,225	226,030	500,001
% Black	0	0.43	1.26	6.08	35.49	58.89	90.12
% Hispanic	5.87	15.07	31.59	57.42	85.61	93.53	98.17
% Asian	0	0.18	0.26	0.45	0.69	0.91	3.06
Cumulative exposure (tons per day)	0	0.01	0.02	0.02	0.03	0.05	0.18

important source of lead exposure for children was "probably lead-based paint, although this has not been confirmed in Los Angeles County" (p. 14). As evidence, Jacobs and Papanek cited California Department of Health Services data that showed the Los Angeles area ranking third in the number of children living in at-risk housing.

The present research suggests that geographic loca-

Table 2. Fitting a taxonomy of multiple regression models to elevated BLL ($N = 273$)[a]

Variables	1	2	3	4	5
Road Buffer					
β	84.14	85.24	82.10	74.44	70.73
Se(β)	12.49	12.30	12.70	12.28	11.87
T	6.74***	6.93***	6.46***	6.06***	5.96***
Housing age					
β		10.78	9.91	16.84	15.82
Se(β)		3.44	3.85	3.94	3.82
T		3.13**	2.85*	4.27***	4.14***
Child Poverty					
β			7.44	20.11	7.63
Se(β)			4.32	4.86	5.33
T			1.72	4.14***	1.43
Home value					
β				0.00	0.00
Se(β)				0.00	0.00
T				4.97***	7.10***
%Black					
β					0.23
Se(β)					0.05
T					4.60***
% Hispanic					
β					0.18
Se(β)					0.04
T					4.42***
% Asian					
β					−1.54
Se(β)					2.21
T					−0.70
R^2	0.14	0.17	0.18	0.25	0.31
F	45.36	28.31	19.06	21.73	17.12
P	0.0001	0.0001	0.0001	0.0001	0.0001
Int.	−0.04	−6.55*	−7.99**	−27.06***	−44.76***

[a] $*P < 0.05$ $**P < 0.01$ $***P < 0.001$.

tion, specifically proximity to transportation corridors, may play an even greater role in determining health outcomes among black and Hispanic children in Los Angeles County. The results of this study suggest the importance of transportation corridors as a source of environmental lead affecting human health. The influence of roadside buffer zones on the number of elevated BLL cases per thousand children was found to be consistently greater than housing, regardless of the environmental management tool used in the model.

From an environmental justice perspective, previous studies of lead-based paint as the primary contributor of environmental lead (in the form of lead dust or precipitation) may not tell the entire story when applied to health outcomes among minority children living near to large infrastructure projects, particularly highways. Cities studied in Maryland, Minnesota, and Louisiana were found to have the highest concentration of soil lead within their central districts, where the number and intensity of transportation networks were greatest (Mielke and others 1984, Mielke 1999). Soil lead attributed to gasoline combustion is the residual effect of lead particles found in gasoline exhaust released into the air, accumulating on the walls of commercial and residential buildings, and finally washed down into the soil where it becomes ubiquitous. This process can cause the lead burden of industrial cities to be much higher in soil than in drinking water, as was found to be the case in Washington, DC (Elhelu 1995). While lead-based paint remains a health threat, it must be considered in addition to potentially more relevant exposure pathways such as the soils surrounding inner-city roadways.

Also of interest to environmental justice advocates is the lack of a significant relationship between proximity to TRI sites and health outcomes (found with both raw and transformed data sets). While further research is needed to substantiate this finding, it does suggest that within industrialized urban centers, advocates should consider redirecting some of their energies toward ad-

Table 3. Adding the main effects of TRI, cumulative exposure, and hot zone variables to baseline model ($N = 273$)[a]

Variables	1	2	3	4
Road Buffer				
β	66.78	71.13	63.35	70.58
Se(β)	14.79	11.76	15.03	5.44
T	4.52***	6.05***	4.21***	5.95***
Housing age				
β	19.54	15.88		
Se(β)	5.41	3.79		
T	3.61***	4.20***		
Child poverty				
β	8.68	7.31		
Se(β)	6.95	5.29		
T	1.25	1.38		
Home value				
β	0.00	0.00	0.00	0.00
Se(β)	0.00	0.00	0.00	0.00
T	7.48***	6.96***	6.73***	5.81***
% Black				
β	0.29	0.23	0.33	0.26
Se(β)	0.07	0.05	0.07	0.05
T	4.55***	4.46***	5.14***	5.42***
%Hispanic				
β	0.20	0.14	0.25	0.18
Se(β)	0.06	0.04	0.06	0.04
T	3.67***	3.20**	4.63***	4.38***
%Asian				
β	−2.05	−1.09	−2.33	−0.60
Se(β)	2.85	2.19	2.85	2.20
T	−0.72	−0.50	−0.82	−0.27
L2TRI				
β	0.70		0.50	
Se(β)	0.62		0.62	
T	1.13		0.81	
Cumulative exposure				
β		88.05		88.56
Se(β)		36.39		37.30
T		2.42*		2.37*
Hot zone				
β			−1.88	−0.89
Se(β)			3.07	2.53
T			−0.61	−0.35
R^2	0.35	0.33	0.30	0.28
F	12.56	15.97	11.61	15.02
P	0.0001	0.0001	0.0001	0.0001
Int.	−59.35***	−44.43***	−44.35***	−32.36***

[a]$*P < 0.05$ $**P < 0.01$ $***P < 0.001$.

dressing the relationship between race and proximity to transportation systems as contributors to negative health outcomes. Toward this end, the authors are preparing a blood lead and soil lead study of children enrolled in South Central Los Angeles schools. This future study will afford us the opportunity to consider proximity to transportation corridors as well as the impact of interventions such as educational programs on student exposure to environmental lead.

A final (and somewhat intriguing) finding of this study concerns the relationship between home values and lead exposure. Previous studies have suggested that the siting of LULUs tends to depress surrounding property values, which, coupled with the outmigration of certain residents, can alter the demographics of surrounding areas *ex post* (Been 1993, 1997). The present research suggests a potentially different market dynamic, demonstrating a uniformly *positive* relationship between property values and elevated BLLs, while poverty was not found to be a significant contributor to BLL cases. Similar findings in Tijuana, Mexico, suggest the potential importance of culture in determining BLLs (Ericson and Baker 1999). Specifically, access to transportation networks might be perceived as a sign of economic opportunity rather than an aesthetically displeasing condition to be avoided. Our work in South Central will continue to explore this finding.

Conclusion

This study has suggested several new directions in the research of the geographic distribution of environmental harm. While not abandoning the importance of point sources and their real and perceived impact on minority communities, environmental justice advocates and social and environmental scientists must consider the complex interplay between race, transportation networks, and housing values that occurs within our nation's urban environments. As greater resources in the form of research and intervention are targeted at children who live, work, and play near the rights-of-way of highways and streets, the possibility of more equitable reductions in the impact of lead on our nation's children will be realized.

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