WHO LIVES NEAR DRYCLEANERS? A GEOGRAPHIC ANALYSIS OF ENVIRONMENTAL INEQUITY IN HILLSBOROUGH COUNTY, FLORIDA

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Introduction

The notion of equity in the distribution of environmental risk and hazards has emerged as a pressing social and scientific issue over the last decade. Growing concerns regarding the disproportionate exposure of minorities and economically disadvantaged groups to technological hazards have led to the rise of the environmental justice movement (Cole and Foster, 2001), formulation of public policy at the federal (Clinton, 1994) and state (Hart, 1995) level, and a flurry of empirical studies seeking to provide evidence of inequities in the distribution of hazards and risk. In order to determine if the principles of environmental justice have been violated, numerous case studies have analyzed the geographic association between the location of hazardous pollution sources and the racial or economic status of the surrounding population, at the national, regional, and local scale (see reviews by Cutter, 1995; Liu, 2000; Bowen, 2002).

The proliferating literature on environmental justice analysis has examined the distribution of various undesirable land uses such as hazardous waste disposal facilities (e.g., Anderton *et al.*, 1994), municipal landfills (e.g., U.S. General Accounting Office, 1995), Superfund sites on the National Priority List (e.g., Hird, 1994), coke production plants and oil refineries (e.g., Gra-

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ham *et al.*, 1999), and industrial manufacturing plants releasing toxic chemicals (e.g., Pollock and Vittas, 1995). While the more obvious pollution sources and environmentally controversial facilities have received attention in empirical research, inequities associated with smaller industries and less conspicuous facilities posing similar risks to the local environment have not been investigated in the same detail.

Our paper addresses the critical need to understand and document the "riskscape" (Cutter and Solecki, 1996; p. 395) associated with apparently innocuous industries, by focusing specifically on drycleaning facilities. Although drycleaners can be commonly found in both commercial and residential areas, these facilities are not perceived to be as dangerous as hazardous waste dumping grounds or industrial factories. Because they provide services, employment, and financial inflows into an area, drycleaners are rarely viewed by local residents as disamenities. However, these facilities store, handle, and use chemical solvents that are highly volatile and potentially hazardous. More than 85 percent of drycleaners use perchloroethylene (perc) as their primary chemical solvent (US EPA, 2003). Even moderate exposure to perc can cause serious health effects in humans such as liver damage, respiratory failure, or skin, eye, lung, and mucus membrane irritations. Evidence from recent studies also suggests a causal association between perc exposure and elevated risks of certain types of cancer (US EPA, 2003). Consequently, drycleaners are now recognized and regulated by both state and federal governmental agencies as technological and human health hazards.

Areas adjacent to drycleaning facilities are often "spheres of involuntary consumption" (Smith, 1998; p. 280) because residents are involuntarily and potentially exposed to both long-term, chronic pollution and short-term, accidental emissions of chemicals. The environmental justice research literature, however, has

not examined the location pattern of drycleaners with respect to the socio-demographic characteristics of potentially impacted neighborhoods. Accordingly, the objective of this article is to analyze the geographic distribution of drycleaning facilities and their environmental justice consequences at the metropolitan level, based on a case study conducted in Hillsborough County, Florida. Our specific goals are:

- to identify the general demographic and socioeconomic characteristics of neighborhoods that contain drycleaning facilities;
- to examine the environmental inequity hypothesis, by determining if drycleaners are located in areas containing a disproportionately high number of minorities and low-income individuals, compared to the rest of the county.

Our analyses are based on information from the U.S. Census of Population and Housing (2000). The methodology includes a combination of conventional statistical measures and geographic information systems (GIS)-based techniques that are consistent with methods used in prior empirical studies of environmental justice. We also provide a comparative assessment of the analytical approaches commonly used to examine the environmental injustice hypothesis.

The Study Area

Hillsborough County, Florida, represents the study area for our metropolitan-scale analysis of drycleaner locations. This county occupies approximately 1,074 square miles on Florida's west central coast, with a population of 998,948 (U.S. Census of Population and Housing, 2000). The county seat and the largest city is Tampa, which accounts for more than 30 percent of the county population. Several factors and characteristics make Hillsborough County an appropriate study area for this research. Almost one-quarter of the county population is non-White and 18

percent is of Hispanic origin, indicating its racial and ethnic diversity. This area also has a long history of attracting immigrant labor force for agricultural and manufacturing activities. The county now includes a variety of industries, farmlands, preserves, as well as a major seaport and airport. The Port of Tampa, a gateway of international trade and business, is one of busiest seaports in the U.S. It is also an industrial center that contains facilities storing and handling large quantities of hazardous chemicals and many inactive sites that are candidates for remediation. New urban development and revitalization projects have recently spread to the blighted and historical areas surrounding the city center and the Port of Tampa that border the industrial and commercial sections of the county. This development of urban residential space includes upscale housing built to attract professionals back into the city and away from the suburbs. The rapidly increasing population in potentially hazardous areas implies that a greater proportion of the population will be exposed to environmental contaminants and pollution in the future.

Several environmental databases and ranking schemes also indicate that Hillsborough County is one of most polluted counties in the state of Florida. In 2003, this county was ranked first in the state for: (a) the number of Superfund sites; and (b) non-cancer risk from industrial releases of toxic chemicals. It was ranked second among all Florida counties in the following categories: (a) total releases of toxic chemicals from industrial facilities; (b) cancer risk from industrial releases of toxic chemicals; and (c) air emissions of criteria air pollutants (Environmental Defense Fund, 2004). For all these categories, Hillsborough County has been consistently ranked in the top ten percent of all U.S counties since 1998. The suitability of Hillsborough County as a study area for environmental justice analysis has also been highlighted in previous studies that have examined the spatial distribution of industrial toxic emissions or accidental releases of hazardous

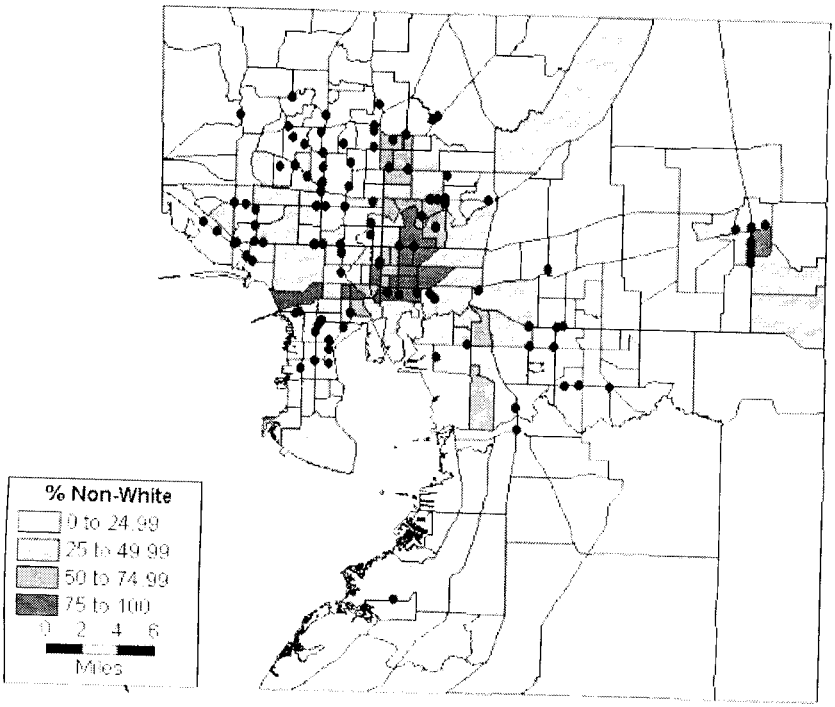
chemicals in this region (e.g., Stretesky and Lynch, 1999; Chakraborty, 2001; Griffith, 2001). More empirical research, however, is necessary to document the geography and environmental justice consequences of less apparent pollution sources (e.g., drycleaners) that are not perceived to be as hazardous as other environmental disamenities and facilities.

Data and Methodology

The names and addresses of all drycleaning facilities in Hillsborough County were obtained from Florida Department of Environmental Protection (DEP)'s drycleaning program database (2003). For the GIS-based analysis, U.S. Census TIGER/Line files (2001 version) were used to create a digital representation of street centerlines and relevant census boundaries in the county. Using the address-matching functionality of GIS software, the location of each facility was geocoded to the street network of the county, based on street address information.

Following the "spatial coincidence" approach (Sheppard *et al.*, 1999; p. 20) used in prior environmental justice studies, our basic methodology consisted of comparing the characteristics of the population in neighborhoods that contain drycleaning facilities with characteristics of the population in other neighborhoods that do not contain such facilities. It should be noted, however, that considerable debate exists over the geographic definition of 'neighborhood' boundaries for environmental justice analysis (McMaster *et al.*, 1997; Williams, 1999). Several scholars argue that the census tract represents the most appropriate analytical unit for this work (e.g., Anderton *et al.*, 1994), while others recommend a finer level of spatial resolution (census block group) for analyzing a single metropolitan area or county (e.g., Sheppard *et al.*, 1999). Recent research suggests than an empirical study based on one particular areal unit cannot produce a reliable indication of environmental inequity, because the analytical results

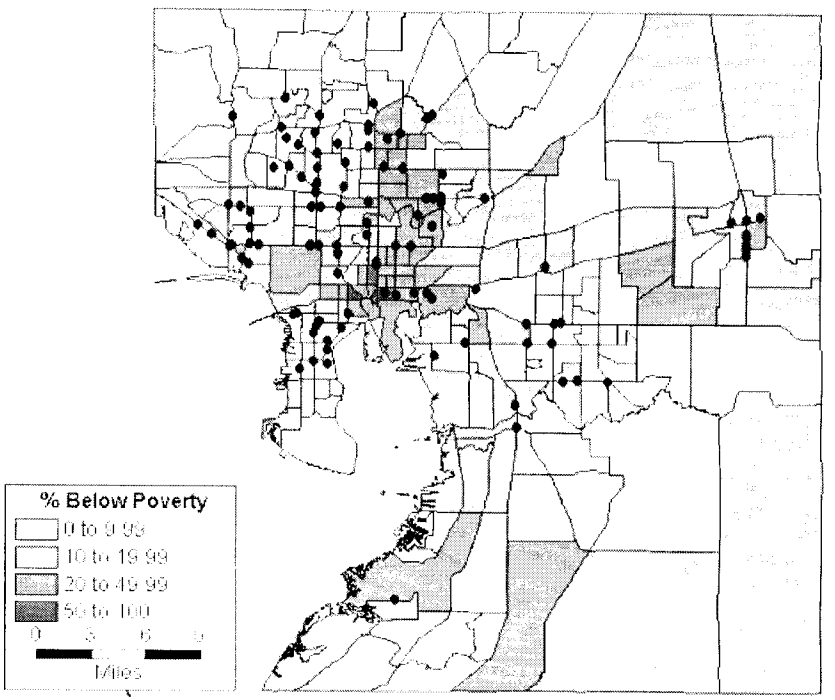
Figure 1. Drycleaner locations and census tracts by percentage of the population non-White, Hillsborough County, FL.



are affected by the nature of data aggregation (Sui, 1999). Instead of selecting a single geographic unit, we used both census tracts and block groups in this study to estimate the socio-demographic characteristics of the areas in which drycleaners have located. Population and housing information for these enumeration units in Hillsborough County were extracted from the 2000 U.S. Census Summary File 3 (STF 3).

It is important, however, to consider the limitations associated with the use of census units to represent the spatial extent

Figure 2. Drycleaner locations and census tracts by percentage of the population below the poverty level, Hillsborough County, FL.



and shape of the neighborhood around a drycleaner. This approach fails to account for potential boundary or edge effects (Basu and Chakraborty, 1997). These effects deal with the possibility that a drycleaning facility could be located so close to the edge of a census unit that its immediate neighborhood includes portions of other surrounding units. A resident in a census tract containing a drycleaner, for example, may live farther away from the facility than another person in an adjacent tract that does not contain any drycleaners. In addition, the pollution generated by a

drycleaner is unlikely to be restricted to the boundary of the census unit hosting the facility.

To address some of these limitations, an alternative circular representation of the potentially impacted neighborhood is also provided. In this application, proximate populations are defined as those residing within a predefined distance from the drycleaning facility and the spatial buffering capabilities of GIS software are used to construct a circle centered at each facility. Several environmental justice studies have used such GIS-based circular buffers around different pollution sources to identify areas and population at risk (e.g., Newmann *et al.*, 1998; Perlin *et al.*, 1999; Sheppard *et al.*, 1999; Chakraborty, 2001). Because considerable uncertainty exists regarding the selection of the buffer radius, we use three distances to construct circular buffers around each drycleaner location: one-quarter (0.25) mile, one-half (0.5) mile, and one mile. We assume that neighborhood boundaries and the pollution generated by a facility are unlike to extend beyond a mile from the drycleaner location. These distances are also consistent with the radii of circular buffer zones used in previous environmental justice studies conducted in other metropolitan areas (e.g., Glickman, 1994; Sheppard *et al.*, 1999).

Results

Drycleaning facilities can be found in approximately 31 percent of the 249 census tracts and 12 percent of the 795 block groups in Hillsborough County. Figures 1 and 2 depict the geographic distribution of these facilities with respect to the non-White population and individuals below the poverty level, respectively, at the census tract level. These maps indicate drycleaners are located primarily in the urbanized areas; in the city of Tampa, in the suburban north-central region of the county, and in Plant City in the east. Few facilities are within census tracts that are predominantly non-White or contain a high percentage of impov-

Table 1. Comparison of census units with and without drycleaning facilities, Hillsborough County, FL, 2000.

	Census Tract Means			Block Group Means		
Variables	with drycleaner	without drycleaner	t-test	with drycleaner	without drycleaner	t-test
Population density	3,119	2,486	3.413 **	3,649	3,599	0.183
Non-White (%)	26.2	24.9	0.471	25.5	25.2	0.129
Hispanic origin (%)	13.2	13.4	-0.135	12.8	13.4	-0.513
Below poverty level (%)	18.9	16.5	0.37	19.9	17.3	1.825
Age over 65 years (%)	11.1	12.7	-1.519	11	13.2	-2.869
Age 18 years or younger (%)	24.5	25.7	-1.472	24	24.9	-1.281
Owner-occupied housing units (%)	56.7	64	-2.251 *	55.9	65.2	-3.101 **
Median housing value ($)	106,703	102,204	0.651	112,537	102,292	1.303
Renter-occupied housing units (%)	43.3	36	2.251 *	44.1	34.8	3.101 **
Median rent ($)	611	662	-0.808	637	634	0.117
Cases (*N*)	77	172		96	689	

* $p<.05$; **$p<.01$.

erished residents. The maps indicate that a majority of drycleaners are located near the boundaries of their host tracts, and several facilities are located at the edge, between tracts that have very different racial and economic characteristics.

Spatial Coincidence Analysis

The first phase of the quantitative analysis focused on estimating and comparing selected characteristics of census enumeration units that contain drycleaners to the characteristics of corresponding units that do not host such facilities. The statistical significance of the observed disparities were analyzed using a t-test for a difference of means. Table 1 summarizes the group means and t-test results for the variables examined in our study, based on both census tract and block group level data from the 2000 U.S. Census. Our results suggest that the racial, ethnic, and economic characteristics of neighborhoods containing drycleaners are similar to those in neighborhoods without such facilities. No statistically significant differences were observed between the average proportion of non-White residents, persons of Hispanic origin, or individuals below the poverty line in census units with and without drycleaners. The average proportion of the younger and elderly population in tracts and block groups containing drycleaners

were also not significantly different from their average proportion in corresponding units without drycleaners. Similar results were observed for median housing values and median rent. The only variables indicating a statistically significant difference included population density (number of people per square mile) at the tract level, and the percentage of renter-occupied or owner-occupied housing units at the tract and block group levels. These variables are probably capturing the same effect since more people per square mile can be expected in areas with more rental units and multi-family housing. Drycleaners in Hillsborough County, in general, appear to have located in densely populated neighborhoods that contain rental housing and relatively fewer owner-occupied homes. There was no evidence to indicate that these facilities are concentrated in areas with a disproportionately high share of minority or low-income (below poverty level) residents.

Circular Buffer Analysis

Census tract or block group boundaries, however, may not be appropriate for representing potentially impacted neighborhoods if polluting facilities tend to locate near the edges of these units. Figures 1 and 2 indicate, for example, that few drycleaners in our study area are located at the center of the census tract hosting the facility. A more detailed examination reveals that: (a) almost 80 percent of drycleaning facilities in the county are located on or near the boundary of their host census tract; and (b) more than 90 percent of the facilities are very close to the boundary of their host block group. These results clearly demonstrate the need to address edge effect problems by using circular areas to define proximate areas and populations around the drycleaners.

The next phase of our analysis, therefore, focused on using the analytical capabilities of GIS software to construct circular buffers of radii 0.25 mile, 0.5 mile, and 1 mile at each of the 110 drycleaning facilities in the county. Census block groups that

Table 2. Comparison of population characteristics inside and outside circular buffer regions surrounding drycleaning facilities in Hillsborough County, FL.

	0.25 mile radius			0.5 mile radius			1.0 mile radius		
Variables	Inside circles	Outside circles	Diff.	Inside circles	Outside circles	Diff.	Inside circles	Outside circles	Diff.
Population density	3,576	882	2,694 **	3,448	763	2,684 **	3,094	509	2,586 **
Non-White (%)	28.7	24.5	**4.1** **	28.6	23.7	**5** **	29.4	19.4	**10.1** **
Hispanic origin (%)	21.4	17.7	**3.6** **	21.1	17.1	**4** **	20.9	14.5	**6.4** **
Below poverty level (%)	13.9	12.4	**1.5** **	14	12.1	**1.9** **	14.3	10.4	**4** **
Age over 65 years (%)	11.2	12	-0.9	11.7	12.1	-0.4	11.5	12.5	-1 *
Age 18 years or younger (%)	24.2	25.4	-1.3 *	24.1	25.7	-1.6 **	24.8	26	-1.2 *
Owner-occupied housing units (%)	47.7	60.9	-13.2 **	50.4	63.1	-12.7 **	53.8	68.3	-14.5 **
Renter-occupied housing units (%)	52.3	39.1	13.2 **	49.6	36.9	12.7 **	46.2	31.7	14.5 **
Land area enclosed (sq. miles)	19	1,055		67	1,007		175	899	

* $p<.05$; ** $p<.01$.

fall inside or intersect with the circles were then identified and data from these block groups were used to estimate the socio-demographic composition of the population within each set of circular buffers. Following the widely used 'buffer containment' methodology (Chakraborty and Armstrong, 1997), a fraction of the total population count was used for block groups that were intersected or partially contained by a buffer, based on the proportion of the block group area enclosed within the circle. For each buffer radius (0.25, 0.5, and 1.0 mile), the study area was then divided into two regions: (a) the area within the circles and their overlapping portions; and (b) the rest of the county (area outside the outer edges of the circles). The socio-demographic characteristics of the population in these two regions were estimated and compared. We were unable to use median housing value and median rent in this comparison, because the values of these variables cannot be computed for a large region by summing or aggregating block group level data. The results of our analyses, for each buffer radius, are summarized in Table 2. A z-test for a difference of proportions was used to analyze the observed differences in the percentages inside and outside the three sets of buffer regions in Hillsborough County.

Table 2 indicates that the characteristics of the population residing near drycleaning facilities are significantly different from those living further away, when a circular buffer is used to define the potentially impacted neighborhood around a facility. Although the circular regions do not cover a large proportion of the land area, they enclose a significantly high share of the county population. The number of people per square mile inside this proximate region is approximately five times larger than the ratio outside this region, for all three radii. The proportion of renter-occupied housing units is also significantly higher in the region enclosed by the circular buffers. These results are consistent with our previous findings (Table 1) which suggested that drycleaners in Hillsborough County, on average, are located in densely populated areas characterized by rental housing and fewer owner-occupied homes. The age-related variables do not show any substantial disparity, although the proportion of the younger population (18 or younger) is smaller inside the proximate region. The analyses of racial, ethnic, and economic characteristics (Table 2), however, reveal several key differences compared to our previous findings summarized in Table 1. Regardless of the buffer radius, the proportion of non-White, Hispanic, and low-income individuals are significantly higher inside the circular region surrounding drycleaners, compared to their corresponding proportion in the region outside. These variables did not indicate statistically significant differences when the host census tract or block group was used to represent the boundaries of the neighborhood around a drycleaner.

Our buffer analysis also provides interesting insights regarding the effect of buffer size on the differences in racial, ethnic, and economic characteristics of the population inside and outside the buffer regions. Table 2 shows that the percentage difference (in bold type) between the proximate and non-proximate regions for three variables (percent non-White, percent Hispanic,

and the percent below the poverty line) tends to increase gradually as the size or radius of the buffer zone increases. When the proximate region around drycleaners is represented by circular buffers of one-quarter mile radius, the non-White proportion inside this region is 4.1 percent higher than non-White proportion outside this region. This regional difference in non-White percentage is 5 percent when the buffer radius is one-half mile, but increases to 10 percent when the buffer region is defined by circles of one-mile radius. The corresponding difference (inside vs. outside) for the below-poverty population is 1.5 percent for the quarter-mile radius, 1.9 percent for the half-mile radius, but almost 4 percent when the one-mile radius is used to represent the close-proximity region. Similar trends can be observed for the percent differences in Hispanic population. For all the key variables, the greatest difference between proximate and non-proximate regions is obtained for the largest buffer radius (one mile) used in our analyses. This finding suggests that the highest concentration of non-Whites, Hispanics, or individuals below poverty can be found outside the region enclosed by the one-half mile buffer but inside the region defined by the one-mile buffer. In other words, minorities and low-income residents in Hillsborough County are more likely to reside between one-half and one mile from drycleaning facilities, and less likely to live within one-half mile of these facilities.

Discussion

This paper contributes to the empirical research literature on environmental justice by examining the spatial distribution of a less conspicuous pollution source that is recognized as a technological and health hazard. A key goal of the case study was to determine if drycleaning facilities are disproportionately located in minority or economically disadvantaged neighborhoods, on the basis of statistical and spatial analysis techniques used in previous

environmental justice studies. Our analyses of Hillsborough County indicate that while drycleaners are generally located in densely populated neighborhoods characterized by rental housing, the proportion of non-White, Hispanic, and low-income residents is significantly higher in areas surrounding these facilities. These groups, however, are mostly concentrated in areas that are not very close to the drycleaners, typically between one-half and one mile from the facilities. This suggests that drycleaning facilities in Hillsborough County are less likely to locate inside minority and impoverished neighborhoods but more likely to be found near them, possibly to remain accessible to consumers residing outside their immediate vicinity.

From a methodological perspective, we demonstrate that the results of environmental justice analysis are sensitive to the method used to delineate potentially impacted neighborhoods. Our results indicated the absence of racial and income inequities when census tracts and block groups are used to represent neighborhood boundaries. The conventional (spatial coincidence) approach of comparing census units with and without polluting facilities used in several prior studies is inappropriate for our study, because most drycleaners are located on streets that represent boundaries of census tracts and block groups. When facilities are located near the edge of their host unit, circular buffers centered at facility locations represent a more accurate way of defining proximate areas and populations. Although the method used to compute population characteristics inside the buffer assumes that population is uniformly distributed within each census unit representing the data source, the potential for estimation errors is minimized when the source unit is as small as a block group (Sheppard *et al.*, 1999; Chakraborty, 2001).

Our case study also reveals an interesting relationship between socio-demographic differences and radius of circle used to represented proximate areas. The larger the radius or size of the

buffer zone, the greater the disparity between minority and below-poverty proportions inside and outside the buffer zone. These results are inconsistent with the findings of previous environmental justice studies (e.g., Glickman, 1994; Chakraborty and Armstrong, 1997) which reported that the percentage of non-White persons and low-income residents are higher when a smaller radius is used to construct circular buffers. The other studies, however, focused on the distribution of industrial manufacturing facilities emitting toxic chemicals. The location pattern of smaller industries such as drycleaners and associated spatial inequities are substantially different, as demonstrated by the empirical results of our study. Drycleaners are perceived to be desirable facilities by potential consumers of drycleaning services, and consequently, a larger number of drycleaners in Hillsborough County have located near neighborhoods that contain a high proportion of White/high-income residents, in areas that are accessible to their customers.

It is important, however, to consider certain assumptions and limitations of our analyses. The case study focused on identifying the pattern of drycleaner locations and not the process that caused the observed racial and income inequities. The results do not establish if areas surrounding drycleaning facilities were predominantly minority or low-income at the time the location decisions were made, or whether subsequent events led to the inequitable pattern observed at present. Pre-existing economic conditions such as low rents and the availability of low-wage labor could have made economically disadvantaged neighborhoods more attractive to businesses like drycleaners. Alternatively, the dynamics of the housing market could have caused the out-migration of White/high-income residents and the in-migration of non-White/low-income individuals into host neighborhoods over time, after the drycleaners located (Been, 1994). Although the establishment dates of the drycleaning facilities are not available

in the Florida DEP database, a longitudinal analysis based on local historical data is required to determine if the observed inequities were caused by discriminatory siting and planning processes, housing market dynamics, or a combination of these factors (Liu, 2000; Pulido, 2000).

A second limitation of the case study was that all drycleaning facilities were assumed to pose equal risk; no distinctions were made based on the quantity, toxicity, or exposure potential of substances released or handled at each drycleaner. This information is required to determine specific environmental and health risks, the precise boundaries of the area potentially exposed to such risks, and the disproportionate burden imposed on minorities and low-income populations. Facility-specific chemical data for conducting a detailed risk analysis of drycleaners, however, is not provided in the Florida DEP database. Other factors that can be used to determine the magnitude of risk posed by these facilities include age and effectiveness of equipment, the amount of safety devices, and mitigation measures in place at each individual site (Florida DEP, 2003). The only information available for relative risk assessment is a priority listing of drycleaning facilities compiled by the Florida clean-up program (Florida DEP, 2003) that contains rankings for each site in the state. Although this ranking scheme was not used in our case study, we found that 101 of the 110 drycleaners in Hillsborough County appear in the listing of 1,182 sites statewide given priority of rehabilitation. None of them have been issued 'site rehabilitation completion orders' that are given after cleanup is completed, and eight unranked drycleaners have been assigned to a state contractor for cleanup. In future research, we plan to incorporate these measures and other related information to assess the magnitude of risk associated with each drycleaner and the geographic distribution of potential exposure in the study area.

In order to determine if principles of environmental justice

have been violated, it is also important to examine if those who live near drycleaning facilities and are exposed to the negative externalities are the ones who benefit from these facilities in terms of services provided and jobs generated. Such analyses require detailed information on the consumers and employees of drycleaning services, their socio-demographic characteristics, and the location of their residences. While the unavailability of facility-specific data was a major impediment in our study, a more focused, local-level investigation should be undertaken to understand the processes that influence the geography of drycleaners and to provide a more comprehensive view of the disproportionate risk burden imposed by these facilities.

REFERENCES

Anderton, D. L., Anderson, A. B., Oakes, J. B., and Fraser, M. R. (1994) " Environmental Equity: The Demographics of Dumping" *Demography*, 31:2, 229-248.

Basu, P. and Chakraborty, J. (1997) "A GIS-based Evaluation of Homeless Shelter Environments in the Minneapolis-St. Paul Area" *Proceedings of GIS/LIS '97* (ASPRS and ACSM: Bethesda, MD) unpaged CD-ROM.

Been, V. (1994) "Locally Undesirable Land Uses in Minority Neighborhoods: Disproportionate Siting or Market Dynamics?" The *Yale Law Journal* 103:6, 1383-1406.

Bowen, W. (2002) "An Analytical Review of Environmental Justice Research: What Do We Really Know?" *Environmental Management* 29:1, 3-15.

Chakraborty, J. (2001) "Acute Exposure to Extremely Hazardous Substances: An Analysis of Environmental Equity" *Risk Analysis*, 21:5, 883-894.

Chakraborty, J. and Armstrong, M. P. (1997) "Exploring the Use of Buffer Analysis for the Identification of Impacted Areas in Environmental Equity Assessment " *Cartography and Geographic Information Systems* 24:3, 145-157.

Chakraborty, J. and Armstrong, M. P. (2001) "Assessing the Impact of Airborne Toxic Releases on Populations with Special Needs" *The Professional Geographer*, 53:1, 119-131.

Chakraborty, J., Schweitzer, L. A. and Forkenbrock, D. J. (1999) "Using GIS to Assess the Environmental Justice Consequences of Transportation System Changes" *Transactions in GIS* 3:3, 239-258.

Clinton, W. J. (1994) "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations: Executive Order 12898 of February 11, 1994" *Federal Register* 59, 7629-7633.

Cole, L. W. and Foster, S. R. (2001) *From the Ground Up: Environmental Racism and the Rise of the Environmental Justice Movement*. New York: New York University Press.

Cutter, S. L. (1995) "Race, Class, and Environmental Justice" *Progress in Human Geography* 19, 111-122.

Cutter, S. L. and Solecki, W. D. (1996) "Setting Environmental Justice in Space and Place: Acute and Chronic Airborne Toxic Releases in the Southeastern United States" *Urban Geography* 17, 380-399.

Environmental Defense Fund (2004) The Environmental Defense Scorecard. Available at http://www.scorecard.org; accessed January 28, 2004.

Florida Department of Environmental Protection (August 2003) "Priority Ranking List (PDF)". Available at: http://www.dep.state.fl.us/waste/categories/drycleaning/pages; accessed November 10, 2003.

Glickman, T. S. (1994) "Measuring Environmental Equity with Geographic Information Systems" *Renewable Resources Journal* 12:3 17-21.

Graham, J. D., Beaulieu, N. D., Sussman, D., Sadowitz, M. and Li, Y-C. (1999) "Who Lives Near Coke Plants and Oil Refineries? An Exploration of the Environmental Inequity Hypothesis" *Risk Analysis* 19:2 171-186.

Griffith, Michael (2001) "A Spatial Coincidence Analysis of Environmental Equity in Hillsborough County, Florida and Marion County, Indiana" *Papers and Proceedings of the Applied Geography Conferences* 24, 209-217.

Hart, S. (1995) "A Survey of Environmental Justice Legislation in the States" *Washington University Law Quarterly* 73: 1459-1473.
Hird, J. A. (1994) "Environmental Policy and Equity: The Case of Superfund" *Journal of Policy Analysis and Management* 12:2 323-343.

Liu F. (2000) *Environmental Justice Analysis: Theories, Methods, and Practice*. New York: Lewis Publishers.

McMaster, R. B. Leitner, H. and Sheppard, E. (1997) "GIS-Based Environmental Equity and Risk Assessment" *Cartography and Geographic Information Systems* 24:3, 172-189.

Newmann, C. M. Forman, D. L. and Rothlein, J. E. (1998) "Hazard Screening of Chemical Releases and Environmental Equity Analysis of Populations Proximate to Toxic Release Inventory Facilities in Oregon" *Environmental Health Perspectives* 106:4, 217-226.

Perlin S. A., Sexton, K. and Wong, D. W. S. (1999) "An Examination of Race and Poverty for Populations Living Near Industrial Sources of Air Pollution" *Journal of Exposure Analysis and Environmental Epidemiology* 9:1, 29-48.

Pollock III, P. H., and Vittas, M. E. (1995) "Who Bears the Burdens of Environmental Pollution? Race, Ethnicity, and Environmental Equity in Florida" *Social Science Quarterly* 76:2, 294-310.

Pulido, L. (2000) "Rethinking Environmental Racism: White Privilege and Urban Development in Southern California" *Annals of the Association of American Geographers* 90:1, 12-40.

Sheppard, E., Leitner, H., McMaster, R. B. and Tan, H. (1999) "GIS-Based Measures of Environmental Equity: Exploring their Sensitivity and Significance" *Journal of Exposure Analysis and Environmental Epidemiology* 9:1, 18-28.

Smith, N. (1998) "Nature at the Millennium: Production and Re-Enchantment" In B. Braun and N. Castree, eds. *Remaking Reality: Nature at the Millennium* London, Routledge; 271-285.

Stretesky, P. and Lynch, M.J. (1999) "Environmental Justice and the Predictions of Distance to Accidental Releases in Hillsborough County, Florida" *Social Science Quarterly* 80:4, 830-846.

Sui, D. (1999) "GIS, Environmental Equity Analysis, and the Modifiable Areal Unit Problem (MAUP)" In M. Craglia and H. Onsrud, eds. *Geographic Information Research: Transatlantic Perspective* London, Taylor and Francis; 41-54.

U.S. Census of Population and Housing (2000) Summary Tape File 3 (STF-3). Washington D.C., Bureau of the Census.

U.S. Environmental Protection Agency (EPA) (2003) "Design for the Environment, Frequently Asked Questions about Drycleaning". Available at http://www.epa.gov/opptintr/dfe/pubs/ garment/ ctsa/factsheet/ctsafaq.htm; accessed November 10, 2003.

U. S. General Accounting Office (1995) *Hazardous and Nonhazardous Waste: Demographics of People Living Near Waste Facilities* Washington, D.C., Government Printing Office.

Williams, R. W. (1999) "The Contested Terrain of Environmental Justice Research: Community as a Unit of Analysis" *Social Science Journal* 36:2, 313-328.