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Social capital, rationality, and inequality : the distribution of environmental health risks in the Southeastern United States

Sammy Joseph Zahran

To the Graduate Council:

I am submitting herewith a dissertation written by Sammy Joseph Zahran entitled "Social capital, rationality, and inequality : the distribution of environmental health risks in the Southeastern United States." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Sociology.

Donald W. Hastings, Major Professor

We have read this dissertation and recommend its acceptance:

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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We have read this dissertation
and recommend its acceptance:

Dr. Sherry Cable

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Social Capital, Rationality, and Inequality: The Distribution of Environmental Health Risks in the Southeastern United States

A Dissertation Presented for the Doctor of Philosophy Degree

The University of Tennessee

Sammy Joseph Zahran

December 2003

DEDICATION

This dissertation is dedicated to my father Karim Zahran, my friend Glenn Coffey, and my graduate school love Lisa Ann Zilney.

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Though authored by a doctoral candidate, and approved by the Graduate Council as a work of their doing, the dissertation is fundamentally a collective endeavor. Here, I thank the collective.

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ABSTRACT

This doctoral dissertation examines the distribution of environmentally risky technologies in the Southeastern United States. The empirical target is commercial treatment, storage, and disposal (TSD) installations of hazardous waste. Two questions motivate the investigation: where are hazardous waste installations located, and why? These installations handle substances that increase rates of mortality and serious irreversible illness, and pose a significant hazard to human health and the environment. Scholars maintain the hazardous waste stream in the United States has a grisly logic – it is distributed on the population unevenly, with poor communities of color burdened disproportionately. The dissertation tests four hypotheses distilled from four theories of human organization of space for risky technologies.

The first hypothesis, *economic rationality*, examines the distribution of TSD installations from the standpoint of commercial operators. TSD installation operators insist they select commercially suitable locations not areas with historically disadvantaged populations. The second hypothesis, *scientific rationality*, examines the distribution problem from the standpoint of EPA geologists, hydrologists and engineers, that insist siting decisions are based on clearly articulated scientific criteria. The third hypothesis, *community social capital*, analyzes the geographic unevenness of environmental health risks as a function of the variable capacity of communities to resist the placement of a facility in their neighborhood by levels of trust, cohesion, and reciprocity that obtain. The fourth hypothesis, *race and class inequality*, examines the claim that inequitable siting of hazardous waste installations is an outcropping of direct and indirect institutional discrimination.

The dataset is a match of records on fully operational treatment, storage and disposal facilities and large quantity generators of hazardous waste from the Environmental Protection Agency, and the Social and Demographic Research Institute at the University of Massachusetts, population and housing data at the census tract level from the US Census Bureau, non-profit organization data from the National Center for Charitable Statistics and the People of Color Environmental Groups Directory, and seismic hazard and hydrologic data from the US Geological Survey.

Bivariate and multivariate statistical results suggest that siting outcomes are predictable by the distribution of social capital assets, the racial composition of a community, the seismological unsuitability a land use, and TSD installation proximity to adequately skilled labor and hazardous materials for processing. The concentration of large quantity generator activity and the percentage of African-Americans in a neighborhood prevail as the most consistent and powerful predictors of TSD installation siting at regional and sub-regional levels, and across different spatial measures of environmental health risk. Uneven distribution of environmental burdens by race violates the promise of President Clinton's Executive Order 12898, mandating fair treatment of all people in the development, implementation, and enforcement of environmental laws, regulations, and policies. The dissertation ends with a risk allocation scheme to solve the systemic Prisoners' Dilemma of concentrated environmental burden and diffuse environmental benefit.

TABLE OF CONTENTS

List of Tables

Acronyms and Abbreviations

ASA	American Statistical Association
BMF	Business Mater File
BRS	Biennial Reporting System
CESQG	Conditionally Exempt Small Quantity Generators
CRCQL	Chester Residents Concerned about Quality of Life
CSDTSC	California State Department of Toxic Substances Control
DAS	Detroit Area Study
ECHO	Enforcement and Compliance History Online
EI	Environmental Institute
EJGAT	Environmental Justice Geographic Assessment Tool
EJM	Environmental Justice Movement
EPA	Environmental Protection Agency
ESD	Environmental Services Directory
FEIN	Federal Employer Identification Number
FIPS	Federal Information Processing Systems
FOIA	Freedom of Information Act
GAO	General Accounting Office
GIS	Geographic Information System
HUC	Hydrologic Unit Code
HWDMS	Hazardous Waste Data Management System
IRS	Internal Revenue Service
LDEQ	Louisiana Department of Environmental Quality
LII	Legal Information Institute
LQG	Large Quantity Generators
LULU	Locally Undesirable Land Use
LUST	Leaking Underground Storage Tank
NAWDEX	National Water Data Exchange
NCCS	National Center of Charitable Statistics
NCDB	Neighborhood Change Database
NCRP	National Committee for Responsive Philanthropy
NRC	National Research Council
NSHMP	National Seismic Hazard Mapping Project
NTTE	National Taxonomy of Exempt Entities
PCEGD	People of Color Environmental Groups Directory
PDEP	Pennsylvania Department of Environmental Protection
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
RTF	Return Transaction File
SADRI	Social and Demographic Research Institute
SIC	Standard Industry Classifications
SMSA	Standard Metropolitan Statistical Areas
SOI	Statistics of Income
SQG	Small Quantity Generator
TDH	Texas Department of Health
TNRCC	Texas Natural Resource Conservation Commission
TRI	Toxic Release Inventory
TSDF	Treatment, Storage, and Disposal Facility
UCB	Under Class Database
UCC	United Christ Church
USGS	United States Geological Survey

It is part of morality not to be at home in one's home.

Theodor Adorno

CHAPTER I: INTRODUCTION AND STATEMENT OF PROBLEM

INTRODUCTION

The objective of this chapter is to detail the road ahead. First, the hazardous waste stream is sized. Environmental Protection Agency and statistical estimates are presented to give the reader a sense of the systemic dangers involved in the generation and proper management of the hazardous waste stream. Second, the problem of inequitable distribution of commercial treatment, storage, and disposal facilities is discussed, with brief presentation of hypotheses to be addressed. The empirical purpose of this dissertation is to answer two questions: *where are commercial treatment, storage, and disposal facilities (TSDFs) located, and why?* The object of analysis is EPA Region IV, encompassing the Southeastern states of Alabama, Georgia, Florida, Kentucky, Mississippi, North Carolina, South Carolina and Tennessee. Third, the hazardous waste distribution problem is specified against the backdrop of the interventions of the modem capitalist state. It is argued the hazardous waste stream is rooted in the structural commitment of the state to capital accumulation and economic growth. Fourth, the methodological and theoretical contributions and organization of this dissertation are delineated.

SIZING THE HAZARDOUS WASTE PROBLEM

The hazardous waste stream in the United States is immense. The actual size of the hazard stream is unknown, but an estimate from the Research Triangle Institute (RTI) places it at 750 million metric tons annually (Watts 1998). According to Environmental Protection Agency (EPA 1991-1999) data, the hazardous waste stream ranges from 230 to 300 million tons per year (see Table 1.1). The EPA only measures the activities of Large Quantity Generators (LQGs)[1] of hazardous waste in its Biennial Reporting System (BRS). Though the hazardous waste stream has declined nationally by approximately 70 million tons from 1991 to 1999, it is still dangerously large. In less than a decade, EPA-classified LQGs generated approximately 2 billion tons of hazardous waste. Add to the hazardous waste stream the residential and commercial solid waste – an unknown percentage of which contains hazardous materials - and the figure eclipses one-billon metric tons generated annually (US Census Bureau, Statistical Abstracts 2002; EPA 1999). This figure is greater than the amount of municipal and hazardous waste generated annually

[1] A facility is defined as a large quantity generator if: 1) 1,000 kg of RCRA waste is generated in any single month; 2) 1 kg of RCRA acute hazardous waste is generated in any single month or accumulated at any time; and 3) more than 100 kg of spill cleanup material is contaminated with RCRA acute hazardous waste (EPA 1999, National Biennial RCRA Hazardous Waste Report: Based on 1999 Data).

TABLE1.1: NUMBER OF RCRA HAZARDOUS WASTE GENERATORS, HANDLERS, AND TONNAGE GENERATED AND MANAGED FROM 1991-1999

	Hazardous Waste Generated	Large Quantity Generators	Hazardous Waste Managed	Treatment, Storage, Disposal Facilities
1991	305,708,881	23,426	294,437,307	3862
1993	258,449,001	24,362	234,864,033	2584
1995	214,092,505	20,873	208,272,032	1983
1997	240,032,072*	20,316	223,616,025*	2025
1999	236,196,233*	20,083	155,956,845*	1575

Notes: To reduce the reporting burden on the regulated community, the EPA streamlined its data collection methods. The 1997 and 1999 Biennial Reports eliminated the Process System Form that required on-site and off-site facilities to indicate the tonnage of aqueous wastes (wastewaters) generated and handled. The exclusion of wastewater data drastically reduces estimates of the hazardous waste stream in the United States. The EPA does provide new estimates for 1995, using the 1997 reporting logic of excluding wastewater data. This allows one to create a simple ratio between aqueous and non-aqueous waste to estimate tonnage totals for subsequent years. Data for 1997 and 1999 presented in this table are ratio estimates. These totals do not include small quantity generators of hazardous waste or solid wastes of potentially harmful toxicity that are routinely mixed with the regular commercial and residential trash stream. Since 1999, biennial reporting has stopped.

Source: National Biennial RCRA Hazardous Waste Reports, 1991-1999.

by the continent of Europe (European Environment Agency 2003). In per capita terms, Americans generate six thousand pounds of hazardous and non-hazardous waste annually.

The Resource Conservation and Recovery Act (RCRA)[2] and amendments authorize the Environmental Protection Agency to safeguard human life and the natural environment from improper management and disposal of hazardous wastes. Under RCRA, a hazardous waste is: "a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics, may: 1) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or 2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed." Hazardous wastes are evaluated on ignitability, corrosivity, reactivity, and toxicity (Watts 1998).

RCRA requires all hazardous wastes be tested, recorded, and traced from their generation to disposal or destruction. This cradle-to-grave system requires commercial generators, transporters and handlers of hazardous substances keep detailed records of their activities. Transfer of waste to permit-approved, off-site treatment, storage, and disposal facilities is strictly controlled. RCRA also authorizes the Department of Commerce to promote market solutions to waste recovery and conservation (Vig and Kraft 2000).

Commercial treatment, storage, and disposal facilities (TSDFs) are the last link in the cradle-to-grave hazardous waste management system. These facilities handle the most dangerous substances known to humankind. Treatment, storage, and disposal facilities perform different functions and assume different forms.[3] Treatment facilities change the physical, chemical, or biological properties of a hazardous waste to make it less threatening to the environment. Treatments can neutralize waste, recover energy or material resources from a waste, render the waste less hazardous, or make the waste safer to transport, store, or dispose. One type of waste treatment involves high temperature incineration. Incineration

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[2] A full text version of RCRA (42 U.S.C. s/s 6901-6992k) is available at Legal Information Institute (LII) at Cornell University. The LII search engine provides up-to-date access to the complete US Code, containing the general and permanent laws of the United States. The most recent version of the U.S. Code released in electronic form contains the laws in effect as of January 16, 1996. http://www4.law.cornell.edu/uscode/42/ch82.html.

[3] This rudimentary discussion of TSD facility operations does not exhaust all the technologies used by commercial operators, nor captures the engineering complexity of such operations. Books are written on individual hazardous waste recovery methods (i.e., distillation, carbon absorption, and solvent extraction), physical and chemical treatment processes (i.e., filtration, chemical oxidation, solidification, and pervaporation), thermal technologies (i.e., rotary kilns, fluid-bed incineration, and asphalt blending), and land storage methods (surface and subsurface impoundments).

significantly reduces the volume of waste, but release of ash and potentially hazardous constituents make waste combustion a controversial treatment method. Hazardous waste is typically treated before it is disposed. Policies on treatment of hazardous waste are found in the RCRA Permit Policy Compendium and in RCRA Online.

Storage involves holding hazardous waste for a temporary period of time. At the end of the storage period, the waste is treated, disposed of, or stored elsewhere. Municipal waste is stored differently than hazardous waste. Municipal waste is sometimes temporarily stored at transfer stations. At transfer stations, waste is off-loaded from local collection routes and sorted according to type. The waste is then loaded on larger trucks or rail cars for transport to either municipal waste treatment or disposal facilities. Hazardous waste storage is more tightly controlled. The most common hazardous waste storage practices are container storage, storage in tanks, and storage in hulking containment buildings. The RCRA Permit Policy Compendium discusses regulatory requirements for hazardous waste storage.

The most common method of disposal of hazardous waste is the placement of waste in or on land. Disposal facilities are designed to permanently contain hazardous waste, and avert the discharge of harmful pollutants to the environment. The most common disposal technology for hazardous waste is the landfill. Landfills are waste management structures with durable liner and leachate collection systems to prevent contamination of groundwater sources. Groundwater monitoring and corrective action systems are design requirements. Hazardous waste landfills have numerous design redundancies to prevent system failure. Inoperable landfills are required to have an impermeable cover to prevent rainwater penetration. Another disposal technology used for liquid hazardous waste is the injection well. Hazardous liquid wastes are injected under high pressure thousands of feet underground. Impermeable underground confinement areas capture the waste waster. Policies on disposal of hazardous waste can also be found in the RCRA Permit Policy Compendium and in RCRA Online.

Management of the hazardous waste stream is costly but profitable. Comprehensive estimates are unavailable and must be assembled from various sources. Cost estimates vary by government agency, the volume, type, and concentration of hazardous substances, site variables, and method of handling. According to the Department of Defense, Environmental Security and Technology Program (2000: 16), the cost of conventional off-site hazardous waste disposal is $0.45 to $1.25 per pound of hazardous waste, or $900 to $2500 per ton. As RCRA mandates, management of hazardous waste is commercialized in the United States. Commercial transportation and disposal of hazardous waste is a multi-billion dollar enterprise, with revenues increasing 817 percent from 1980 to 1999. Hazardous waste management is a growth industry, with revenue exceeding $5 billion dollars annually. Environmental industry segments like analytical and remediation services have experienced similar growth trajectories. The environmental industry as a whole, as defined by the US Standard Industry Classifications (SIC) System, is inelastic and almost recession proof (see Table 1.2). Industry periodicals, from *Solid Waste Digest* to *Clean Energy Business*, recognize the US hazardous waste stream as a feature of chemical-intensive[4] production.

Hazardous waste stream trends, patterns of revenue, and investment in the environmental industry clue us to the future. They reveal how markets coordinate system externalities, but the story of hazardous waste management is more socially and politically complex.

Conflicts over the location of TSD installations have erupted nationally, giving rise to a radical environmental populism (Szasz 1994). Most American's recognize and endorse the benefit of scientific treatment, storage and disposal of hazardous waste, but very few are willing to take on the burden directly. In 1980, the US Council on Environmental Quality surveyed American citizens on their willingness to accept a hazardous waste facility at various distances from their place of residence (see Figure 1.1 below).

Results revealed an almost unanimous unwillingness to accept a hazardous facility within 1 mile of one's home. Less than 25 percent of respondents are willing to accept a TSD installation within 10 miles of their home. At 10 miles from a TSD facility, negative externalities are negligible. Only at a distance of 70+ miles does willingness surpass 50 percent. This figure of 70 miles exceeds the average distance between major municipalities in the contiguous United States. Patterns of community mobilization and resistance to hazardous waste facility siting, testify to the determination of communities to act on attitudes revealed in the survey.[5] In game theoretic terms, the problem of hazardous waste distribution is similar to a

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[4] Time series on US production and sale of organic and inorganic synthetic chemicals and their raw material sources, as finished products and input commodities applied to the production of finished goods, reveal a J-curve pattern of growth (Barnett 1994; United States International Trade Commission 2002). An estimated 70,000 synthetic chemicals are in commercial use, with approximately 1,000 added annually (Johns Hopkins School of Public Health 1998). Of this total, thousands are potentially hazardous, and hundreds are potentially carcinogenic (United States Office of Technology 1983). Reliable data on risks to human health from exposure to, or ingestion, inhalation, and assimilation of, synthetic chemicals are unavailable because the majority of synthetics have not been thoroughly tested for toxicity (National Academy of Sciences 1984).

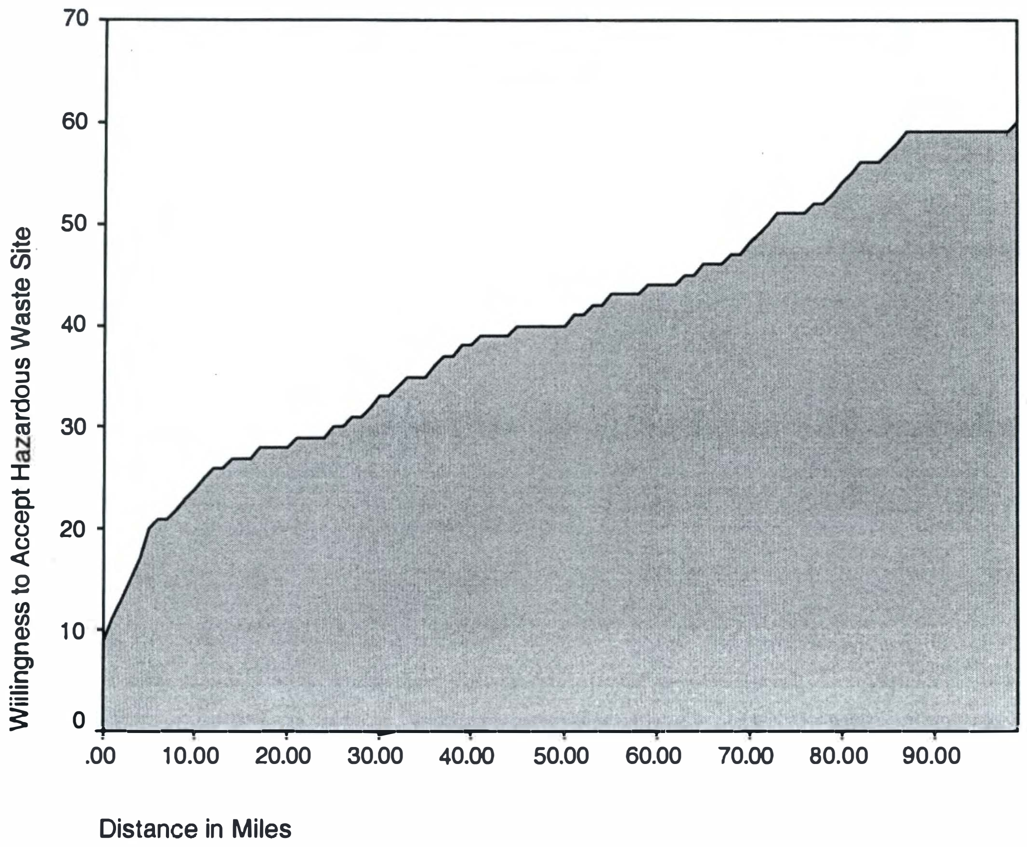
[5] Though TSDFs are massive, noisy, malodorous, cause damage to property and human health, cleave communities, induce residential instability, and are sources of catastrophic risk, Bohon and Humphrey (2000) have discovered that some communities actually court such facilities for economic gain. Courting communities are those experiencing economic decline, in dire need of local employment and taxable wealth, where opportunities for development are scarce. These communities are found in the rust belt of the American Mid-Atlantic and Mid-West, as well as the resource exhausted Appalachian South. In the South, courting communities have lower than average socio-economic status, and are committed ideologically to business and industry.

Table 1.2: Revenue of Environmental Industry Segments, 1980-1999 in Billion Dollars

Industry Segment	1980	1990	1993	1994	1995	1997	1998	1999	Percent Change
Analytical Services	0.4	1.5	1.6	1.6	1.2	1.1	1.1	1.1	+ 175
Wastewater Treatment	10.9	20.4	23.4	25.7	23.4	24.4	25.6	26.3	+ 141
Solid Waste Management	11.2	26.1	29.4	31.0	32.5	34.9	36.1	36.9	+ 229
Hazardous Waste Management	0.6	6.3	6.5	6.4	6.2	5.8	5.7	5.5	+ 817
Remediation and Industrial Services	2.4	11.1	8.4	8.6	11.1	11.2	11.0	11.6	+ 383
Consulting and Engineering	1.7	12.5	14.6	15.3	15.5	15.3	15.8	15.9	+ 835
Water Equipment and Chemicals	6.9	13.5	15.0	15.6	16.5	18.2	19.1	20.0	+ 190
Instrument Manufacturing	0.2	2.0	2.7	2.9	3.0	3.3	3.3	3.5	+ 1050
Air Pollution Control Equipment	3.3	13.1	11.5	11.7	14.8	15.7	16.5	17.1	+ 418
Waste Management Equipment	3.5	8.7	10.9	11.2	9.9	9.8	9.5	9.7	+ 177
Process and Prevention Technology	0.1	0.4	0.7	0.8	0.8	0.9	1.0	1.1	+ 1000
Water Utilities	11.9	19.8	23.1	24.2	25.3	27.6	28.8	29.4	+ 147
Resource Recovery	4.4	13.1	13.3	15.4	16.9	15.3	13.3	16.4	+ 273
Environmental Energy Sources	1.5	1.8	2.1	2.2	2.4	2.7	3.0	3.1	+ 107
Industry Total	**59.0**	**150.3**	**163**	**172.5**	**179.5**	**186**	**189.8**	**197.7**	**+ 235**

Source: U.S. Census Bureau, Statistical Abstract of the United States: 1999-2000

FIGURE 1.1: CUMULATIVE PERCENTAGE OF PEOPLE WILLING TO ACCEPT HAZARDOUS WASTE SITE AT VARIOUS DISTANCES FROM THEIR HOMES



Source: United States Council on Environmental Quality. 1980. Public Opinion on Environmental Issues: Results of a National Public Opinion Survey. Washington, DC: Government Printing Office.

non-cooperative Prisoner's Dilemma with rational egoists incapable of cooperation for mutual gain. How this dilemma is managed is of great concern to social scientists, environmental activists, TSDF operators, and public officials alike. By examination of cross-sectional data, and application of statistical methodologies, one can infer carefully the social forces involved in location outcomes for commercial treatment, storage, and disposal installations.

STATEMENT OF DISSERTATION PROBLEM AND HYPOTHESES

TSD installations are environmentally risky and locally unwanted technologies. In neighborhoods sited for TSD installations, there is real and perceived decline in physical and psychological well-being, housing market instability, and increasing social currents of dread and impending catastrophe. Debate swirls on the issue of equitable distribution of TSDF associated environmental risks. Government reports (GAO 1983), social scientific studies (Bullard 1983; Boer, Pastor, Sadd, and Snyder 1997), and statements by environmental activists (Commission of Racial Justice 1987) suggest that treatment, storage, and disposal facilities are located systematically in poor and/or minority communities. The words of Congressman John Lewis (D.GA) capture the seriousness this accusation (Lewis, in Bullard 1994: vii-viii):

> The signs are gone, but the residuals of Jim Crow housing and unfair industrial and land use policies are still with us. African Americans and other people of color are burdened with more than their share of toxic waste dumps, landfills, incinerators, lead smelters, dirty air and drinking waster, and other forms of pollution that threaten their health I their homes and workplace. . . . Just as African Americans and others mobilized to protest the evils of segregation and discrimination, they have now mobilized to protest unjust public policies, discriminatory facility siting practices, unequal protection, and other forms of environmental racism.

Congressman Lewis is at the forefront of an environmental justice movement that calls for an end to disproportionate dumping of toxic waste by race and social class. The empirical questions this movement raises are: *Where are commercial TSD installations located, and why? And, more generally, is there a correspondence between population distribution and environmental risk distribution?* This dissertation takes on these questions. Four hypotheses are tested, distilled from four theories of human organization of space and location for risky technologies.

The first hypothesis, *economic rationality*, examines the distribution of TSD installations from the standpoint of TSD commercial operators. TSD facility operators insist they select commercially suitable locations not areas with historically disadvantaged populations. Using period data, this dissertation infers from location outcomes economic motives by TSD facility operators. The second hypothesis, *scientific rationality*, examines the distribution issue from the standpoint of EPA geologists, hydrologists, and engineers who insist siting outcomes are driven by clearly articulated scientific criteria. The third hypothesis, *community social capital*, analyzes the geographic unevenness of environmental health risks as an assumed function of the capacity of communities to resist the placement of a facility in their neighborhood by levels of trust, cohesion, and reciprocity that obtain. The fourth hypothesis, *race and class inequality*, examines the claim that inequitable siting of hazardous facilities is a projection of direct and indirect institutional racism and classism. By estimating the beliefs and intentions of different stakeholders in statistical modeling, this dissertation hopes to explain variation in commercial TSD installation siting outcomes.

Before discussion of this study's organization and relevance, it is important to address the root causes of the hazardous waste problem. The root causes of the hazardous waste stream stem mainly from the defects of the modern capitalist state. The competing commitments of the state to capital accumulation and social harmony prevent it from acting purposefully on the hazardous waste question. This macro political economic context is key to understanding policy proposals discussed in Chapter V.

Political Economic Roots of the Hazardous Waste Problem

Environmental sociologists have produced a political economic framework for understanding the human dimension of environmental change. The framework concentrates on the production, consumption, exchange, and resource allocation practices of human societies. This framework has been used effectively to examine the social costs of private ownership of nature (Beckenbach 1994), and the diminished capacity for economic growth by the degradation of land, labor, and capital, and toxic contamination of human habitat (O'Connor 1994; 1998).

Three scholars exemplify this political economy of the environment framework - Allan Schnaiberg (1980 and with Gould 1994), James O'Connor (1973; 1994; 1998), and Sherry Cable (1993; 1995). All regard the modern capitalist state as reducible analytically to two functions: capital accumulation and legitimization.[6] These functions stabilize hierarchy by moving the site of class conflict from the shop floor to

[6] This structural conception of the state, according to Weberian theorists like Theda Skocpol (1993), simplifies the totality of state functions. State bureaucracies have internal logic that radical political economists overlook. The state is not only an arbiter of class conflict, but also a network of administrative, policing and military organizations, coordinated loosely by executive, legislative and judicial apparatuses. This network of organizations is a resource that supplies the state with the potential to override narrow class interests, and concentrate energies on organizational preservation. According to Skocpol, the motive to maintain and perpetuate bureaucracy provides the state with the potential for autonomy. Recently, state theorizing has experienced rebirth in New Economic Sociology, and re-conceptualizations of the great structuralist versus instrumentalist debates of the 1960s and 70s. I believe the structural framework presented here remains the most elegant of state theories, with concepts sufficiently flexible and abstract to adorn with specificity.

the halls of government. The *capital accumulation function* involves government protection of liberal economic interests by creating and sustaining conditions for private capital investment and economic growth. The *legitimization function* involves creating and maintaining conditions for social harmony by protection of democratic political interests through delivery of public and individual primary goods. These functions contradict each other on environmental matters. The hazardous waste stream in America is an outcropping of the unresolved tension between capital accumulation and legitimization. How did the modern capitalist state arrive in this position of environmental ineffectiveness? These functions emerged as solutions to market underperformance and class antagonism, springing from the mind of British economist John Maynard Keynes.

THE FIRST CONTRADICTION OF CAPITALISM

Keynes built an economic risk insurance framework to correct macroeconomic instabilities arising from microeconomic decisions. Keynes saw the market economy as plagued by contradictions and capacity underutilization. Economic problems spring from the drive for profit maximization. To maximize profit, economic actors invest in cost minimization methods. A common method is to increase the ratio of fixed (machines) to variable (workers) capital in production. Use of machinery is rational at the level of economic agency. Market coordination problems arise when economic actors simultaneously cost minimize. Without regular income, laborers cannot buy goods and services (absent a deflation of prices). The outcome is underutilization of human labor, class antagonism, insufficient aggregate demand, and declining rates of accumulation. Keynes recognized that absent inter-firm coordination of profit taking methods, crises of aggregate demand and market failure will reoccur. Keynes theorized that government can steer the economy, and minimize human suffering from job loss.

Keynes (1964) rejected the concept of an invisibly governed and smooth operating price system. He viewed the market economy as chronically sub-normal and cyclical.[7] His risk management system called for stabilization of the market economy through fiscal levers of expenditure and taxation. The Keynesian formula for economic stability and maximization of productive output established the modem

[7] In sorting out variations in rates of economic growth, unemployment, income, and pattems of inventory, economists of various theoretical persuasion have identified many cycles of various periodicity and amplitude, including long-swings of 40 to 60 years presumably governing the whole of capitalist development (see Gordon, Edwards and Reich 1994). Should these cycles *actually* exist, most economists presume they are self-correcting and governed endogenously (see Chase-Dunn and Grimes 1995). Recently, scholars have turned attention to extra-economic institutions (or social structures of accumulation) to explain economic cycles (see Weisskopf 1994).

capitalist state and its politically expensive double commitment to private (capital accumulation) and public (social harmony) interests. The tension of this double commitment is evident in government budget disputes over the allocation of public resources and the enforcement of environmental regulations (see Cable and Cable 1995).

With knowledge of predictable economic phenomena like consumption propensities for population strata, and the multiplying effects of government expenditures under variable conditions (i.e., level of unemployment), Keynes advocated a range of demand-side interventions to be funded by transfers of money capital in the economic system (Keynes 1964). These demand-side interventions perform the legitimization function by delivering the public good of social stability, and individual primary goods like "rights and liberties, powers and opportunities, income and wealth" (Rawls 1971: 62). The commitment of the state to demand-side services to disadvantaged populations fostered the belief "that people could turn to the government to shield them from the insecurities and hardships of an unrestrained market economy" (Fox-Piven and Cloward 1982: ix). Management of the deleterious effects of economic cycles of varying periodicity and amplitude through transfers of money capital to disadvantaged populations, established the modern capitalist state as a mediator of class inequality, and planning agency for reproduction of capitalist relations (Block 1977). Legitimization measures neutralized the systemic dangers of class militancy and cyclical economic instability.

On the capital accumulation side of the Keynesian risk insurance system, steady economic growth could be achieved by investments in capacity-building sectors of the private economy. By a basic calculation relating stock of capital to productive output, one can estimate unit increases in output by the size of investment in a particular sector of the economy (Heilbroner 1972). Investments to encourage economic output included: allowing accelerated depreciation of fixed capital investments; legal protection from foreign competition; price controls; infrastructure subsidies; technology transfers from the armaments economy; lowering levels of taxation; and provision of maintenance services like weather mapping, policing, and fire protection (Lindblom and Woodhouse 1993).

These capital accumulation measures decrease the cost of business, directly benefiting producers by increasing the rate at which circuits of investment are realized (absent inflation). These measures also benefit consumers by depressing the real price of desirable goods and services (should sufficient competition exist). These capital accumulation measures offset potential liquidity crises of capital, and stabilize macroeconomic output by encouraging the circulation of money capital, and boosting productive capacity. These measures also perform a macro-psychological function of satisfying business confidence, and encouraging risk tolerant behavior (Block 1977).

The Keynesian economic risk management system, with its high modem, order-maintaining mechanisms, temporarily offset the contradiction between forces and social relations of production in the economy, but profoundly politicized the budget process, and intensified debate about the proper relationship of the state to the economy in a private enterprise system. Whatever stability was achieved by these ideas (i.e., limiting periodic economic contractions, and buffering the structure of class dominancy), the Keynesian system ultimately failed. It failed because it weakened the link between income and employment, undermining a major pillar of the market economy; it could not effectively resolve the relationship between unemployment and inflation; it retarded information flow and price signaling, undermining the ability of producers and consumers to arrive at mutually beneficial transactions; it blurred the distinction between politics, administration, and the economy; it embroiled the state in Mafia tactics of taking protection money and picking winners, violating its constitutional neutrality; and it caused fiscal crises that handcuffed state action (O'Connor 1973).

From an environmental standpoint, the Keynesian framework failed miserably, and set in motion an environmentally pernicious growth system of production and surplus extraction (Schnaiberg 1980). By trying to solve one problem, the modem capitalist state exacerbated another - the enduring conflict between the environment and society (Schnaiberg & Gould 1994). This conflict is termed the second contradiction of capitalism by James O'Connor (1994; 1998). Problems of hazardous waste mismanagement and geographic unevenness of environmental health risks are located in the second contradiction of capitalism.

The Second Contradiction of Capitalism

The commitment of the modem capitalist state to democratic political *and* liberal economic interests is contradicted because it causes realization crises of capital (i.e., falling and stagnant rates of profit) on the cost-side of economic production. Cost-side instabilities arise from patterns of environmental degradation. By commitment to economic growth as a societal stability model, the modem capitalist state accelerated the rate of environmental withdrawals and additions[8] (Schnaiberg 1980). Environmental withdrawals and

[8] Human modification of the earth has led to unsustainable loss of functional landscape, desertification, deforestation, excessive exploitation of plant and animal species, famine and constraints on global food supplies, coastal and oceanic pollution, atmospheric turbidity, deterioration of marine ecosystems, crises of biodiversity, and a series of boomerang effects related to world health and polarization of the planet into politically unstable factions of vulgarly advantaged and raggedly poor peoples (Southwick 1994).

additions degrade ecosystems and the physical conditions of economic production (i.e., geophysical environment and human labor). Because of the thermodynamic law of entropic irreversibility, degradation of the factors of production gradually increases the cost of organizing the economy. Misuse of the conditions of production lower system-level productivity and long-term rates of profit taking (O'Connor 1994). The reproductive capacity of the economic system is undermined, in the long-term, by resource exhaustion.

Political economists of the environment (Cable and Cable 1995) argue that patterns of environmental degradation are caused by the motivational underpinnings of capitalism - profit maximization and unabated economic growth. The modern capitalist state allows the externalization of the costs of environmental degradation to maintain engines of economic growth. Harmful additions to the environment degrade the conditions of human and wildlife habitat. The hazardous waste stream is caused by this shortsighted managerial time horizon. Controlling the hazardous waste stream means slowing the rates of environmental withdrawal and addition. Scientific evidence of the dangers of ecological disorganization and unfettered destruction of human habitat has increased public concern and action for environmental management (Dunlap and Mertig 1992). Concern for restoration and protection of the physical conditions of life has led to the passage of numerous environmental laws regulating the adaptation of nature to human needs (see Table 1.3).

By tightening rules on human use of nature, the modern capitalist state is responding to its legitimization function of sustaining the public good of environmental health. In the process, the state contradicts it capital accumulation function. The passage of environmental laws increases the transaction costs of enterprise. Environmental regulatory interventions cause system-level liquidity problems, and upset the societal stabilization program predicated on economic growth.

Environmental laws are necessary to guarantee the long-term stability of the capitalist mode of production, but antagonize business confidence. These laws make production more expensive and undoubtedly discourage investment in production of socially desirable goods and services. These laws are challenged relentlessly (Austin 2002; Zahran and Zilney 2000), and their enforcement undermined by regulatory lethargy (Barnett 1994). It seems the modern capitalist state will only act when prodded because its machinery and constituencies are married more strongly to capital accumulation. Cable and Benson (1993), for example, argue that ecological problems at the local level stem from the miscarriage of environmental regulations at the national level. Because environmental regulations are not enforced

TABLE 1.3: FEDERAL ENVIRONMENTAL LEGISLATION PASSED FROM 1970-1980

Year	Federal Legislation
1970	Estuary Protection Act
1970	National Mining and Minerals Act
1970	Clean Air Act
1970	Occupational Safety and Health Act
1970	Resource Recovery Act
1970	Pollution Prevention Packaging Act
1971	Lead-Based Paint Poisoning Prevention Act
1972	Water Pollution Control Act
1972	Marine Protection, Research and Sanctuaries Act
1972	Coastal Zone Management Act
1972	Home Control Act
1972	Federal Insecticide, Fungicide, and Rodenticide Act Amendments
1972	Parks and Waterways Safety Act
1972	Marine Mammal Protection Act
1972	Ports and Safe Waterway Act
1972	Clean Water Act
1973	Endangered Species Act
1974	Deep Water Port Act
1974	Safe Drinking Water Act
1974	Energy Supply and Environmental Coordination Act
1974	Federal Non-Nuclear Research and Development Act
1974	Forest and Rangeland Renewable Resources Planning Act
1974	Archeological and Historic Preservation Act
1974	Solar Energy Research, Development and Demonstration Act
1974	Shoreline Erosion Control Demonstration Act
1975	Eastern Wilderness Act
1975	Hazardous Materials Transportation Act
1976	Toxic Substances Control Act
1976	Federal Land Policy and Management Act
1976	Resource Conservation and Recovery Act
1976	Energy Policy and Conservation Act
1976	Forest Management Act
1977	Clean Air Act Amendments
1977	Pure Water Act
1977	Surface Mining Control and Reclamation Act
1977	Soil and Water Resources Conservation Act
1978	Endangered Species Act Amendments
1978	Energy Tax Act
1978	Outer Continental Shelf Lands Act Amendments
1978	Public Utilities Regulatory Policy Act
1978	Uranium Mill-Tailings Radiation Control Act
1978	National Parks Service Act Amendments
1979	Archeological Resources Protection Act
1980	Comprehensive Environmental Response Compensation and Liability Act
1980	Alaska National Interest Lands Conservation Act
1980	Low-Level Radioactive Waste Policy Act
1980	Non-game Wildlife Act
1980	Farmland Protection Policy Act
1980	Asbestos School Hazard Detection and Control Act

Sources: Environmental Protection Agency, National Oceanic and Atmospheric Administration, National Park Service, National Forest Service, and Department of the Interior.

strongly, polluters not sanctioned negatively, and the costs of environmental damage carried by the public, Cable and Benson reason that the modern capitalist state is structurally committed more strongly to capital accumulation and liberal economic interests. Grassroots environmental justice groups emerge rationally in this context to push authorities to enforce the law and carry out their democratic function of maintaining the conditions of life equally for all persons under its juridical authority. Though government reluctance to enforce the law radicalizes aggrieved persons, and dramatically increases in the number of grassroots environmental organizations, Cable and Benson doubt the possibility of "legitimacy crisis" in which the interests of the public triumph over private interests. This doubt is based reasonably on the historically supported assumption that corporate actors "will not simply acquiesce" to government rules increasing the transaction costs of conducting business (Cable and Benson 1993: 474).

Using this framework, environmental political economists exposed a cruel irony – to resolve the contradiction between forces and relations of production to achieve economic growth and social harmony, state managers unleashed a second contradiction with the same shocks to economic stability, plus the unsustainable exploitation and degradation of the natural world.[9]

The problem of hazardous waste - its generation, management, and distribution on the population - is rooted in the managerial defects of the modem capitalist state. The state is not organized sufficiently to match the systemic challenges of the second contradiction of capitalism. Government administrators are handcuffed into non-action by competing imperatives, and the hazardous waste stream persists. As more TSD installations appear in more neighborhoods, a change in consciousness is possible, and a political will to address the chemical-intensity of modern life may emerge. The problem of hazardous waste distribution is an opportunity to address deeper social cleavages in American life - class hierarchy, racial discrimination, and political power. The conclusion of this dissertation proposes a resolution to the hazardous waste distribution problem. The proposal coordinates the problem of commercial hazardous waste management with state legitimization and capital accumulation functions in mind. On the issue of equitable hazard waste distribution, a Keynesian optimism for systemic reform is possible.

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[9] Degradation of the earth has led to unsustainable loss of functional landscape, desertification, deforestation, excessive exploitation of plant and animal species, famine and constraints on global food supplies, coastal and oceanic pollution, atmospheric turbidity, deterioration of marine ecosystems, crises of biodiversity, and a series of boomerang effects related to world health and polarization of the planet into politically unstable factions of vulgarly advantaged and raggedly poor peoples (Southwick 1994).

CONTRIBUTIONS AND RELEVANCY OF THE STUDY

This section discusses the theoretical and methodological contributions of this dissertation. Again, the purpose of this dissertation is to examine the geographic distribution of commercial treatment, storage, and disposal facilities, theorize the social forces governing siting decisions and outcomes, and conduct statistical tests to objectively evaluate hypotheses. This dissertation is relevant for seven reasons.

First, this dissertation is environmentally sociological. It rejects the epistemic assumption that human beings are separable from nature. It accepts the assumption that ecological laws cannot be repealed. It recognizes that human social organization is linked ontologically to geo-physical and bio-chemical processes. Human management of the hazardous waste stream is an empirical target for understanding the dialectic between society and nature. In this dissertation, the hazardous waste stream is sized. The mode of production and government complacency are identified as root causes. Socio-cultural *and* geo-physical factors are identified as possible predictors of the distribution of commercial TSDFs in the Southeastern United States. As an environmental sociology dissertation, it contributes to the gradual reform of the social facts dictum.

Second, the problems of space and location are under-theorized in sociology. These concepts are forfeited to geographers and urban planners.[10] This dissertation wrestles the concepts of space and location into a sociological framework of power, stratification, and group behavior. Space and location are ideal concepts to mine the level of analysis problem in sociology. Location for TSDF operations is an agency and structure problem. It involves stakeholders with intentions that are structured by systemic imperatives. Stakeholder intentions conflict as a function of conflicting systemic imperatives. The patterning of stakeholder conflict reflects the resolution of systemic cross-purposes. Take for example, the decision of a company to locate a TSD facility in a poor community of color. The decision may be motivated by utility maximization, or conflict avoidance in permit acquisition. These motivations are systemically induced by market competition and regulatory norms. The location decision induces opposition from targeted communities. The actions of targeted communities force changes in the regulatory milieu, as public officials

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[10] The notions of space and location were fundamental to the Chicago School of sociology. Sociologists developed a POET model of analysis that specified the reciprocal relations between population, social organization, environment, and technology. This model adapted spatial reasoning from the science of ecology. The Chicago School furnished sociology with spatial concepts and metaphors (i.e., concentric zone, region, field, periphery and landscape), and articulated a brilliant model of co-evolution. Social theorists as early as Ibn Khaldun (1332-1406) recognized the importance of location-specific factors as climate, the fecundity of soil, and levels of precipitation in determining forms of human society and trajectories of culture. This dissertation is a resuscitation of these theoretical traditions.

balance the will of the public and the private interests of capital (see Table 2.1). These changes cause TSDF operators to behave differently in their use of space and location. The patterning of this change in behavior constitutes a fluid resolution of systemic contradiction. Entering the agency-structure problem through an environmental sociological conception of space and location can yield creative ideas for purposeful resolution of systemic contradictions.

Third, this dissertation confronts moral philosophical notions of equity and justice. These concepts explicitly direct a large percentage of sociological research. The terms equity and justice are hotly contested in moral philosophy. Philosophical traditions (i.e., Kantian, Utilitarian, Liberal, Rawlsian, and Communitarian) can be sorted on a continuum of procedural and distributional justice. Sociologists generally emphasize distributional justice and de-emphasize procedural justice. In the political arena, this is a logical trap, given the American constitutional commitment to procedural fairness. This dissertation attempts to bend the continuum of distribution and procedure. It measures distributional outcomes objectively as an indication of justice, and reasons from outcomes procedural reforms that balance the interests of all parties. Balancing the interests of stakeholders is not easy, but the dissertation proposes a non-coercive solution to the distributional problem. This hazard allocation proposal is discussed in the conclusion.

Fourth, this dissertation organizes the literature on distributional outcomes uniquely into four hypotheses: 1) business rationality; 2) scientific rationality; 3) social capital; and 4) race and class discrimination. Although the environmental justice literature is interdisciplinary, researchers tend to use discipline-specific methodologies and hypotheses to explain variations in quality of life linked to environmental insults, and whether risks of exposure to different kinds of environmental hazards are patterned within and across statistical, geographic, and juridical units. This dissertation is consciously interdisciplinary, synthesizing economic geography, geology, environmental sociology, demography, political economy and juridical literatures. All reasonable hypotheses are tested objectively.

Fifth, by virtue of its interdisciplinary character, this dissertation introduces numerous, never-before-tested independent variables, linked carefully to never-before-tested theoretical propositions. Measurement theory mandates careful linkage between indicators/operations and abstract constructs. Indicator selection is constrained by researcher bias, time and financial considerations, and availability of good data. Such constraints produce questionable measurement decisions, use of data driven hypotheses rather than hypothesis driven data collection, politically motivated variable selection and under-specified model fitting to advance social agendas (see Chapter II). The environmental justice scholars routinely commit such mistakes. Indicators are used inadequately as proximate measures of fuzzy notions linked to poorly articulated theories in a demolition of the logic of measurement. By carefully attending to the logic of measurement, this dissertation clarifies the linkage between theory and observation, enriching the pool of variables to predict patterns of environmental risk distribution, and attempting to provide a valid and reliable basis for public policy and elimination of regulatory complacency.

Sixth, this dissertation makes numerous research design improvements to existing scientific literature to strengthen reliability and validity of knowledge claims. Improvements include: expanding the notion of hazardous exposure to include all populations within 1 and 1.5 miles of a TSD installation instead of locating such facilities squarely in statistical units; and enhancement of model specification to explain greater variation in the geographic variability of environmental hazards.

Seventh, analysis of the distribution of commercial treatment, storage, and disposal facilities is inherently relevant. Research evidence on distribution equity is contradictory. Results vary by research design, unit of analysis, variable selection, and object of analysis. Several gaps in the empirical literature undermine its credibility. The review of scientific literature in Chapter II identifies shortcomings and sets the table for analyses that follow. Also, commercial TSDFs are uniquely important because of the way they are sited. As privately owned companies, commercial TSDFs are market maneuverable. They locate to areas on the basis of profit, unlike their public and onsite counterparts. The sociological study of economic action provides opportunity for structural analysis of market behavior and identification market underperformance on socially important measures of human well-being, in contrast to the neo-classical economic study of markets erected on questionable premises of rational actors and perfect information, and narrow concern for economic advancement.

ORGANIZATION OF STUDY

This dissertation is organized into five chapters. Chapter I problematizes the issue of hazardous waste treatment, storage, and disposal. The hazardous waste stream is sized, the political economic backdrop explained, the regulatory context is described, objectives of the dissertation are delineated, and reasons are given for the relevancy of such research.

Chapter II is a comprehensive and critical review of scientific literature on the distribution of treatment, storage, and disposal facilities in the United States. The review is organized by methodology, and studies are evaluated critically on their contribution to science. Articles are criticized on research design elements like sampling methodology, variable operations, measurement precision, conceptual clarity, and hypothesis validity. Such criticism guides design decisions and analyses in subsequent chapters.

Chapter III is a detailed discussion of the theories of TSDF site selection and location. Each theory is distilled into a testable proposition or hypothesis. Variable operations and definition statements are presented, data sources are described and evaluated for validity and reliability, construction of the dataset is described, and reasons are given for object and unit of analysis selection and statistical tests to be used.

Chapter IV presents results of statistical tests. Descriptive statistics on independent variables are used to sort and describe the data for the region as whole and individual states. Next, statistical tests of comparison (i.e., t-Test) between host and non-host neighborhoods are conducted. Results are presented in table format for the entire region, and two sub-regions – the South, and Deep South. Last, binary logistic regression results are presented. Regression coefficients are transformed from log odds to odds ratios for ease of interpretation and readability.

Chapter V recapitulates hypotheses in relation to results. The implications of results are discussed. President Clinton's Executive Order 12898 on environmental justice is discussed. A hazard allocation system is proposed to achieve procedural and distributional justice. The mechanics and benefits of the hazard allocation system proposal are described and summarized in table format.

CHAPTER II: REVIEW OF SCIENTIFIC LITERATURE

INTRODUCTION

The principal objective of this chapter is a comprehensive and critical review of treatment, storage, and disposal facility studies to set the table for analyses that follow. The review of scientific literature is organized methodologically into: 1) cross-sectional studies, and 2) longitudinal studies. The studies are presented in more-or-less chronological order, and critically evaluated on their contributions to scientific understanding of the geography of environmental health risks.

TREATMENT, STORAGE, AND DISPOSAL FACILITY CROSS-SECTIONAL STUDIES

The generally acknowledged progenitor of environmental justice research is sociologist, Robert D. Bullard.[1] In 1983, Robert Bullard, at the urging of his wife Linda McKeever, conducted a case study of waste disposal practices in Houston, Texas. Bullard did not examine TSD installations specifically, but the logic and design of the study influenced investigations that followed. The stated purpose of the study was to see if blacks were more likely than whites to reside near waste disposal facilities. Houston was selected because of its racial diversity and hazardous waste disposal practices that seemingly targeted African-American communities. Bullard's evidence pointed to a new and gruesome form of inequality – residential proximity to human and industrial waste. Bullard discovered that all 5 municipal landfills were located in black neighborhoods; of the city's 8 garbage incinerators, 4 were located in black communities, and 1 located in a mostly Hispanic community; and all the city's mini-incinerators were located in majority black or Hispanic neighborhoods. In total, 21 of Houston's 25 hazardous waste facilities were located in predominantly minority communities.

Bullard (1983) theorized this environmental inequity as a failure of government. The federal government failed in its enforcement of environmental regulations, and Houston's municipal government failed miserably in its zoning practices. Bullard strongly rejected the argument that such inequity could be the product of residential choice, with minorities trading environmental quality for affordable housing. For

[1] More recently, researchers (Zahran, Zilney, and Hastings 2003) note numerous environmental justice studies that pre-date Bullard. For example, Myrick Freeman (1972) observed that persons of low-income and minority status were exposed to higher levels of air pollution, and generally lived in communities of significantly lower environmental quality. Freeman argued this problem of disproportionate exposure to harmful air pollutants could be ameliorated by wealth re-distribution. Freeman's recognition and diagnosis of the problem anticipates whole debates in the environmental justice literature, from the explanatory power of race versus class, to the role of market forces in allocating environmental burdens unjustly.

Bullard, the evidence was an out-cropping of institutional racism. He concluded passionately that Houston typified an insidious national problem.

Bullard's Houston case study has been very influential, frequently cited as proof of environmental racism. It is also credited with spawning a new line of social scientific inquiry, with 200+ environmental justice journal articles published from 1990 to 2001 (Zahran, Zilney, and Hastings 2003). Above all, the study's results energized civil rights and grassroots environmental justice activists, and stirred policy makers and elected officials to action (see Table 2.1).

The study's political influence is not matched by its scientific merit. Vicki Been's (1994) replication of Bullard's study raised questions about its scientific credibility. Been discovered that Bullard inflated his sample by double-counting sites, counting abandoned sites, and sites erected in the 1920s, long before Houston turned into a racially diverse city. Bullard also provided no description of how neighborhoods were defined, how racial data were collected, and ignored cross-sectional controls like income or other potentially important factors that may render the observed relationship between race and environmental risk spurious.

In 1990, Robert Bullard expanded his Houston case study with the publication of *Dumping in Dixie: Race, Class, and Environmental Quality.* Dumping in Dixie used the collective study method, examining the relationship between environmental distress, demography, and attitudes of black residents toward environmental quality. The study lumps commercial TSDFs with other locally undesirable land uses. Bullard used ethnographic methods, conducted in-depth interviews with community leaders, distributed and analyzed data obtained from a survey of African-American households, and analyzed archival and government documents to build an impressive case for environmental injustice. Based on a random sample of 120 African-American households in five communities, examining: popular responses to environmental hardships and justice concerns; tactics used to resolve environmental conflicts; the role of African-American organizations in remedying environmental inequity; the role of "outsiders" in activism; and the effects of negotiated compensation[2] in siting of hazardous waste facilities (Bullard 1990).

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[2] Negotiated compensation is an economic scheme to diffuse the concentrated external costs of a hazardous facility. Targeted communities are given a set of "offsetting benefits." Benefits may include, direct payments to affected residents; host fees paid to a general fund for community development; grants for local health care, parks, and recreational amenities; and distribution of abatement devices to greatly reduce the risk of exposure. Negotiated compensation, it is argued, can force the internalization of negative externalities, mediate the effects of residential instability, and "guarantee a socially optimal level of pollution" (Boerner and Lambert 1995: 95). Critics see negotiated compensation as a band-aid idea that undermines efforts to reduce the size of the hazardous waste stream, and as a pornographic economic logic that requires already disadvantaged communities to make cruel trade-offs between health and wealth.

TABLE 2.1: CHRONOLOGY OF MAJOR EVENTS IN THE ENVIRONMENTAL JUSTICE MOVEMENT

Year	Event
1971	Council of Environmental Quality reports link between racial discrimination and environmental quality.
1982	Warren County, North Carolina residents protest the siting of PCB landfill, focusing national attention on issue of environmental racism.
1983	Robert Bullard publishes groundbreaking case study of waste disposal practices in Houston Texas.
1983	General Accounting Office report discovers that 3 of 4 hazardous facilities in EPA's Region IV are in majority African American communities.
1987	United Church of Christ (UCC) Commission for Racial Justice issues report on the distribution of hazardous facilities nationwide.
1990	Conference at the University of Michigan releases report called Race and the Incidence of Environmental Hazards.
1990	Robert Bullard publishes influential text Dumping in Dixie.
1990	Environmental Protection Agency (EPA) creates Environmental Equity Workgroup
1991	First National People of Color Leadership Summit in Washington, D.C. crafts EJ Principles.
1992	EPA releases Environmental Equity: Reducing Risk for All Communities.
1992	Environmental Justice Act of 1992 introduced in Congress by Senator Albert Gore and Congressman John Lewis.
1992	EPA establishes Office of Environmental Equity.
1993	EPA establishes the National Environmental Justice Advisory Council.
1993	Environmental Equal Rights Act introduced to amend the Solid Waste Disposal Act. Did not pass.
1993	Environmental Health Equity Information Act of 1993 introduced to amend the Comprehensive Environmental Response, Compensation and Liability Act. Did not pass.
1994	Federal agencies, including the National Institute of Environmental Health Sciences hold symposium on environmental justice.
1994	President Clinton issues Executive Order 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations"
1994	EPA renames Office of Environmental Equity as the Office of Environmental Justice
1994	EPA creates Office of Civil Rights
1994	Interagency Working Group on Environmental Justice is established.
1995	Social & Demographic Research Institute (SADRI) at the University of Massachusetts releases study indicating no racial inequities in the siting of hazardous waste facilities
1998	EPA issues Interim rules for Title VI Complaints Challenging Permits for public comment
1999	Environmental Justice Act of 1999 is introduced into US Legislature.
2001	Second National People of Color Leadership Summit in Washington, D.C.
2003	EPA establishes environmental justice bibliographic database

Sources: Environmental Protection Agency Office of Environmental Equity; and Clark Atlanta University's Environmental Justice Office.

Bullard examined five mostly African-American communities with histories of environmental distress. Whether a function of selection bias or not, each case fits a pattern of racial injustice and environmental inequity. Three of the five cases are discussed below. These cases specifically examine treatment, storage and disposal facilities.

In West Dallas, TX, Bullard discovered a history of disproportionate dumping and community radicalization. West Dallas is a segregated enclave outside Dallas city limits, home to a high percentage of African-American residents. West Dallas is grossly impoverished, with very low levels of home ownership, high levels of public assistance, and the majority residents crammed into high-density housing projects. Just fifty feet from the housing project is a bullish lead treatment and smelting complex. For decades, lead particles were pumped routinely into the air, and swept by prevailing winds onto "West Dallas streets, sidewalks, ballparks, and children's playgrounds" (Bullard 1990: 55). Because "city officials refused to enforce lead emission standards" (Bullard 1990: 56), residents suffered a high-percentage of lead-related health problems. Hit hardest were the elderly, pregnant women, and children.

In 1981, a formal epidemiological survey of the area confirmed the obvious – health risks were distributed unevenly in Dallas by race. The report's findings were leaked to the *Dallas Morning News*. Newspaper coverage set off public outrage, and numerous class action lawsuits were filed. West Dallas residents agreed to an out-of-court settlement with lead smelters estimated at $20 million, among the largest lead-contamination settlements in the United States. Like residents of Northwood Manor in Houston, residents of West Dallas were radicalized by the experience. Quoting D. W. Nauss of the *Dallas Times-Herald* (Bullard 1990: 60): "Once united only by poverty and powerlessness, the community has been brought together by the shared trauma of living with the lead smelter and the need to save what little they have. The pollution problem has awakened the community to other concerns, such as industrial development and housing re-development, and has made residents for the first time cast a hard, distrusting eye toward city plans for the area."

West Dallas residents prevailed. They forced a capacity reduction, eventual closure of the facility, received financial compensation, and had the area's environmental problems significantly remedied. Bullard attributes the victory to tactical maneuvers like petition signing, protests, demonstrations, legal action, government lobbying, and enlistment of the popular press. Environmental justice activists herald the West Dallas case as a model of community mobilization and just compensation for environmental and public health degradation.

The story of Alsen, Louisiana is slightly different. Alsen is a small community of 1,100 people, 98.9 percent of whom were African-American, located just north of Baton Rouge. It is comparatively well off economically, with a poverty rate below the African-American national average, and higher than average rates of home ownership and family income. The inclusion of Alsen in the collective case study allows Bullard to mechanically control for the effects of economic class.

Alsen sits on the periphery of an 85-mile industrial stretch that hugs the Mississippi River, dubbed cancer corridor, where 25 percent of the nation's petrochemicals are produced (Bullard 1990). Carcinogens, mutagens, and embryo-toxins saturate the area. Millions of tons of hazardous waste are generated annually, with mostly all of it shipped to Rollins Environmental Services, a landfill and incinerator complex abutting Alsen.

As the fourth largest handler of hazardous waste in the country, Rollins was a constant source of distress for community residents. In five years after it was built, the Rollins facility had been cited for more than 100 state and federal violations of environmental and occupational laws. In the late 1980s, residents mobilized to end contamination of their community. Residents filed lawsuits, recorded complaints with the Louisiana Department of Environmental Quality (LDEQ), and engaged in direct action protests with the help of national environmental organizations. After considerable legal wrangling and backbiting, an out-of-court settlement was reached. Each plaintiff received a pitiful $3000 the day before Christmas. The dollar amount fractured the community into "money versus health factions" (Bullard 1990: 68), and the settlement shielded Rollins from future liability. In the end, environmental quality for Alsen residents improved only marginally, and the underlying cause of the problem, Louisiana's economic dependence on chemical-intensive industry, remained in place.

Last, Bullard's (1990) case study of Sumter County, Alabama probes the political economy of hazardous facility siting, and how an impoverished community is structurally coerced into a merciless trade-off between economic survival and environmental quality. Sumter County is located in the interior of the Southern blackbelt. One-third of the county's population lives below the poverty line, 90 percent of which are African American. Inside Sumter County is a small, rural settlement called Emelle. Emelle is home to 626 residents, 90 percent of whom are African American. More than 40 percent live in poverty, with a sizable percentage living in mobile homes scattered unevenly on a winding system of dirt roads.

Many residents are descendants of plantation slavery. With the dismantling of racial apartheid and the gradual disappearance of sharecropping arrangements, the community drifted economically. The lack economic opportunity caused an out-migration (i.e., 40 percent of residents) that, in turn, caused a significant devaluation of property. Because of intensive farming practices in the past, the land was unsuitable for large-scale or subsistence agriculture. The area, it seemed, was too isolated for regular industrial production, but Bullard argues (1990: 70), "these bleak economic conditions and cheap land made [Emelle] a likely candidate for polluting industries – especially waste disposal companies."

In 1978, Chemical Waste Management (Chemwaste) purchased 3200 acres of land in Sumter County, and erected the largest hazardous waste treatment, storage, and disposal facility in the country. Chemwaste is a subsidiary of Waste Management, Incorporated – a transnational corporation with a sizable share of the hazardous waste market. The sprawling facility was built on top of Emelle without political transparency or community input. It was a classic environmental justice scenario – a desperately poor, minority community bulldozed politically by a profit-seeking conglomerate.

To Bullard's surprise, Emelle residents did not resist the placement of the TSD facility. Residents mistakenly assumed, or were misled into assuming, that the facility was relatively harmless and would generate employment. Chemwaste agreed to a waste tax of $5 dollar per ton, with monies spent on public services like schools, libraries, law enforcement and basic infrastructure. The company also sponsored local charities, youth groups, and other community enterprises. Most of these offsetting benefits went to white residents of Sumter County, and only 50 of the 400 jobs created went to Emelle residents.

As residents learned of the hazardous materials transported to their community, and failed to get guarantees from the company about long-term protection of the water supply, a small group of local black activists and mostly white environmentalists from Tennessee and greater Alabama emerged. The group failed to wrestle any concrete reforms from the company or local political figures, but for Bullard, the group symbolized a new and potentially powerful interracial alliance of civil rights activists and national environmental organizations.

Bullard's *Dumping in Dixie* (1990) suggests that TSDF operators target socially disadvantaged communities. Targeted communities tend to be depressed economically, disproportionately minority, segregated residentially, and politically marginalized. Bullard argues that such communities are structurally vulnerable to toxic assault because TSDF operators use a community's economic status and racial composition as indicators of a community's propensity to resist facility siting or seek legal redress of grievances.

Bullard's proof is challengeable methodologically and theoretically. On methodology, Dumping in Dixie is unreliable. Bullard provides no objective reason for case selection. Anyone can scour the country for five examples of anything. Why select West Dallas and not Buffalo, New York? This criticism is not to suggest Bullard's cases are unreal. These communities have suffered immeasurably because of corporate negligence and government ineffectiveness. Bullard's rendering of their stories raises questions about social organization and environmental planning. Still, one cannot conclude a national or regional pattern of environmental injustice from the evidence presented, as Bullard does confidently.

On theory, Bullard is deeply suspicious of economic explanations for site selection. For their part, TSDF operators insist their decision-making is color-blind, motivated strictly by scientific and commercial considerations. They target areas, not populations. Site selection is based on proximate access to hazardous materials for processing, and the availability of cheap land for construction of a TSD installation. This argument is plausible. The case studies reveal that targeted communities are generally located near industrial parks where large quantities of hazardous waste are generated. Bullard downplays this fact - it does not fit with the underdog mythology of his narrative.

In 1983, at the urging of Walter Fauntroy, Chair of the Congressional Black Caucus, the General Accounting Office (GAO 1983) undertook an empirical study to examine the factors of race and economic class in the distribution of hazardous facilities in the EPA's Region IV. Researchers used secondary data from the US Census Bureau and the EPA, and conducted telephone interviews with various stakeholders. Results indicated that African-Americans were burdened disproportionately by hazardous waste. In 3 of the 4 hazardous waste locations examined, African Americans constituted a demographic majority. The study also suggested that economic class played a role in the distribution of environmental burdens. As one moved closer to facilities, rates of poverty increased. In fact, the relationship appeared perfectly linear. Poverty levels ranged from 26 to 42 percent, almost 3 times the region's average. The study seemingly confirmed the rotten suspicion of environmental racism.

Because of the small sample size and circumscribed geography, the results are non-generalizable nationally or regionally. The GAO study also made no attempt to establish why these locations were sited, population characteristics at the time of facility siting, how siting decisions affected the population, and relied on a simple analytic methodology. Ultimately, the study's relevance has less to do with its scientific merit, than with its political effect of advancing the environmental justice movement.

In 1987, the United Church of Christ's (UCC) Commission for Racial Justice (1987) published the first national, cross-sectional study of 415 commercial hazardous waste facilities in the United States. Zip code level population and housing data were obtained from the US Census Bureau, and data on commercial TSDFs were gathered from the Environmental Services Directory and the EPA's Hazardous Waste Data Management System (HWDMS). The study compared host and non-host communities to isolate the independent effects of race in siting decisions. Researchers found that communities with the highest percentage of minorities had the highest concentration of hazardous facilities. This pattern of environmental racism obtained nationally. Statistical controls did not diminish the relationship between race and environmental risk. In fact, "race proved to be the most significant among variables tested in association with the location of commercial hazardous facilities (1987: xiii). According to researchers, the likelihood of this finding being a function of chance is "virtually impossible" (Mohai and Bryant 1995).

The UCC study also noted the role of political economic factors in the location of hazardous facilities. Commercial operators are motivated by instrumental rationality. They seek inexpensive land, access to raw materials and skilled labor, and politically compliant neighborhoods. Such factors increase profitability and reduce potential transaction costs. These factors cluster in minority communities. The combination of institutional racism, and political economic disadvantage, make minority neighborhoods vulnerable to siting of environmentally suspect land uses.

The UCC study is credited with raising important questions about the linkage between race and environmental risk, but has been criticized fiercely on methodological grounds. In William Bowen's (2001: 140) words: "there are several subtle but nevertheless grave reasons to doubt the accuracy of its conclusions." Majority of the criticism centers on the unit of analysis. The zip code unit is a poor approximation of community. They are too large, arbitrarily defined, and prone to erroneous inferences. What is true and valid at the zip code level may not be at smaller levels of analysis like the census tract. Other criticisms focus on the study's aggregated definition of minority, its incorrect usage of statistical analyses and diagnostic tests, questionable controlled comparisons, and lack of scientific peer review before publication. Though lacking in scientific merit, the United Church of Christ (1987) study was groundbreaking. It attracted the attention of policy makers to potentially disproportionate siting made on the basis of race, and introduced the politically powerful concept of environmental racism. [3]

[3] In 1994, Benjamin Goldman and Laura Fitton replicated the UCC study using updated data. They arrived at a similar conclusion - race prevailed as the most important predictor of the distribution of environmental hazards.

In 1992, Paul Mohai and Bunyan Bryant examined the geographic distribution of 14 commercial hazardous waste facilities in the Detroit metropolitan area (i.e., Oakland, Macomb, and Wayne Counties). Mohai and Bryant (1994: 16) conducted their study "to determine whether race has a relationship with the location of commercial hazardous waste facilities that is independent of income." Population data were obtained from the University of Michigan's 1990 Detroit Area Study (DAS), and information on facility locations from the Michigan Department of Natural Resources.

Mohai and Bryant performed a stratified probability sample of households within 1 and 1.5 miles of a hazardous facility, and of households outside these zones of exposure. The residential location of each respondent was graphically mapped and measured to the nearest 0.1 mile. In total, 793 individuals participated in the study, with 289 of them residing inside 1.5 miles of a hazardous facility. Analyses suggested race and poverty to be statistically significant predictors of hazardous waste siting. Of persons residing within one mile of a hazardous facility, 48 percent were minority and 29 percent lived below the poverty line; between 1 and 1.5 miles of a facility, 39 percent of residents were minority and 18 percent lived below the poverty line; and of those residing more than 1.5 miles of a commercial hazardous waste facility, 18 percent were minority and only 10 percent lived below the poverty line. Mohai and Bryant discovered that the chance of a minority living within 1 mile of hazardous facility was 4 times greater than for a white individual. Of their findings, Mohai and Bryant (1994: 20) conclude boldly: "results of our Detroit area study provide clear and unequivocal evidence that income and racial biases in the distribution of environmental hazards exist."

Mohai and Bryant's study is uniquely designed. It is the first study to use geographic mapping technology to plot the relationship between environmental risk and race. This method more accurately measures exposure. For this reason, the study ought to be commended. However, their findings are far from unequivocal. Mohai and Bryant committed computational errors, and misrepresented results. Their chi-square results are not reproducible because frequency distributions on race and poverty do not add to 100 percent. Also, chi-square results for the sub-sample of Detroit residents suggest race and hazardous waste exposure are statistically independent. Even more damaging of their claim of unequivocal proof is their regression model. The adjusted R-square left much to be desired. Almost 95 percent of variation in their dependent variable is unexplained by the data. Mohai and Bryant provide no reason for under-specification of their model (Bowen 2001). On balance, the study is insufficiently rigorous and too narrow geographically to be of much relevance to the macro question of environmental justice.

In 1992, Harvey White of the World Health Organization conducted a study of hazardous waste incineration in Baton Rouge, Louisiana. White compared rates of incineration in the 10 largest white and black communities in the area. No logic is provided for selection of communities apart from their size and racial composition. While the article found hazardous waste incineration facilities to be disproportionately located in minority communities, it failed to use statistical controls for other socio-economic variables that may influence siting decisions. Lack of statistical control, arbitrary selection of comparison groups, and statistical regression bias render the study scientifically marginal (Bowen 2001). At best, the results weakly hint toward environmental racism in selected communities in Baton Rouge.

In 1993, James Hamilton examined the role of collective action in thwarting expansion decisions by hazardous waste facilities. The article was an empirical test of the Coase Theorem - the notion that voluntary bargaining among different users of an environment will lead to a Pareto-optimal allocation. Hamilton matched socio-demographic data from the 1980 US Census with EPA data on treatment, storage, and disposal facilities scheduled for capacity expansion. Data were merged at the county level of analysis. Of the 156 counties examined, 72 had facilities scheduled for expansion. Hamilton included the following variables in his regression model: capacity surplus, hazardous waste generated, manufacturing value added, median housing value, percentage voter turnout in the 1980 presidential election, percent college educated, population density, percent urban dwellers, and percentage non-white population. Voter turnout prevailed consistently as the only variable significant at the 1 percent alpha level. Hamilton discovered that the higher a community's voter turnout, the lower the likelihood it would be targeted for capacity expansion. The race variable behaved unexpectedly. The probability of capacity expansion decreased as percentage of minority increased.

Hamilton's study is a significant contribution to the literature methodologically and theoretically. It is rigorously designed, the regression models fully specified, and variables linked logically to theoretical propositions. The study advances the literature in a sensible, mathematical direction and extricates it theoretically from a tired race versus class debate. We learn that the blackness of a community does not destine it for hazardous waste. Other attributes matter. This conclusion should not upset activists. On the contrary, it confirms their reason for being. Community action can thwart racial animus on the part of TSDF operators. One downside of the study is the level of analysis. The county level precludes any real discussion of public health effects or risk of exposure to environmental contaminants as a function of proximity. Another problem is the use of voter turnout data to estimate community cohesion and political power. The act of voting is a political ritual that masks inequalities of influence.[4]

In 1994, Douglas Anderton, Andy Anderson, John Michael Oakes, and Michael Fraser (1994) of the Social and Demographic Research Institute (SADRI) at the University of Massachusetts, Amherst entered the environmental justice debate. Anderton et al dissect the literature objectively. The question of race and environmental risk is cut with analytical precision and methodological rigor. The article is a departure from the emotionally charged language of the literature. No political indictments or battle cries to upend the mode of production are made. They write (1994: 230): "Our interest here is not in the perception of injustice . . . but in the question of empirically demonstrable discrimination in the distribution of facilities across social groups."

Anderton et al. examined the distribution of 408 commercial treatment, storage and disposal facilities in the 48 contiguous states (Anderton, Anderson, Oakes, and Fraser 1994). Unlike the UCC study, analysis is conducted at the census tract level. Anderton et al argue persuasively against the use of zip code or county level data. Such units invite errors of aggregation, misplaced concreteness, and fallacies of ecology. Moreover, because census tracts are delimited by local persons with knowledge of the physical and cultural makeup of a metropolis, they reasonably approximate of the sociological concept of neighborhood. In addition to methodological refinements, Anderton et al. introduce the hypothesis that market forces drive the allocation of facilities. Because management of hazardous waste is a business, operators of TSDFs are reasonably assumed as utility maximizing agents. They seek cheap land, labor, and access to materials. The population characteristics of a community are secondary, or so the argument goes.

Anderton et al. focused their analysis on a specific class of TSDFs – privately owned and fully operational facilities that receive hazardous waste from other firms – what the EPA calls off-site handlers. This sample excludes TSDFs that are also large quantity generators of waste – what the EPA calls on-site handlers. Because publicly available data from the EPA do not distinguish between on-site and off-site handlers, nor include information on facility status or the date operations began, Anderton et al. rely on the Environmental Institute's Environmental Services Directory (ESD) on TSDFs to construct their frame. To

[4] Voter turnout data also underestimate the social and political influence of African-Americans on the American polity. Black voter turnout routinely lags behind the national average. Explanations range from African-American distrust of the electoral process, white intimidation of black voters, and barriers to African-American voter registration. Because convicted criminals are stripped of their juridical status in the United States, the effects of incarceration play a growing role in African-American political disenfranchisement.

guarantee validity and reliability of ESD data, they conducted telephone interviews with operators. Anderton et al. use the following independent variables in their model: percentage Hispanic; percentage African American; percentage of families below the poverty line; percentage of families receiving public assistance; percentage male employment; percentage employment in manufacturing; and mean housing value.

Statistical comparison of host and non-host tracts disconfirmed the racial discrimination hypothesis in TSDF siting. In fact, non-host tracts had higher percentages of African American and Hispanic persons than host tracts. Multivariate analyses indicated that areas with at least one TSD facility were mostly white, industrial, and working class. The percentage of the population employed in manufacturing was the most consistent and significant predictor of TSDF siting. Anderton et al. (1994: 232) conclude: "no consistent national level association exists between the location of commercial hazardous waste TSDFs and the percentage of either minority or disadvantaged populations." EJ activists dismissed the study as politically motivated because the SADRI accepted research monies from Waste Management Incorporated. Funding source should not disqualify a study outright otherwise the pool of studies regarded as scientifically legitimate would be substantially smaller. The merger of advocacy and science is played on both sides of the issue. Like the UCC study, SADRI studies must be evaluated on merit. Overall, this study is carefully conceived and executed.

In 1995, James Hamilton published a revision of his TSDF capacity expansion study. Hamilton (1995) moved his analysis from the county to the zip code level of geography, and broadened discussion of economic theories that may explain the unevenness of environmental health risks by race. Hamilton objectively tested the following hypotheses: pure discrimination, the Coase theorem, and Mancur Olson's theory of collective action. The pure discrimination hypothesis holds that TSDF operators trade profits for prejudice. They derive utility from shouldering minorities with hazardous waste, so much so that they are willing to forfeit profits to achieve prejudicial ends. The Coase Theorem holds that hazardous facilities locate to areas with lowest transaction costs. TSDF operators are strapped by an economic logic that requires them to factor compensation demands and expected liabilities into siting decisions. If the Coase Theorem is correct, facilities will locate to areas with populations of low propensity to seek legal redress, and lower expectations on compensation agreements. The third hypothesis is a corollary to the Coase Theorem. The theory of collective action holds that communities vary in their capacity to thwart siting decisions by organized behavior. Socially organized communities have linkages to the political system, place higher value on environmental amenities, and are more likely to force operators to internalize the external damages they cause.

Hamilton (1995) collected socio-demographic data on 207 zip code areas with fully operational TSDFs in 1986. Of these facilities, 84 had expansion plans and 123 did not. T-tests indicated that communities with expanding TSDFs had higher nonwhite populations and higher rates of poverty. Logistic regression analyses performed differently. Statistical controls erased the significance of race as a predictor of TSDF expansion plans. Communities targeted for capacity expansion had lower rates of voter participation, lower median household income, smaller population size, and higher percentage of renters. Hamilton concluded the ability and/or willingness of communities to mobilize politically against noxious facilities is the most important predictor of facility expansion. Hamilton cautioned that his results do not exclude the possibility of racism. In his words (1995: 129): "To the extent that racism in political markets or outcomes in housing, education and employment affect political participation, then these results should be consistent with claims that institutionalized racism affects the distribution of pollution." On this point, Hamilton is absolutely correct. Race, politics, and economy are tightly integrated, and related dialectically. This problem is solvable mathematically by inclusion of interaction terms in regression equations. This statistical solution escapes Hamilton. Nevertheless, the article is a decent theoretical and methodological contribution to the literature.

In 1997, J. Tom Boer, Manuel Pastor, James Sadd, and Lori Snyder analyzed the location of 82 TSDFs operating in Los Angeles County, as listed by the California State Department of Toxic Substances Control (CSDTSC). TSDFs are divided into categories based on tonnage of hazardous waste handled. Boer et al. conducted their study at the census tract unit of geography. Census tracts are superior to zip code polygons for their compact size and homogeneity. Boer et al. begin with visual presentation. Cartographies of waste suggest facilities concentrate in the central business district near transportation routes, and minority communities of low-income. Bivariate data indicate TSDFs locate in largely Hispanic, working class communities that abut industrial areas. The probability of ethnic targeting increases with facility size. Facilities that process over 1000 tons of hazardous waste are located overwhelming in Latino neighborhoods.

Multivariate analyses behave similarly. Boer et al. created three measures of exposure – tracts with a TSDF; tracts within .5 miles of a TSDF; and tracts within 1 mile of a TSDF. On all measures of exposure, percentage Latino is statistically significant. Percentage African-American is insignificant. The strongest predictor is the percentage of land devoted to industry. As the zone of exposure is expanded to 1 mile, racial, economic, and political inequities harden. Percentage African American, household income, and percentage of voters registered become significant.

Overall, the mixed behavior of the data deepens suspicion that results can be had either way, so long as one can rationalize a research design. The guard to full-blown advocacy, data tinkering, and aiming for a priori conclusions, is academic honesty. Boer et al fail to adequately defend radii selection. Why select a 1mile radius as a zone of exposure, and not a 2mile radius? Other concerns include: the study excludes census tracts with no industrial land, providing no sensible reason for doing so; the object of analysis is too small for nomothetic purposes; and failure to report residual analyses raises suspicion about spatial clustering and problems of auto-regression.

In 1997, William Markham and Eric Rufa examined the hazardous waste trade in the United States. They classified neighborhoods as generators and/or recipients of hazardous waste, and compared their population attributes. Neighborhoods receiving waste, Markham and Rufa hypothesized, are poorer, less educated, and disproportionately minority. It is the first and only study to link generators and handlers of hazardous waste, and attempt to unravel patterns of hazardous waste trade between neighborhoods.

Markham and Rufa randomly selected 49 US cities with populations greater than 100,000, and containing a waste disposal facility, sewage treatment plant, or hazardous waste incinerator. They contacted city planners and zoning administrators to assemble their sampling frame. They conducted a mail survey of facility operators to validate government records. Results indicated that tracts receiving waste had higher incomes, and lower percentage of minorities than tracts that generated waste. Only the relationship between education and hazardous waste behaved in the direction researchers expected. These regularities obtained across facility type and region. The environmental racism and classism hypotheses were disconfirmed.

The findings raise questions. EJ researchers emphasize the disorganizing effects of facility siting, and assume a pattern of waste transfer from privileged to disadvantaged communities. EJ activists argue that hazardous facilities are public health and environmental burdens, and ought to be distributed evenly on the population without regard to race or income. Markham and Rufa's results suggest that positive effects may accompany facilities, leading to a different kind of inequity. These facilities create jobs, and facility operators increasingly work with local officials to offset environmental burdens with risk substitution and compensation agreements that increase economic welfare of the host community. Markham and Rufa's results could mean that communities court such facilities as an economic growth strategy, and their benefits accruing disproportionately to white, working class communities.

The capital intensity of TSDF operations obviates this explanation. As case studies indicate, job creation is minimal, and the benefits, no matter how sweet, are outweighed by the harm done.
A more likely explanation is that Markham and Rufa inadvertently confirmed the industrial location hypothesis that generators and handlers cluster spatially. Meaning, LQGs and TSDFs target similar communities, and in some cases, the same community. Close examination of summary tables reveals that both generating and receiving neighborhoods had higher percentages of African-American persons and rates of poverty, and lower rates of home ownership and household income than the nation at large. Small differences obtain on measures of educational attainment. This point is lost on Markham and Rufa. Last, the study failed to use statistical controls, leaving one to wonder if their results are illusory and worth the attention given it.

In 1997, Ann Bowman and Kelly Crews-Meyer examined the distribution of RCRA-regulated facilities in the Southeastern United States. Bowman and Crews-Meyer measure environmental risk as the sum of TSDFs and LQGs in a jurisdiction – a slight deviation from the typical dichotomous presence-absence measure used in the literature. According to Bowman and Crews-Meyer, inclusion of LQGs "more accurately captures the fundamental issue of risk of exposure than does the more narrow focus on TSD facilities" (Bowman and Crew-Meyer 1997: 112). No explanation is given. Population data are collected at the county level of analysis – a peculiar, and internally inconsistent decision given their emphasis on "the fundamental issue of risk of exposure." Counties may have social and political meaning, but they are simply too large for exposure analysis. Bowman and Crews-Meyer focus on the Southeast because of its growing reputation as an environmental "sacrifice zone" and dumping ground for the nation's toxic detritus.

OLS regression models produced mixed results. The stripped down model of percent black and per capita income insinuates a pattern of environmental racism. As Bowman and Crews-Meyer add a population size variable and a race-class interaction term to their model, the race effect disappears. Population size is the strongest predictor of hazardous waste exposure at the county level, explaining 47 percent of the variance in number of Locally Undesirable Land Uses (LULUs). Bowman and Crews-Mayer (1997: 116) conclude that: "on balance, race and class characteristics . . . add little to the explanation" of facility siting in the Southeast.

There are problems with this study. OLS regression models are under-specified, intercepts are statistically insignificant, and model explanatory power inflated artificially by the unit of analysis. Also, the decision to create a LULU measure as the sum of RCRA-regulated hazardous facilities is logically weak. LQGs and TSDFs are qualitatively different enterprises, even if regulated by the same government agency under the same laws. A typical LQG is an automotive assembly facility – hardly a locally undesirable land use. Cities aggressively court such facilities for economic growth. Jobs are created directly as the assembly plant is fully operational, and indirectly as suppliers gravitate to the area, as wages and salaries are spent in the retail sector, and as regulators spend tax receipts on desirable public goods. The economic multiplier effect of such industry is unmatched.[5] The same cannot be said of a capital-intensive hazardous waste incinerator. This conceptual mistake with technical problems mentioned above render the study minimally relevant.

Cross-sectional studies are superior to case studies in controlling for non-spuriousness, but inadequately address the temporal order condition of establishing a genuine statistical relationship between community-level characteristics and siting of a hazardous waste facility. Single snapshot studies with good theory and statistical controls reveal co-variation, but gloss over neighborhood dynamics that may cause concentration of environmental risks in minority and low-income neighborhoods. The mere existence of unequal distribution of environmental burdens is an insufficient basis for nomothetic claims of racial discrimination in siting decisions and enforcement of environmental laws and regulations. Such claims are refutable legally because the sequence of events is unknown. The next section discusses longitudinal studies.

TREATMENT, STORAGE, AND DISPOSAL FACILITY LONGITUDINAL STUDIES

The question of what came first, the hazardous waste facility or the disadvantaged group, is unanswerable using a cross-sectional design. It is theoretically possible that siting decisions are procedurally fair with regard to race and income, with discriminatory outcomes a function of time-sensitive push and pull factors that operate differently on groups of people. Longitudinal studies with before and after snapshots can ferret

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[5] In a study commissioned by Mississippi Development Authority called "The Economic Impact of Nissan in Mississippi," economists estimate that 25,000+ jobs are created indirectly from 4000 jobs created on the shop floor. An estimated $810 million dollars in personal income is generated in 10 years. In seven years, every government dollar invested to attract the facility is recouped in tax receipts. In 20 years, the typical lifespan of such a facility, $990 million dollars are had in taxes. Whatever governments do with such revenue – hire people, invest in public goods – the economic effects multiply positively.

out these factors, identifying race and income-specific migratory patterns and residential dynamics stemming from the placement of a hazardous facility.

The first study to explore the dynamics of environmental inequality diachronically was conducted by Vicki Been in 1994. Been revisited data from the General Accounting Office's *Siting of Hazardous Waste Landfills and Their Correlation with Racial and Economic Status of Surrounding Communities* (1983) and Robert Bullard's Houston study (1983). Recall, the highly publicized GAO study concluded that host communities were disproportionately black and poor, and Bullard's Houston study found that hazardous waste landfills were located overwhelmingly in predominately minority communities. Both studies, Been noted, failed to examine the socio-demographic composition of communities at the time facilities were sited. Been acknowledged the correlation between race and environmental risk discovered by the two studies, but suggested market forces and migratory patterns may have caused this uneven distribution. For example, negative externalities associated with hazardous facilities often significantly alter property values (Karaouni 1997)[6], decreasing the desirability of homes in the host community for upper-income households, "pushing" them to leave for cleaner neighborhoods, and "pulling" low-income, disproportionately minority households to the environmental nuisance. Such market coordination produces disparate outcomes by race and income, but is legally permissible in liberal societies where geographic mobility and residential choices are not centrally coordinated.

To test the market forces hypothesis, Been gathered census tract-level data on population and housing characteristics from the US Census Bureau for 1970, 1980, and 1990. Because census tract boundaries change from decade to decade in response to population growth and patterns of migration, Been reconciled tract boundaries across decades to guarantee appropriateness of comparisons. Been compared the socio-demographic composition of host neighborhoods to counties, metropolitan areas and states, before and after the placement of the locally undesirable land use (LULU). Been's study produced mixed results. For the GAO study, the market forces hypothesis was disconfirmed. Of the four sites examined by GAO, host communities at the time of placement had a significantly higher percentage African-Americans as compared to state population levels.

For Bullard's (1983) Houston study, Been found evidence of African-American in-migration as property values decreased following the LULU siting. Been arrived at this finding by making important

[6] Alia Karaouni (1997), in a nationwide study of the impact of noxious facilities on property values, discovered that homes in host neighborhoods, over a ten-year period, declined 4 percent as other comparably priced homes appreciated in value, keeping pace or acceding the rate of inflation.

corrections to Bullard's research design. She discovered that Bullard had double-counted sites, and included waste sites that were inoperative. These corrections brought the universe to 10 sites from Bullard's original 25. Of these sites, 7 were landfills, and 3 were mini-incinerators. Of the landfills examined, 4 had a percentage of African-Americans equal to or lower than the city as a whole. Of the 3 communities hosting a mini-incinerator, one was inhabited almost exclusively by whites. Bullard's snapshot in the 1980s overlooked a decades long process of neighborhood racial turnover. Been found that in less than two decades following the placement of the LULU, neighborhoods in the surrounding area had become overwhelmingly African-American, in one case increasing by 233 percent, compared to the 7 percent increase for Houston entirely. From the data, Been concluded, "considerable support [exists] for the theory that market dynamics contribute to the disproportionate burden LULU's impose on people of color and the poor" (Been 1994: 1405).

Been's study is not without flaws. Because it was limited to TSDFs in selected geographic regions and analyzed only a limited number of neighborhood characteristics, substantive findings are non-generalizable. Also, the study did not include tests of statistical significance, leaving one to wonder if her results were a function of chance rather than post-siting dynamics. Last, and perhaps most devastating to Been's argument, it is unclear if the racial changeover resulted from the undesirable land use, or a cascade of white flight from a modest increase in black in-migration.[7] These criticisms notwithstanding, Been's revision of GAO and Bullard's classic Houston study is a lesson in social scientific replication, and raised serious questions about the "price mechanism" as the possible culprit of environmental injustice.

In 1994, two national level longitudinal studies by the Social and Demographic Research Institute (SADRI) at the University of Massachusetts, Amherst (Anderson et al. 1994; Anderton et al. 1994b) were conducted. With tract level, population and housing census data from 1970, 1980, and 1990, SADRI researchers used a quasi-panel design to analyze the spatial relationship between environmental risk and neighborhood characteristics, taking statistical snapshots before and after commercial TSD facility

[7] Thomas Schelling argues that turnover in racial composition of a residential neighborhood is caused by racial intolerance and anti-black prejudice. Racial segregation is the inevitable macro level outcome of micro level variations in preferences for racial integration. Because whites generally prefer lower levels of integration than blacks, a domino dynamic arises when black families move into majority white neighborhoods. Massey and Denton (1993: 96) explain: "[W]hen a black family moves into a formerly all-white neighborhood, at least one white family's tolerance threshold is exceeded, causing it to leave. Given strong black preferences for integrated housing, this departing white family is likely to be replaced by a black family, pushing the black percentage higher and thereby exceeding some other family's tolerance limit, causing it to leave and be replaced by another black family, which violates yet another white family's preferences, causing it to exit, and so on."

operations commenced. Independent variables in logistic regression models included: percentage industrial employment, percentage black population, percentage Hispanic population, percentage of families under the official poverty line, percentage of households receiving public assistance, percentage of homes built before 1960, mean value of owner occupied homes, and percentage of males employed. No clearly articulated reasons were given for the selection of independent variables.

Results indicated no statistical support for claims of environmental inequity by race. Racial differences between host and non-host neighborhoods were insignificant statistically. Instead, TSD facilities were located predominately in working class communities, with a high percentage of neighborhood residents employed in industrial occupations. Results suggest commercial TSDF operators use a bottom-line rationality in making facility placement decisions, seeking cheap property; abundant and affordable labor supply; and proximate access to hazardous materials for profit maximization. Previous studies, Anderton et al. reasoned, arrived at different conclusions because of methodological errors, including use of zip-code measures of neighborhood instead of census tracts, causing problems of aggregation bias; and failure to include statistical controls, resulting in spurious discoveries of unequal distribution of environmental risks by race. The industrial working class, not African-Americans, is burdened disproportionately by hazardous waste, Anderton et al. concluded.

Environmental justice advocates lambasted SADRI studies as inaugurating an anti-justice, counter-assault designed to blunt movement momentum and social systemic reform. SADRI researchers were accused of bias by accepting research monies from Waste Management Incorporated and the Institute for Chemical Waste Management to conduct their studies (see Goldman 1996). Laura Pulido (1996) blamed SADRI researchers for "muddying" the debate by raising the question of economic class. The SADRI's studies stirred a classic, and somewhat tired, social scientific debate on the explanatory power of race versus class. The race versus class debate emerged, Pulido argued, as a backlash of sorts, as scholars, organizers, and political types recognized the "potentially threatening implications" of environmental justice claims to "white political hegemony and capital accumulation" (Pulido 1996: 146). Pulido (1996) and Bullard (1997), separately attacked SADRI researchers for adherence to methodological rigor and positivist epistemology, obscuring how racism intersects with "relations of production and regimes of accumulation, to create highly oppressive circumstances" (Pulido 1996: 148), and for implicitly denying the racist nature of American society by attributing environmental inequities to the class hierarchy and a cool business rationality. Statistical studies, environmental justice advocates insist, cannot separate class and race effects cleanly because all factors of life, the social division of labor, poverty, and class inequities are thoroughly racialized. Therefore, such studies are designed to derail claims of environmental racism with the specter of scientific uncertainty, not to deepen our understanding of the mechanisms of environmental risk distribution (see Morello-Frosch, Pastor, Sadd 2001).

Such critics are right to raise questions about sources of funding and scholarly integrity since countless empirical studies have demonstrated "funding effects" on method selection, theoretical slant, and interpretation of findings.[8] Still, dodging important, and widely accepted analytical distinctions between race and class, and attributing the worst intentions to researchers for raising a diachronic question is counter-productive. Also, dismissal of a whole line of argumentation on epistemological grounds is too convenient and intellectually disabling. Instead, one can critique the SADRI studies methodologically. Both studies failed to reconcile tract geography from decade to decade, violating basic rules of historical comparison. Both studies failed to account for changing definitions of race as measured by the US Census Bureau, invalidating racial comparisons over time. SADRI researchers wrongly assumed census tracts are superior to zip code units of analysis as measures of community – each possessing certain advantages and disadvantages (see Liu 2001). Lastly, both studies rely on occupational data to estimate neighborhood industrial activity, assuming wrongly that laborers reside and work in the same neighborhood,[9] to advance a clumsily operationalized business rationality thesis.

Such flaws raise questions about the validity of findings, but I agree generally with Bowen's (2001: 165) characterization of these studies as: "... systematic, controlled, empirical, and critical investigations of the spatial relationship between environmental hazards and the locations of minority and low-income neighborhoods." One can disagree sensibly with the theoretical thrust of their data interpretation, and identify methodological flaws that undermine the validity of their findings, but SADRI researchers must be commended for elevating the environmental justice debate by "bringing in" a regard for technical precision in evaluation of truth claims.

[8] Knowing funding effects exist, scientific (i.e., Nature) and medical journals (i.e., Journal of the American Medical Association) have adopted strict financial disclosure guidelines as a powerful disinfectant against researcher bias.

[9] On this issue, SADRI researchers ought to have known better. According to US census data, the average commute from home to work was 22.4 minutes in 1990. This figure rose 13.8 percent to 25.5 minutes in 2000. In major metropolitan areas like New York, Atlanta and Chicago, the average commute to work is 35 minutes. Average commute data are drawn from responses to the "long form" version of the 2000 and 1990 Censuses, and are arithmetic means for workers who do not work at home.

In 1995, Eric J. Kreig (1995) examined the distribution of toxic waste sites, and toxic waste facilities in the greater Boston area, including Boston itself, and 43 neighboring municipalities. Kreig refers to his study as a historical analysis of the political economy of place, which he distinguishes from spatial-temporal analyses of disposal facilities. Greater Boston's unique history of simultaneous industrial and suburban development, and substantial ethnic/racial diversity, "allows for a reliable empirical analysis of race and class associations with waste sites" (Kreig 1995: 3). Kreig's study is cross-sectional, but analytically longitudinal by his division of cases into time-based categories. Kreig divides greater Boston into two categories: 1) Boston, consisting of 19 historically industrialized towns; and 2) Region 128, consisting of 25 newly industrialized towns. Of the 171 waste sites examined, 100 appear in region 128, and 71 in the Boston area.

Descriptive data and inferential statistics suggest that minority and low-income groups are concentrated in older industrialized areas, with the race variable accounting for 53 percent of siting variance. Kreig's inflated partial correlation is likely a function of aggregation bias (i.e., the unit of geography was the town), and a small universe of 44 cases. This study is of minimal empirical importance because of very serious methodological flaws, but raises important theoretical questions by linking the distribution of hazards to historical patterns of industrialization, suburbanization, and residential segregation by income and race.

In 1996, Tracy Yandle and Dudley Burton (1996) analyzed hazardous waste landfill siting patterns in metropolitan Texas. Data were drawn from the Environmental Protection Agency and the Texas Natural Resource Conservation Commission (TNRCC). Landfills located in rural areas, landfills sited before 1944, and landfills for which census-tract level data was unavailable were excluded from the study. These parameters yielded a universe of 72 historic sites, and 69 currently operational sites. Demographic data were obtained from the census period closest in time to the date of facility placement, and from the 1990 census to trace demographic shifts. To measure the effects of race and income, Yandle and Burton used a quartile ranking method. This method is commonly used for studying series data that are unevenly distributed. Both host and non-host communities were divided into relatively evenly sized quartiles, and chi-square tests of statistical independence were conducted. Comparisons on racial and income characteristics revealed no racial inequity, with hazardous waste landfills more likely to be sited in white, working class communities. The authors also discovered significant demographic turnover in host communities. By 1990, host communities had become predominantly African-American and disproportionately poor.

Yandle and Burton's study has been harshly, but justifiably criticized (see Anderton 1996; Mohai 1996) on methodological grounds for model under-specification; using non-reconciled units of analysis, neglecting changes to tract and metropolitan area delineations[10]; failure to conduct controlled comparisons; inadequate defense of unit selection; and use of suspect statistical techniques. Despite these criticisms, this study is generally acknowledged as ventilating the environmental justice debate (Bowen 2001).

The first national, tract-level study, using reconciled US Census data from 1970, 1980, and 1990, was conducted by SADRI researchers, John Michael Oakes, Douglas Anderton, and Andy Anderson in 1996. Oakes et al. examined the distribution of 476 commercial TSDFs operating in 1992. Data were obtained from two sources, supplemented by a telephone survey to determine the time facility operations began: 1) the Resource Conservation and Recovery Information System (RCRIS) and 2) the Environmental Institute's (EI) Environmental Services Directory (EDI). Oakes et al. examined an array of community characteristics, before and after facility siting, including: percentage African American, percentage Hispanic, percentage of families below or at the poverty level, percentage of households on public assistance, percentage of males in the civilian labor force, percentage employed in industrial and manufacturing occupations, percentage unemployed, mean value of housing stock, and total neighborhood population. Results from "before and after" t-tests, and logistic regression models indicated commercial TSDFs were located primarily in disproportionately white, working class, and industrialized communities. Oakes et al. (1996) found no evidence of bias siting by race, or a pattern of minority move-in exceeding the pattern for areas of similar industrial activity. In their words: "[The study found] no support for claims of stark national patterns of systematic bias in the siting of commercial TSDFs" (Oakes et al. 1996: 146). The discriminatory siting and minority move-in hypotheses were not supported.

The main accomplishment of this SADRI study is methodological. Oakes et al. partially solved the national census tract incompatibility problem by conducting a 4-group stratified random sample of all non-host tracts within 1, 2, 3, and above 3 miles from the nearest host tract. These tracts, and all TSDF tracts were tediously spilt, merged, and slightly adjusted to correspond with tracts of previous censuses until all tract boundaries were similar across decades. Such attention to methodological detail increases reliability of measurement, but may decrease the validity of results.

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[10] The US Census Bureau estimates approximately 18 percent of all census tracts changed borders significantly from 1970 and 1980, and around 21 percent of all tracts changed from 1980 to 1990 (Been and Gupta 1997).

The relationship between validity and reliability is a complex matter to be left to philosophers of science, but it is generally recognized that a trade-off exists between the two, with attempts to increase one, diminishing the other. SADRI researchers have been criticized of measurement fetishism, failing to balance this tension between reliability and validity. Their study is high on reliability, but possibly invalid because of strict and questionable measurement criteria. For example, their definition of non-host (unaffected) tracts includes tracts within relatively short distances of commercial facilities. Hedonic price studies on property values before and after facility siting reveal that the "collateral damage" to surrounding homes extends for miles beyond the facility.[11] Such misunderstanding of the "effects of proximity" invalidates their controlled comparisons. Their discovery of non-difference is a logical outcome of comparing like objects.

Other problems exist. Because the US Census Bureau only tracted localities inside Standard Metropolitan Statistical Areas (SMSA)[12] in 1970 and 1980, the stratified sample conducted by the authors had an urban bias, confounding the relationship between race and siting decisions. What conclusions about environmental risk can one draw from studying such a methodologically circumscribed universe? Like other researchers, Oakes et al. also failed to account for changing racial categories, nullifying racial comparisons over time.

Three years after raising the longitudinal/market forces question, Vicki Been, with graduate student Francis Gupta (1997), examined the location of 554 commercial TSDFs operating in the continental United States in 1994. Been and Gupta painstakingly complied their list of facilities by cross-referencing several sources: 1) EPA's RCRIS; 2) the 1994 ESD; and 3) thousands of telephone calls to trade organizations and regulatory authorities. Been and Gupta opted for the census tract as their unit of analysis. They provide a series of sensible justifications for this decision, including data availability, the relative stability of tract boundaries over time, the general conformity of tract boundaries to physical boundaries like transportation

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[11] Hedonic price studies consistently indicate that zones of negative impact extend for up to two miles around a noxious facility. The distance function is non-linear, with acutely negative price effects within a quarter mile of the facility. Studies indicate that negative price effects disappear between 2.25 and 6.19 miles of the hazardous facility (Liu 2001: 78-80).

[12] A metropolitan area is an agglomeration of socially and economically integrated residences and commercial districts that intersect the boundaries of central cities, counties, and suburbs. The Census Bureau's definition reads: "A large population nucleus, together with adjacent communities which have a high degree of economic and social integration." Each SMSA has "one or more central counties containing the area's main population concentration: an urbanized area with at least 50,000 in habitants [and] . . . outlying counties which have close economic and social relationships with central counties, . . . a specified level of commuting to the central counties; and . . . also meet certain standards regarding metropolitan density, urban population, and population growth" (US Department of Commerce, 1980 Census of the Population, General Social and Economic Characteristics 1983: 2).

networks and waterways, and the cost prohibitions of applying superior Geographic Information System (GIS) technologies to three decennial censuses.

To validly analyze neighborhood demographic change over time, Been and Gupta laboriously fixed the tract boundaries of every "host community" from decade to decade using tract comparability tables. For non-host tracts, they randomly drew five one-percent samples for each decade and similarly reconciled these tracts by hand. Again, because rural areas and communities outside SMSAs were not covered by the 1970 and 1980 censuses, many facilities were omitted from the study, giving it an urban bias. Such a bias may contaminate the actual relationship between race and population density with facility location.

Been and Gupta conducted various statistical analyses for host and non-host tracts, including: 1) measures of centrality; 2) comparisons of means for theoretically relevant variables; 3) logistic estimations to control variable correlations; 4) and longitudinal comparisons using logistic regression coefficients. Results suggest that environmental health risks are concentrated in communities with higher percentages of poverty, unemployment, and blue-collar laborers, with strikingly lower median housing values, and modestly lower family incomes. On the variables of race and ethnicity, Been and Gupta (1997: 19) conclude: "Our analysis finds no substantial evidence that the siting process was systematically flawed as to African-Americans during any of the three decades at issue. There is stronger evidence that the percentage of Hispanics in a tract was correlated with the probability that the tract was chosen to host a facility." Results from t-tests validate this assertion, but Logit estimations behave differently. In both 1970 and 1990, percentage African-American was positively and significantly related to facility presence at the 90 and 99 percent confidence levels respectively. Such inconsistency across statistical tests raises questions. Did the authors violate logistic regression test assumptions? Or more serious, did they deliberately downplay certain findings in favor of others? Whatever questions one may have, data presented in the study are too ambiguous and incomplete to draw any conclusions. For example, Been and Gupta provide averages for community characteristics, but do not provide measures dispersion, nor do they provide residuals of their analyses. The study falls short on other grounds. Like others, Been and Gupta failed to account for racial formation, undercounted the number TSDFs, and inadequately connected indicators to theories. For all its careful methodology and organization, the study's findings, in Bowen's (2001: 161) words "are not believable."

In 2001, Manuel Pastor, Jim Sadd, and John Hipp published a nicely designed longitudinal study of environmental health risks in Los Angeles County. The study tackles a central issue in the environmental justice literature: what came first, the toxic facility or the minority group? The study is conceptually weaves notions of community efficacy, housing discrimination, market coordination, ethnic migration and racial churning. Methodologically, the authors use GIS technology and a circular buffer method to pinpoint affected tracts, including adjacent residential populations, instead of simply tagging facilities to single tracts. Statistically, Pastor et al introduce a "simultaneous two-stage least squares model" to estimate the entangled effects of minority move-in and disproportionate siting practices.

The authors match data from 1970, 1980, and 1990 US censuses with EPA data on high capacity[13] TSDFs. Statistical models included the following variables: percentage minority, percentage African-American, percentage Latino, household income, home value, median rent, percentage college educated, percentage single family housing, population density, percentage blue-collar workers, and percentage manufacturing employment. Results suggest TSDFs are concentrated in predominately poor and minority communities. This pattern obtains for all decades examined. In their words (Pastor et al 2001: 19): "Demographics reflecting political weakness – including a higher presence of minorities, a lower presence of home owners, or significant degree of ethnic churning – seem to be the real attractors of TSDFs." Pastor et al find no evidence for the minority move-in hypothesis, discovering that ethnic churning and white avoidance of minority neighbors, not price signals and property devaluations from TSDF siting, determine residential patterns.

Like other longitudinal studies, the authors failed to address changing government definitions and measures of race. This compromises their findings. The focus on Los Angeles County renders their study non-generalizable. The authors provide no theoretical justification for usage of ¼ mile and 1 mile impact zones. Also, their regression models perform terribly, explaining between two and six percent of the variation in TSDF site selection using population characteristics. This model under-specification is not addressed. Last, the conclusion does not follow from the evidence. Pastor et al talk about political weakness and social capital as determinants of residential organization and environmental injustice, but do not measure or address these concepts in statistical models. They conflate both terms with community demography and economics. Social capital may be reflected in economic measures, but not necessarily. Social capital is a measure of community trust, reciprocity, and cohesion. It is reflected in norms of cooperation. It is conceptually incorrect to assume that minority or income status equals low social capital

[13] High capacity TSDFs, Pastor et al correctly note, process nearly all the hazardous waste stream in the United States. Facilities are classified as high capacity if they handle more than 50 tons of hazards annually. In fact, the hazardous waste industry is evolving into an oligopoly, with large, self-regulating, and publicly traded corporations controlling the trade in hazardous substances (Freeman 1989).

and political weakness. One must measure these phenomena, not assume their presence or absence from demographic indicators.

Summary of the Evidence

What conclusions can be drawn for this heterogeneous body of empirical research? On the question of race and environmental risk, a majority of studies hint (25 of 32), but do not demonstrate conclusively, that African-American and Hispanic communities are exposed disproportionately to TSD installations. The same may be said of economic class, and other measures of community organization (see Table 2.2). TSD installations seem to locate in working class communities with residents concentrated in industrial occupations (11 of 32 studies). The profit motive and post-siting dynamics have equally modest explanatory power. Studies hint that TSD operators are utility maximizing actors, siting installations in areas with affordable land and access to hazardous materials for processing. Contrary to popular opinion, population, housing, post-siting, and economic variables predict a small percentage of variation in siting of TSD installations. There does not appear any consistent, statistically significant pattern of discrimination in location of hazardous facilities. To the extent that any meaningful patterns of environmental inequity are discernible from the studies examined, they occur sub-nationally. I venture this claim*: In some areas, in some instances, some disadvantaged population group resides closer to some environmental hazard*. Why such a boring statement about the literature? Why not venture something bolder?

The literature is in its infancy. With few exceptions, it is methodologically below average, and conceptually underdeveloped. Concepts are poorly measured, the range of hypotheses limited, analytic possibilities tapered by researcher lethargy and bias, the unavailability of reliable and sufficiently clean data, a general failure among researchers to recognize the difference between cross-sectional correlation and causation, and a strong tendency to overstate the relevance of results. Most destructive to the literature's evolution is the ideological puffery and stakeholder intransigence. No reasonable proposal tied to scientifically valid statements about environmental justice has emerged. In short, our state of knowledge is uncertain. In Bowen's (2001: 184) words: "Until the research needed to sufficiently reduce this uncertainty is completed, whether or to what extent minorities, low-income, and otherwise disadvantaged and susceptible populations disproportionately experience exposure to environmental hazards, and therefore face greater health problems, is a question that will remain largely unanswered." The flaws identified in this literature review are correctable.

TABLE 2.2: SUMMARY OF ENVIRONMENTAL EQUITY STUDIES EXAMINING THE DISTRIBUTION OF TREATMENT, STORAGE, AND DISPOSAL FACILITIES

Author (s)	Universe	Unit of Analysis	Analytic Methods	Race Inequity	Class Inequity	Market Forces	Other Factors
Anderton, Anderson, Oakes, Fraser, Weber, and Calabrese (1994)	National 25 Largest SMA	Census Tract	Cross-sectional	Yes Hispanic	No	Yes Industrial Labor Housing Value Male Employment	Yr. House Built
Anderton, Anderson, Oakes, and Fraser (1994)	National 25 Largest SMA	Census Tract	Cross-sectional	Yes Hispanic	Yes	Yes Industrial Labor Housing Value	*
Anderson, Anderton, and Oakes (1994)	National	Census Tract	Cross-sectional Longitudinal	No	Yes	Yes Industrial Labor Male Employment	*
Baden and Coursey (2002)	Chicago	Census Tract	Cross-sectional Longitudinal	Yes Hispanic	Yes	Yes Transport access	Density Water proximity
Been (1994)	Houston, TX EPA Region IV	Census Tract	Cross-sectional Longitudinal	No/Yes African-American	Yes	Yes Pop. In-migration	*
Been (1995)	National	Census Tract	Cross-sectional	Yes African-American Hispanic	Yes	Yes Housing value Industrial labor Unemployment	*
Been and Gupta (1997)	National	Census Tract	Cross-sectional Longitudinal	Yes Hispanic	Yes	Yes Industrial labor	Pop. Density

TABLE 2.2: CONTINUED

Author (s)	Universe	Unit of Analysis	Analytic Methods	Race Inequity	Class Inequity	Market Forces	Other Factors
Boer, Pastor, Sadd, and Snyder (1997)	Los Angeles County	Census Tract	Cross-sectional	Yes African-American Hispanic	Yes	Yes Industrial Labor	Zoning
Bowman and Crews-Meyer (1997)	EPA Region IV	County	Cross-sectional	No	No	*	Population size
Bullard (1990)	Houston, TX West Dallas, TX Institute, WV Alsen, LA, Emelle, AL	Neighborhood County	Case Study Cross-Tabulation Survey	Yes African-American	Yes	Yes	Politics
Bullard (1983)	Houston, TX	Census Tract and Census Block	Case Study Cross-Tabulation	Yes African-American	*	*	Politics
Clarke and Gerlak (1998)	Southern Arizona	GIS-Defined	Cross-sectional Survey	Yes Hispanic	Yes	*	*
Cole and Foster (2001)	Chester, PA	Neighborhood	Case Study	Yes African-American	Yes	Yes	Politics
Collin and Harris (1993)	King-Queen, VA Halifax, VA	County	Case Study	Yes African-American	Yes	*	Politics
Davidson and Anderton (2000)	National	Census Tract	Cross-sectional	No	Yes	Yes Industrial Labor Male Employment Housing Value	Education

TABLE 2.2: CONTINUED

Author (s)	Universe	Unit of Analysis	Analytic Methods	Race Inequity	Class Inequity	Market Forces	Other Factors
General Accounting Office (1983)	EPA Region IV	Zip Code	Cross-Tabulation Correlation	Yes African-American	Yes	*	*
Goetz and Kemlage (1996)	National	County	Cross-sectional	Yes African-American Asian-American Native-American	Yes	Yes Transport access Rail access Industrial proximity	Education
Hamilton (1993)	156 Counties	County	Cross-sectional	No	Yes	*	Voter Turnout
Hamilton (1995)	Capacity Expansions	Zip Code	Cross-sectional	Yes African-American	No	No	Population size Education Voter Turnout
Hite (2000)	Franklin County, OH	Census Block	Cross-sectional Survey	Yes African-American	No	*	*
Krieg (1998)	44 Towns	Town	Cross-sectional	Yes Non-White	No	Yes Commercial Taxes	*
Kreig (1995)	Greater Boston	Town	Cross-sectional	Yes African-American	Yes	*	*
Markham and Rufa (1997)	49 Cities Pop. 100,000+	Census Tract	Cross-sectional	No	No	No	Education
Maher (1998)	Indiana	County	Cross-sectional	Yes African-American Hispanic	No	No	*

TABLE 2.2: CONTINUED

Author (s)	Universe	Unit of Analysis	Analytic Methods	Race Inequity	Class Inequity	Market Forces	Other Factors
Mohai and Bryant (1992)	Detroit Area, MI	Neighborhood (concentric)	Cross-sectional Survey	Yes African-American	Yes	*	*
Oakes, Anderton, and Anderson (1996)	National	Census Tract	Cross-sectional Longitudinal	No	Yes	Yes Industrial Labor Male Employment Housing Value	*
Pastor, Sadd, and Hipp (2001)	Los Angeles County	Census Tract Circular buffers	Cross-sectional Longitudinal	Yes Hispanic African-American	Yes	Yes Industrial Labor	*
Ringquist (2000)	Chicago, IL Kettleman, CA St. Regis, NY	Neighborhood Reservation	Case Study	Yes African-American Hispanic Native-Indian	Yes	*	*
UCC, Commission of Racial Justice (1987)	National	Zip Code	Cross-sectional	Yes African-American	Yes	*	*
Warriner, McSpurren, and Nabalamba (2001)	Detroit, MI Toronto, ON Kitchener, ON Elmira, ON	Neighborhood County	Case Study	Yes African-American	Yes	Yes	Politics
White (1992)	Baton Rouge, LA	Community	Cross-tabulation	Yes African-American	*	*	*
Yandle and Burton (1996)	Texas	Census Tract	Cross-sectional Longitudinal	No	Yes	Yes Industrial-labor	*

Chapter III: Hypotheses, Data Sources and Variable Operations

Introduction

The research design is a framework for investigation. Decisions are made on the unit of analysis, what data to collect, variables to observe, control and measure, and appropriate statistical tests to solve research problems. Decisions are guided by analytic economy. The following research design elements are discussed: hypotheses, variable operations and definition statements, data sources, logic of unit selection, object of study, and statistical methods.

Theories and Hypotheses of TSDF Location

Empirically driven environmental justice researchers are concerned with two questions: *where is hazardous waste treated, stored, and disposed of, and why?* The first question is descriptive and easy to answer. It involves gathering data from various governmental and non-governmental sources on TSD facility type, location, and date operations commenced. The second question is analytical and significantly more difficult. It requires not only a careful reading of the scientific literature for theoretical tips, but an interdisciplinary adventure into public health, environmental science, political economy, economic geography and environmental sociology. All these disciplines provide unique insight into how and why land, labor, and capital is used. Because management of hazardous waste is a risky enterprise, with potentially catastrophic consequences for persons involved directly in facility operations, persons residing near the facility, and persons governing the facility permit process, the decision about where to place such a TSD facility is full of stakeholders with contradictory claims and interests. Understanding this fundamental point about competing stakeholders is the first step to unraveling the regional patterning of environmental health risks.

In mapping the spatial distribution of commercial TSD installations, environmental justice researchers notoriously reduce the number of stakeholders to two parties - facility operators and targeted communities – and oversimplify the motives and capacities of each player (for alternative see Cable, Hastings, and Mix. 2002). As the review of literature shows, TSDF operators are assumed as negligent, racially discriminatory, and imperialist in their pursuit of low-income minority communities to site operations. Targeted communities are uniformly characterized as dreadfully poor and politically marginalized, but valiant and dignified in their resistance (see Bullard 1994, *Unequal Protection*). This recurrent and slightly embellished story of big versus small captures an important fault line in how siting decisions unfold, and explains a modest level of variation in siting outcomes. Most of the empirical literature is underwritten by this underdog story. To advance the empirical literature on TSDF site selection, one must account for the totality of actors, estimate and measure their interests, and treat outcomes as the balance sheet of power. By accounting for all stakeholders, and objectively distilling their discourses to measurable phenomena, may one deal reasonably the question of equity, and devise policy that properly balances the interests of all parties to guarantee fair and just outcomes in the future.

With this in mind, this dissertation examines four hypotheses linked to four separate discourses on commercial TSD installation locations: 1) economic rationality; 2) scientific rationality; 3) neighborhood social capital; and 4) race and class inequity. What follows is a brief discussion of each discourse, and a distillation each story into a testable statement on TSDF siting. At the end of the theoretical discussion, variable operations are clearly delineated and a diagrammatic model of the argument is presented.

Economic Rationality Hypothesis

The management of hazardous substances in the United States is a commercial enterprise. The decision on where to locate an environmentally risky enterprise is admittedly more complicated bureaucratically than finding a place for a convenience store, it is none the less governed by a business rationality. Economic success in business decision-making is partially a function of location. The question of location is intriguing because it empirically saddles microeconomic action and macroeconomic circumstances. Inappropriate location is costly for freight bills, unavailability of affordable and sufficiently skilled labor, time lost by traffic congestion, complicated access to input commodities for production, or difficulty in reacting to market vagaries. The perils of poor location haunt the entrepreneurial spirit and undermine the productivity of labor and capital in the economy. From a purely economic standpoint, TSDF operators, like all economic actors, must utility maximize or perish.

In 1909, Alfred Weber (1929), the lesser-known brother of Max Weber, articulated a simple, but elegant theory of industrial location: *to optimize the value of a location decision, capital must minimize transport and production costs.* Transport costs are a curvilinear function of distance traveled. Transport costs flatten with increasing economies of scale, but the distance function is a powerful constraint. TSDF operators must calculate loading, carrier, journey and unloading costs to figure the variable of transport. Material inputs with lower transport costs per unit of weight and distance pull TSDF operators. More specific, commercial treatment, storage, and disposal facilities are more likely to locate to areas with hazardous waste generators to reduce transport costs and risks associated with hazardous waste transport.

To minimize costs, TSDF operators must fully consider the characteristics of place, with labor cost being the most important. Despite the increasing mobility of labor, it is an immobile input because the cost of labor varies by location. Labor cost is a function of location specific variables like housing and living expenses, and levels of labor competition, unemployment, unionization, occupational structure, and human capital. Low-wage locations pull TSDF operations, all else equal. In Weber's cost reduction theory, low-wage locations that are proximate and connected to manufacturing inputs are more enticing.[1] To estimate the cost and availability of appropriately skilled labor, industrial and technical-managerial labor rates are created. To estimate the cost of productive property, aggregate housing and rental prices are evaluated, as well as the percentage of housing units built before 1960 and 1970. To estimate proximate access to manufacturing inputs and transport costs, the number of Large Quantity Generators of hazardous waste in a delimited area is counted. With all this in mind, the following hypothesis is proposed:

Hypothesis I: TSDF location is driven by cost minimization. TSDF operators locate to areas with appropriately skilled labor, and low property and transport costs.

Scientific Rationality Hypothesis

The treatment, storage, and disposal of hazardous waste are technical and scientific enterprises. Such facilities include acid neutralization laboratories, biological treatment units, and long-term storage areas like landfills and incinerators. TSD installations are brilliantly engineered to handle hydrocarbons, insecticides, fungicides, soil fumigants, primary explosives, industrial intermediates, polychlorinated biphenyls, and metals and inorganic non-metals. These facilities regularly absorb 250 million tons of

[1] Weber's cost reduction theory has been extended to include other location specific costs like property prices, municipal taxes, public utility services and fees, and the effects of agglomeration. Agglomeration effects are difficult to measure and estimate. Benefits accrue from proximity to similar businesses. Companies can share specialized infrastructure and a skilled labor pool, and collectively bargain for municipal, state, and federal dollars.

hazardous waste annually (see Table 1.1), and serious accidents occur rarely. Technical requirements for landfills and incinerators have successfully reduced risk of catastrophic failure to random error (Watts 1998). According to William Bowen (2001), environmental justice researchers exaggerate the risks involved, and are generally poorly informed of the scientific complexity of TSDF activities. TSD installations are without question the most stringently regulated commercial enterprises in the country. The Resource Conservation and Recover Act on hazardous waste management is, itself, gigantic and menacingly complex. Permit applications regularly exceed 2000 pages in length, roughly 20 doctoral dissertations in size.

Just as there are strict rules on facility operations, the EPA has delineated technical criteria for commercial TSD installation location. A potential site must be environmentally sound. Environmental factors include topography and land contouring, surface soils and subsurface geology, hydrology and subsurface water characteristics. The EPA's publication on *Sensitive Environments and the Siting of Hazardous Waste Management Facilities* (2002) strongly discourages the placement of TSD installations in floodplains, wetlands and other productive ecosystems, earthquake zones, areas with unfavorable weather conditions, high-value groundwater areas, and on unstable terrains like limestone, gypsum, and dolomite. The purpose of site selection restrictions is to reduce the risk of contaminant migration and toxic exposure to human beings and the environment.

In 20 years of environmental justice research on TSDF location outcomes, hydrologic and geologic factors have never been empirically examined, yet scientists, engineers and EPA officials insist adamantly these factors matter. The geological and hydrological characteristics must be understood to optimize suitability of intended land uses, all things equal. To estimate the geological suitability of a site, earthquake hazard data are collected. The seismology measure of peak ground acceleration (PGA) is used. PGA is expressed as a 10 percent probability of occurring in 50 years. Each census tract in the Southeastern United States is assigned a PGA figure.

To estimate the hydrological suitability of a site, hydrologic data are assembled from the US Geological Survey. The hydrology measure is less precise. Because census tract data and hydrologic data are collected at different levels of analysis, some mathematical manipulation is required. To measure the hydrological soundness of an area, the percentage of a Hydrologic Unit Code (HUC) encased in a census tract, weighted by the size of the land area (square km) is used. Two other measures are used to estimate physical suitability: land and water areas in square kilometers. Thus, the following testable hypothesis is proposed:

Hypothesis II: TSDF location outcomes are driven by scientific criteria. TSDF operators locate to areas with suitable geological and hydrological features.

SOCIAL CAPITAL HYPOTHESES

The social world is ordered by capital. Its volume, distribution, and accessibility shape social relationships and the nature of social hierarchies. Capital has been defined historically by its economic function as an input commodity or financial asset in the production, consumption, and exchange activities of individuals and firms (Castle 2002). Recently, social scientists have shown strong interest in non-economic forms of capital. Non-economic forms of capital have been discovered at the individual and group levels of analysis (Coleman 1988; Putnam 2000), as well as linkages between non-economic forms of capital and socially important outcomes like rates of democratic participation, crime and juvenile delinquency, health and life expectancy, and educational attainment. The most popular of these new forms of non-economic capital is social capital.

Social capital consists in networks of social relations characterized by norms of trust, reciprocity, and morality that create expectations for predictable behavior (Putnam 2000). According to James Coleman (1990), social capital "inheres in the structure of social relations between persons and among persons." Social capital enables social order. It functions as a bonding agent that enables groups of people to cooperate for mutual benefit and solve problems they share commonly. In practical terms, social capital can be understood as an intangible resource for collective action. Researchers locate social capital in civil society. It is reflected in voluntary associations and nonprofit organizations.

The presence of voluntary association and non-profit organizations is associated with healthy democracy, and their absence symptomatic of autocracy and centralized power. Conservative political philosophers like Edmund Burke and Alexis de Tocqueville argued that voluntary associations function as linchpins between government and the individual. A civil society of many organizations with sufficient resources to participate effectively in public debate could buffer systemic tendencies toward state totalitarianism, tyrannical majority rule, and grandiose schemes to engineer the human condition. Liberal philosophers like John Locke railed against the notion of absolute government sovereignty for the maintenance of social order. Order, rationality, and morality, Locke and Rousseau reasoned, could spring from civil society in a social contract based in cooperation, mutual protection and peace. The radical philosophers Antonio Gramsci and Jurgen Habermas had similarly strong views of civil society and voluntary associations. Gramsci viewed civil society as a terrain of conflict between voluntary associations for the intellectual and moral levers of society. Voluntary associations, Gramsci argued, anchor a society's culture, produce accounts of the world that define what is politically thinkable, and provide the crucial link between structure and agency in the creation of social order. For Habermas, civil society is the site of public deliberation and nourishment of the human life-world. Voluntary associations, Habermas insisted, protect the life-world from the onrush of systemic power.

Whatever the political philosophy, voluntary associations and non-profit organizations are normatively desirable. They provide social order and smoothen social interaction. They provide group members a sense of purpose and help crystallize identity. Voluntary associations teach trust and cooperation for mutual benefit. They are proximal indicators of social capital (Putnam 2000). All things equal, the more organizations one finds in a delimited area, the greater the level of social capital, and the greater the likelihood population groups of that area can work together for common ends.

What do voluntary associations and non-profit organizations have to do with the regional patterning of environmental health risks? Environmental justice researchers know that population groups vary in their capacity to resist the placement of a hazardous facility in their neighborhood (see Hamilton 1993; 1995). Hazardous facilities are undesirable land uses. People oppose the siting of a TSDF in their neighborhood because they assume costs and risks are too high relative to the benefits. Public opposition to TSDF siting is so great it is given the status of a public malady – the NIMBY (Not-in-my-backyard) Syndrome (Dunlap and Mertig 1992). The NIMBY Syndrome is an example of citizens exercising their constitutional right to participate in governmental decisions, leading to a perversion of justice and equity in distribution of hazardous facilities by race and economic class. Because TSDFs are generally locally unwanted land uses, operators and regulators rationally take the path of least resistance. It is cost effective to avoid public conflict and gridlock. TSDF operators use this logic in site selection.[2] It is not the only element in decision-

[2] Environmental justice researchers discovered a secret study commissioned by the California State Waste Management Board that recommended explicitly the targeting of politically disenfranchised and socially disorganized communities for placement of trash-to-steam plants. For many it is the smoking gun - definitive proof of the siting logic of hazardous waste operators and regulators.

making, but a crucial element in the decision-making matrix. The publicly deliberate permit process engenders this logic (see Chapter V).

EJ researchers assume that TSDF operators demographically profile neighborhoods (Pulido 1996). TSDF operators presumably use a community's economic status and racial composition as indicators of a community's propensity to resist facility siting or capacity expansion. This reasoning is discriminatory because operators knowingly exploit the marginal political status of poor communities of color. Statistical models indicate purely demographic factors as modest predictors of facility siting (see Chapter II). Perhaps, EJ researchers wrongly assume demography is destiny, or forget the actions of TSDF operators are responded to by regulators and targeted communities, with outcomes a function of the dialectical interplay between these stakeholders.

To advance the scientific literature on commercial TSDF location outcomes, one must understand the layer of social life between demographic structure and behavior. Civil society is that layer. There is a correspondence between community demography and community social organization, but not always. Poor communities of color, as the EJ movement literature has discovered, can mobilize effectively to block the placement of a hazardous facility in their community. Mobilization effectiveness depends on community integration, coherence, and vitality. By measuring a neighborhood's level of social capital, one can estimate the robustness of its civil society, and its potential for organized and deliberate behavior.

To estimate resistance capacity, data on nonprofit organizations and voluntary associations are collected from the National Center for Charitable Statistics and the People of Color Environmental Groups Directory. Each census tract is assigned a social capital assets score, and a social capital rate, measured as total nonprofit organization assets divided by population size.[3] An environmental capital assets score and environmental capital rate are also calculated for each neighborhood. For this, nonprofit organizations with an environmental focus, as specified in the national taxonomy of exempt entities system, are counted. Population density, youth dependency and old dependency ratios are used - all are regarded as estimates of structural potential for social capital (Putnam 2000; Fukuyama 1995). Therefore, the following hypothesis is proposed:

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[3] The assumption of consensus arising from community social capital is justifiable. Granted, more groups may mean more conflict, but in the case of environmentally risky technologies we have uniformity of opinion. Recall, public opinion survey in Chapter I, revealed consistent and widespread opposition to the siting of a TSD installation in ones neighborhood.

Hypothesis III: TSDF location is driven by the capacity of targeted populations to resist the placement of a facility in their community. This capacity is a function of community social capital.

Racial and Class Inequity Hypothesis

As the review of empirical literature in Chapter II shows, the two most tested hypotheses focus on the uneven distribution of environmental hazards by race and socio-economic status. Very seldom is a smoking gun found revealing the rationale behind TSDF siting, but patterned outcomes suggest poor communities of color bear a disproportionate burden of negative environmental externalities.[4] The precise reason for this is conceptually underdeveloped. Some researchers explain disproportionate outcomes as flowing from race and class hierarchies. These hierarchies constrain individual opportunity and influence life chances. The stratification system influences the allocation of desirable and undesirable goods. The question of intentionality is generally unimportant. The vertical organization of society is the culprit of environmental inequality, not the people that inherit positions in the social system (see Pellow 2000). Unequal outcomes can result from institutional webbing and cumulative disadvantage, with a person or community intentionally discriminated against in one social milieu, rippling unintentionally into other domains of life.[5] This is standard sociology. This explanation of discrimination by race and socio-economic status is

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[4] The problem of negative externalities arises when goods people desire are not bought and sold as commodities because there is no market available, or the good is difficult to price. A simple example may involve loud and terribly annoying music being played by neighbor as one tries to complete a dissertation. What is the price of quiet if no functioning market is available? Minimally, two parties are involved in the price distortion – a benefactor and a loser. On the issue of environmental justice, benefactors are non-host communities. The societal benefit of proper hazardous waste management is imposed as a direct burden on host communities.

[5] According to Feagin and Feagin (1978), indirect institutional discrimination refers to current practices that have a negative impact on members of a subordinate group even though organizational rules were established with no intent to harm members of subordinate groups (i.e., the use of certain hiring practices that require educational standards that systematically handicap subordinate groups, even though they are not designed to do so). Indirect institutional discrimination occurs because of institutional overlap. Groups disadvantaged intentionally or unintentionally in one institutional domain (i.e., housing), may be disadvantaged unintentionally in another (i.e., education). It is common for a subordinate group in a formal democratic system to deal with indirect institutional discrimination, and for individuals of that subordinate group to deal with direct isolate, and small-group discrimination. The various types of discrimination are overlapping and mutually reinforcing, and occur in various community and organizational settings.

persuasive in the abstract. Life trajectories are explainable as a function of social place and inherited status, but what about the concrete thoughts and behaviors of people involved in the determination of land uses? Two attempts have been made to link thoughts and behaviors to inequitable environmental outcomes by race and social class. Both are inadequate.

First, the pure discrimination hypothesis holds that TSDF operators are motivated by racial animus, and derive utility from harming minorities (see Hamilton 1995). They target historically disadvantaged groups because of racial and class hatred. This explanation is probably wrong, but possible given America's history of white supremacy and class domination. The explanation is inconsistent with the min-max logic of economic practice. Operators use racial and class prejudice at their economic peril. The other popular explanation suggests that TSDF operators select poor communities of color because of lower anticipated liability costs. Again, the liability argument is inconsistent with business rationality. The liability argument is undermined by risk transfer insurance that all TSDF operators take. TSDF operators reduce legal exposure and risk of catastrophic financial loss by purchasing pollution liability protection, remediation cost protection, and contract default protection. Liability insurance costs vary imperceptible by community racial and class attributes.

A more likely explanation has to do with the permit process and TSDF operator avoidance of transaction and opportunity costs. Facility siting is a risky investment. Proposals are regularly rejected.[6] Commercial operators hire scientific and political consultants to navigate the regulatory thicket. Site selection must pass strict environmental guidelines. This compliance process is expensive and time consuming. Public input is required at two separate stages of the permit process. This input can derail plans. TSDF operators target poor communities of color because they are less likely to derail the process, or so it is assumed.

Another plausible explanation is that TSDF operators calculate compensation costs in siting decisions. By offering direct payments, donations, and agreeing to tonnage taxes, TSDF operators can scuffle proposal acceptance from regulators and targeted communities. To minimize these costs, operators target poor communities of color because relatively educated, white, and affluent residents presumably place higher value on environmental amenities (see Jones 1998 for refutation) .

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[6] In 1987, a national study of rejection rates conducted the New York Legislative Commission found only six of eighty-one TSDF applications were accepted. Public opposition was identified as responsible for half of proposal rejections.

These explanations are better at connecting thoughts and behavior to outcomes, but obviously ignore historical trends that residentially isolate Americans from each other on the basis of race and social class. It is not the purpose of this dissertation to explore the historical effects of racial and economic apartheid, nor explain the gradual disappearance of manufacturing jobs that helped create the American underclass, but these effects are assumed as determinative of the parameters of contemporary land use decision-making and outcomes.

Whatever the explanation for the outcome, environmental justice advocates insist strongly that uneven distribution of environmental risks must end. Federal legislation has been advanced to achieve such an end. Various measures are used to estimate the racial and socio-economic status of a community, including: educational attainment, poverty rates, percent of persons on public assistance, percent African American, percent Hispanic, percent American Indian, percent female headed households with children, percent Black female headed households, and percent housing unit under rental contract. All variables are defined in Table 3.1 and organized diagrammatically in Figure 3.1. All demographic data are derived from the US Census Bureau's population and housing data files. The following hypothesis is proposed:

Hypothesis IV: TSDFs are sited disproportionately in communities with lower than average socio-economic status, and higher than average percentages of minority residents.

WHY STUDY THE SOUTHEASTERN UNITED STATES?

The empirical target or object of analysis of this dissertation is the EPA's Region IV. Region IV encompasses the following states: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. As the annual waste stream decreased nationally, the amount of hazardous waste generated in the Southeastern United States (EPA Region IV) increased by 600+ percent from 11 million tons in 1991 to 81 million tons in 1999.

TABLE 3 .1: VARIABLE DEFINITION STATEMENTS AND HYPOTHESIZED DIRECTION OF RELATIONSHIP

Variable	Definition	Direction
Managerial Technical Labor Rate	Number of workers in managerial and technical occupations, divided by the total number laborers, as defined by the Standard Occupational Classification system, residing in the census tract area.	+
Industrial Labor Rate	Number of machine operators, assemblers, and inspectors; transportation and material moving occupations; and handlers, equipment cleaners, helpers, and laborers, divided by the total number laborers, as defined by the Standard Occupational Classification system, residing in the census tract area.	+
Average Price of Housing	Aggregate price of specified owner-occupied housing units, divided by the total number of owner-occupied housing units in the census tract area. Price is based on the respondent's estimate the property's (house and lot, mobile home and lot, or condominium unit) market worth.	-
Gross Rental Value	Gross rent is the contract rent plus the estimated average monthly cost of utilities paid for by the renter.	-
Large Quantity Generators	Number of large quantity generators of waste per census tract area. A facility is classified as a large quantity generator if it: generates or imports greater than or equal to 1,000 kilograms (2,200 pounds) of hazardous waste in a calendar month; generates or accumulates at any time, more than 1 kilogram of acute hazardous waste in a calendar month; or more than 100 kilograms of residue, contaminated soil, waste, or other debris resulting from the clean-up of a spill of acute hazardous waste.	+
Percentage of Homes Built Before 1960	Number of housing units constructed before 1960, divided by the total number of housing units in census tract.	+
Percentage of Homes Built Before 1970	Number of housing units constructed before 1970, divided by the total number of housing units in census tract.	+
Peak Ground Acceleration	Maximum acceleration experienced by an object during the course of earthquake motion estimated for each census tract centroid. Acceleration estimates are calculated at the 10 percent probability of being exceeded in 50 years, and expressed as %g.	-
Hydrologic Proximity Land Area	Percentage of the Hydrologic Unit Code encased in the census tract, weighted by the size of the land area (square km).	-
Land Area Square Km	Total land area in square kilometers.	+
Water Area Square Km	Total water area in square kilometers.	-

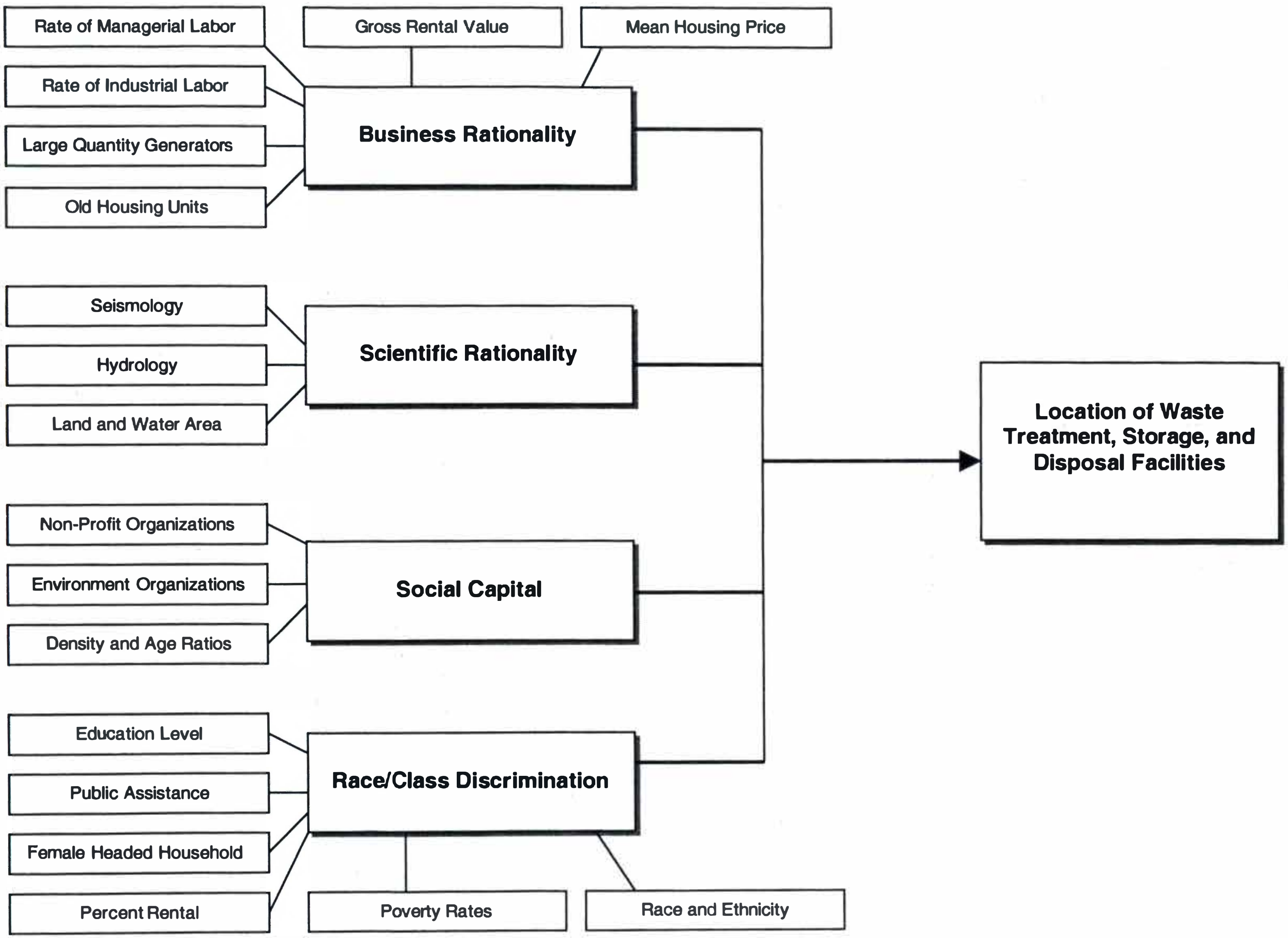
TABLE 3.1: CONTINUED

Variable	Definition	Direction
Social Capital Assets	Total assets of all non-profit organizations as inventoried by the National Center of Charitable Statistics in a census tract area.	-
Social Capital Rate	Total assets of non-profit organizations as inventoried by the National Center of Charitable Statistics in a census tract area, divided by the total number of persons in a census tract area.	-
Environmental Capital Assets	Total assets of non-profit organizations with a specified environmental focus in a census tract area as inventoried by the National Center of Charitable Statistics	-
Environmental Capital Rate	Total assets of non-profit organizations with a specified environmental focus in a census tract area as inventoried by the National Center of Charitable Statistics, divided by the total number of persons residing in the census tract area.	-
Population Density	Number of persons per square kilometer, calculated by the total number of persons residing in the census tract area, divided by the total land area (square km).	-
Youth Dependency Ratio	The ratio of the number of young persons of an age (under 15) when they are generally economically inactive, to the number of persons of working age (15 to 64).	+
Old Dependency Ratio	The ratio of the number of elderly persons of an age (over 65) when they are generally economically inactive, to the number of persons of working age (15 to 64).	-
Percent Hispanic	Number of persons identifying themselves as Mexican, Puerto Rican, Cuban, or other Hispanic, divided by the total number of persons residing in the census tract area.	+
Percent Non-Hispanic White	Total number of persons identifying themselves as non-Hispanic Black divided by the total number of persons.	+
Percent Non-Hispanic Black	Total number of persons identifying themselves as non-Hispanic White divided by the total number of persons.	-
Percent American Indian	Total number of persons identifying themselves as American Indian divided by the total number of persons.	+
Percent of Families Below the Poverty Line	Total number of families with income less than 1989 poverty level ($12,675, defined by 1991 Statistical Abstract of the United States), divided by the total number of families.	+

TABLE 3.1: CONTINUED

Variable	Definition	Direction
Percent of Families at 50% Below the Poverty Line	Total number of families with income less than 50 percent the 1989 poverty level ($12,675, defined by 1991 Statistical Abstract of the United States), divided by the total number of families.	+
Percent on Public Assistance	Total households receiving public assistance income in 1989 divided by the total number of households. Public assistance income includes 1) federal and state supplementary security income payments, 2) AFDC, and 3) general assistance.	+
Percent Renter Occupied Units	Total number of renter occupied housing units, divided by the total of housing units in a census tract.	+
Percent 18 + without High School Education	Total number of persons 18 years of age and older without a high school diploma, divided by the total number of persons 18 tears of age and older.	+
Percent 18+ with 1+ Years of College Education	Total number of persons 18 years of age and older with at least one year of college education, divided by the total number of persons 18 tears of age and older.	-
Percent Female Headed Household with Children	Number of female-headed households divided by the number of households in a census tract area.	+
Total Persons	Total number of persons	-
Hazardous Waste Treatment, Storage, and Disposal Facilities	Measured dichotomously as presence or absence of a facility in a census tract area. Adjacent tracts within 1 and 1.5 miles of facility will be counted as affected tracts.	

FIGURE 3.1: MODEL OF THE DISTRIBUTION OF HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL FACILITIES IN THE SOUTHEASTERN UNITED STATES



Only Region VI, encompassing the states of Texas and Louisiana, produced more hazardous waste. The amount of waste handled and managed by EPA Region IV has increased correspondingly.[7] The Southeast has become the largest handler of waste in the United States, treating, storing, and disposing over 85 millions tons annually (see Table 3.2 and 3.3). The increasing concentration of toxic waste in the Southeast should not surprise environmental justice researchers.

Environmental justice advocates would undoubtedly note the region's high concentration of African-Americans, seemingly validating their argument that siting decisions are motivated by racial prejudice. Region IV encompasses the "Black Belt" of the United States – a socio-demographic crescent of Southeastern geography. The Black Belt is characterized by depressed quality of life, with higher than average rates of poverty and unemployment, and lower levels of educational attainment (Wimberley and Morris 1997). It has a history of racial hierarchy, residential segregation, and economic underdevelopment, with benefits and burdens accruing from the structure of white privilege. The concentration of environmental health burdens in the Black Belt is consistent with the EJ narrative of disparate risk outcomes by race and social class. Hazardous waste generators and handlers, EJ advocates would argue, have taken the path of least resistance, cynically exploiting the region's economic desperation and patterned history of quiescence and deference to economic power (Gaventa 1980).

Conversely, environmental justice skeptics would likely note the region's re-industrialization. In the last two decades, various chemical-intensive industries have located to the Southeast. Auto manufacturers in Alabama and Tennessee (i.e., BMW, Saturn, Nissan), automotive suppliers in Georgia and Kentucky (i.e., DESA International) logistics and transport industries in Mississippi (i.e., Union Pacific), computer hardware manufacturers in South Carolina and Tennessee (i.e., Dell Computers), and pharmaceutical and bioengineering industries in North Carolina and Georgia (i.e., Theragenics Corporation) have all gravitated to the Southeast. Such manufacturers note the competitive advantages: lower average hourly manufacturing wages (Bureau of Labor Statistics 2003); lower levels of private-sector unionization (Bureau

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[7] Though a very strong correlation (.973, p-value .000) exits between the amount of hazardous waste generated and the amount of hazardous waste managed at the regional level for the period of 1991 to 1999, in recent years we have witnessed a gradual increase in inter-state and inter-regional trade in hazardous waste. At the state level, Montana, New Hampshire, South Dakota and Wyoming exported all the non-aqueous waste generated in their territories. In 1999, total state-level exports exceeded 8 million tons, representing a 30 percent increase in export activity as compared to 1997 totals. At the regional level, 14.28 percent (5.7 million tons) of non-aqueous waste was exported out of region. Approximately 3.7 million tons of this waste was absorbed inter-regionally, with the difference (2 million tons) presumably transported out of country. This gradual separation of the sites of waste generation from waste management is market coordinated, with generators and handlers responding to price signals and opportunities for reduction in unit costs, leading to an absurdly rational inter-regional division of labor in dangerous substances.

Table 3.2: Total Tonnage of Hazardous Waste Handled by Environmental Protection Agency Region

	EPA Region 1	EPA Region 2	EPA Region 3	EPA Region 4	EPA Region 5	EPA Region 6	EPA Region 7	EPA Region 8	EPA Region 9	EPA Region 10
1991	390337	51033570	9105896	11847776	53068621	137423123	4009857	1440228	12308044	13809857
1993	145707	19953849	17703960	39145810	41912210	86102783	3894112	1442585	12899741	11663277
1995	193603	12325904	14964908	42394321	21068208	94461025	2325076	3142881	14295594	3096424
1997	182651	4561975	9414588	51139606	21704186	101689277	2129651	5642971	29989482	7263355
1999	70885	5114049	6852104	81838575	20106188	49831652	2981253	2508640	11430095	4143419

Table 3.3: Total Tonnage of Hazardous Waste Generated by Large Quantity Generators by Environmental Protection Agency Region

	EPA Region 1	EPA Region 2	EPA Region 3	EPA Region 4	EPA Region 5	EPA Region 6	EPA Region 7	EPA Region 8	EPA Region 9	EPA Region 10
1991	2416332	50648243	9505997	12948706	54312901	137402630	4063618	2078526	13098837	19233091
1993	1376647	20851111	18341172	38889905	43515867	97268534	3922966	3107508	14123755	17051536
1995	976616	13552560	15506970	44201147	30501562	87683092	2370374	3127590	11796670	4369946
1997	403267	12247536	9135627	63025029	30026983	109085856	1950161	2795366	10675603	7384069
1999	2926915	19272810	10177054	85235502	32764294	90964304	2384705	2546324	6868418	6332905

Source: Environmental Protection Agency's National Biennial RCRA Hazardous Waste Reports, 1991-1999.

Note: The 1997 and 1999 Biennial Reports eliminated the Process System Form that required on-site and off-site facilities to indicate the tonnage of aqueous wastes (wastewaters) generated and handled. Data are based on estimates using a simple ratio of aqueous to non-aqueous waste.

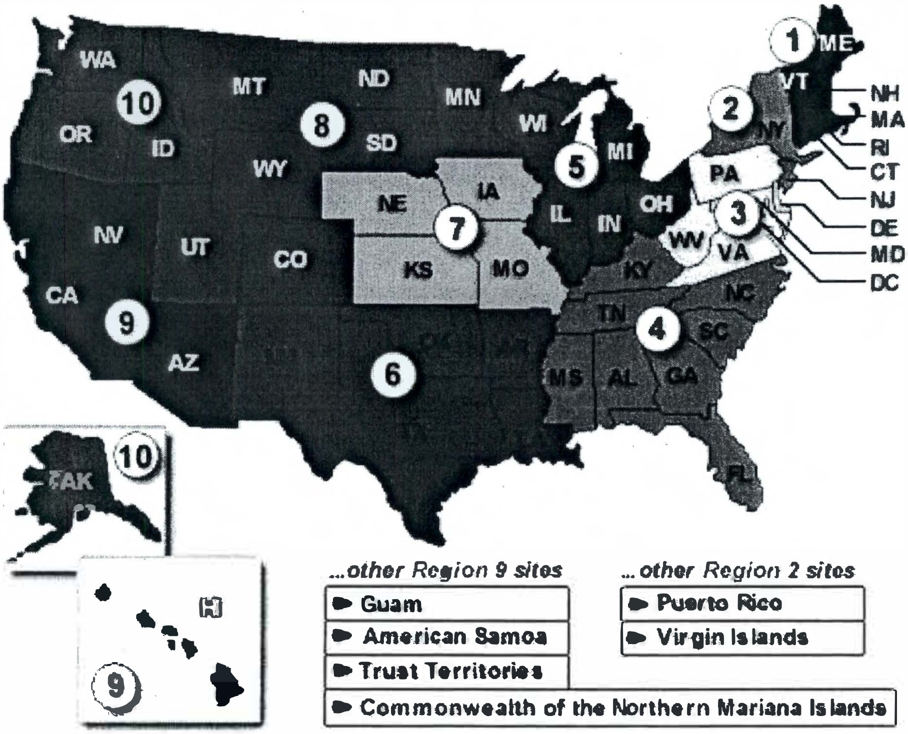
of National Affairs Inc. 2001); right-to-work labor laws; lower levels of workers compensation (Actuarial and Technical Solutions Inc. 2001), significantly cheaper industrial property for sale, lease and rental both inside and outside central business districts, and a panoply of sweeteners, from tax breaks to publicly financed inputs for production. The emergence of this "Southern industrial corridor" has brought with waste products of production, and therefore a systemic need and market opportunities for treatment, storage and disposal of hazardous waste. The high presence of racial minorities in the region, EJ skeptics would argue, is purely coincidental with re-industrialization.

Both lines of argumentation are at their logical best in the Southeastern United States, making it an excellent testing ground for the various theories of environmental risk distribution. In addition to its distinction as the nation's leading handler of dangerous substances, other factors make Region IV ideal for environmental equity research. This dissertation also divides the eight states of the Southeast into Southern and Deep South sub-regions. Sub-regional analysis may prove fruitful given emerging patterns of uneven industrial development in the South, and higher than average concentration of African-Americans in the Deep South.

Region IV (see Figure 3.2) has been studied extensively since the inception of the environmental justice movement. In 1983, the General Accounting Office produced the first government report of the relationship between population characteristics and the distribution environmental health risks. The report examined the location of off-site landfills in Region IV. Three of the four landfills examined were located in majority African-American neighborhoods, intimating a form of environmental racism. The need for a new study is obvious – the hazardous waste situation in the Southeast has changed qualitatively since the early 1980s. This scientific literature on the region provides opportunity for critical reflection and comparison.

Region IV is also the birthplace and epicenter of the environmental justice movement. The most high profile environmental justice conflicts have taken place in the Southeast. Warren County, North Carolina was the first nationally significant conflict over hazardous waste and race. Warren County is a story of corporate negligence, government ineffectiveness, and popular uprising. It is the origin story of the grassroots environmental justice movement. Warren County had all the characteristics researchers have come to associate with a vulnerable community. It was sparsely populated and rural, with no known history of political agitation; it was the poorest county in North Carolina, with a per capita income of $5,000 dollars in 1980; and 65 percent of residents were African American (Geiser and Waneck 1994: 50).

FIGURE 3.2: ENVIRONMENTAL PROTECTION AGENCY REGIONS



Region 1:	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.
Region 2:	New Jersey, New York, Puerto Rico and the U.S. Virgin Islands.
Region 3:	Delaware, Maryland, Pennsylvania, Virginia, West Virginia, and District of Columbia.
Region 4:	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.
Region 5:	Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.
Region 6:	Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.
Region 7:	Iowa, Kansas, Missouri, and Nebraska.
Region 8:	Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming.
Region 9:	Arizona, California, Hawaii, Nevada, and the territories of Guam and American Samoa.
Region 10:	Alaska, Idaho, Oregon, and Washington.

Source: Environmental Protection Agency 2003

In the fall of 1982, after months of unsuccessful political and legal struggle to block the siting of a hazardous landfill in their community, residents took to the streets in a campaign of non-cooperation and civil disobedience. Protesters from around the country, including members of the Congressional Black Caucus, joined locals to form human battlements to physically prevent the dumping of 6000 truckloads of PCB-laden soil in Warren County (Geiser and Waneck 1994: 43). Hundreds of arrests were made. The images of African American bodies dragged from the streets by armed police were painfully reminiscent of the civil rights struggle for racial equality. The event drew national attention, and led immediately to a formal government inquiry into the spatial distribution of hazardous facilities. One can reasonably assume from the Warren County case, and many others like it, that the region's people have greater literacy in matters of racial equity and environmental distress.

Data Sources and Construction of the Dataset

The data set is a match of records on operational hazardous waste treatment, storage, and disposal facilities and large quantity generators of hazardous waste from the Environmental Protection Agency, and the Social and Demographic Research Institute at the University of Massachusetts, population and housing data at the census tract level from the US Census Bureau, nonprofit organization data from the National Center for Charitable Statistics and the People of Color Environmental Groups Directory, and seismic hazard and hydrologic data from the US Geological Survey.

Secondary data analysis is fraught with managerial and technical challenges. Locating and acquiring usable data are laborious and expensive. Time is spent tracking and downloading data electronically from public data providers, sifting through gigantic datasets for theoretically relevant variables, translating impenetrable codebooks for variable definition statements and value labels, purchasing high priced data from private data agencies, signing numerous copyright and data agreement forms, devising validity and reliability tests for data quality, merging data sources collected at different levels and units of analysis, and adjusting and re-adjusting hypotheses to match analytic possibilities presented by the data. The end product is a highly developed and comprehensive dataset on commercial hazardous waste facilities in Southeastern United States, and concomitant geophysical, economic, and socio-demographic predictors. What follows is a discussion of data sources and database construction.

DATA ON COMMERCIAL TREATMENT, STORAGE, AND DISPOSAL FACILITIES, 1998

Quality data on handlers of hazardous waste in the Southeastern United States are not readily available. Following the events of September 11th, complete data on hazardous waste treatment, storage, and disposal facilities, and large quantity generators of hazardous waste were closed to the public for national security reasons. The decision to close access followed a Justice Department memorandum urging federal agencies to exercise caution in release of information to the public under the Freedom of Information Act (FOIA). The Environmental Protection Agency advised all regional offices to identify potentially "sensitive" information, especially "resources which provide information on chemicals, and/or location, and/or amounts, and/or impacts on the environment or human health." In March 2002, the EPA announced that it would close direct access to Envirofacts databases.[8] In an email to Direct Connect Users, EPA stated that "As part of our continuing efforts to respond to Homeland Security issues . . . starting April 1, 2002, Direct Connect access will no longer be available to the general public. Direct Connect access to Envirofacts will only be available to U.S. EPA employees, U.S. EPA Contractors, the Military, Federal Government, and State Agency employees" (www.ombwatch.org).

Because of data availability problems, data on commercial treatment, storage, and disposal facilities[9] had to be assembled tediously from numerous EPA sources, and data provided by Dr. John Michael Oakes of the Social and Demographic Research Institute (SADRI) of the University of Massachusetts. Oakes (1998) constructed a database of commercial TSDFs from two primary sources: 1) the EPA's Biennial Reporting System and 2) the Environmental Institute's Environmental Services Directory. The dataset is a work of art. SADRI researchers tirelessly verified every TSDF record with phone surveys, conducted installation visits, cross-referenced different data sources, and filed Freedom of Information petitions to acquire dates facility operations started.

The SADRI dataset was trimmed to include only the Southeastern United States. The regional set yielded a total of 100 commercial TSDFs operating in EPA Region IV. Variable columns were created for measures of hydrology, seismology, social capital assets and rates, environmental capital assets and rates,

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[8] For more information on federal government initiatives limiting public access to sensitive materials visit: http://www.ombwatch.org/

[9] A commercial operator is in the business of hazardous waste management, receiving hazardous waste generated by other firms for profit. Commercial facilities are typically classified as off-site handlers by the Environmental Protection Agency, in the sense of being physically separate from the site of waste generation.

zones of environmental impact of 1 and 1.5 miles from a TSDF, large quantity generator concentration, and other population and housing variables excluded from the original database. A private geo-coding firm was consulted to press zip code records to the census tract level and append longitude and latitude coordinates for geographic analysis.

Large Quantity Generators of Hazardous Waste, 1992

The Resource Conservation and Recovery Act (RCRA) and amendments authorize the Environmental Protection Agency to safeguard human health and the natural environment from improper management and disposal of hazardous wastes. RCRA requires all hazardous wastes be tested, recorded, and traced from their origin to their final disposal or destruction. This cradle-to-grave system requires commercial and non-commercial generators, transporters, and handlers of hazardous substances keep detailed records of their activities. Generators of hazardous waste are the first link in the cradle-to-grave management system. Section 260.10 of RCRA defines a generator of hazardous waste as: "any person, by site, whose act or process produces hazardous waste identified or listed in Part 261 or whose act first causes a hazardous waste to become subject to regulation." (PAGE CITATION) This definition encompasses the generator of waste and all those involved in subsequent handling and/or removal.

The term *by site* refers to the location of hazardous waste generation. The EPA tracks hazardous waste generation by site. A company operating three laboratories at one location is issued one EPA ID number. If this same company operates these same three laboratories at three different sites, each laboratory is defined as a separate generator and required to obtain an individual EPA ID number. A *person* is defined broadly as: "an individual, trust, firm, joint stock company, federal agency, corporation (including a government corporation), partnership, association, state, municipality, commission, political subdivision of a state, or any interstate body." The element of *act or process* is tricky. A generator is the person whose act or process causes a hazardous waste to become subject to regulation. Situations arise where the generator of hazardous waste may not be the actual producer. For example, if a cleaning service is hired to remove residues from a storage tank excluded under section 261.4(c), the cleaning service is considered the first person causing the waste to become subject to regulation rather than the owner of the tank or the individual that actually produced the hazardous material.

Congress separates generators into three categories: large quantity generators (LQGs), small quantity generators (SQGs), and conditionally exempt small quantity generators (CESQGs). Categorization is based on the quantity of waste produced per calendar month (see Table 3.4). Facilities may change their status monthly as the amount of waste generated fluctuates. This dissertation is concerned only with large quantity generators of waste operating in the Southeastern United States.

In gathering data on LQGs, the following publicly available sources were examined: the Biennial Reporting System (BRS) data files; the Resource Conservation and Recovery Act (RCRA) online database; the Hazardous Waste Query Form; the Enforcement and Compliance History Online (ECHO) database; Office of Solid Waste reports and memos, and the Environmental Justice Geographic Assessment Tool (EJGA). The ECHO database was used as the primary search engine because of its simple architecture and user-friendliness, up-to-date information on generators of hazardous waste, flexible search functions, ease of data transportability into Excel and SPSS analytical software, and completeness of facility records, including EPA ID number, firm name, address, telephone number, type of facility. The ECHO database was temporarily open to the public in direct violation of Homeland Security admonitions. Other EPA sources, such as the Hazardous Waste Query Form, EJGA, and BRS files were used to cross-reference and externally verify ECHO records.

US Census Bureau Population and Housing Data, 1990

Article I, Section II of the US Constitution mandates full enumeration of the US population every ten years. It states: "Representatives and direct taxes shall be apportioned among the several states which may be included within this Union according to their respective numbers . . . The actual enumeration shall be made within three years after the first meeting of the Congress of the United States and within every subsequent ten years, in such manner as they shall by law direct." Census data are used for allotment of congressional seats among states, to draw legislative districts at various levels of government, and allocation of federal funds (approximately $200 billion) to lower levels of government for delivery of social services on education, health, and transportation. The US Bureau of the Census is responsible for physically counting the US population.

TABLE 3.4: TYPES OF HAZARDOUS WASTE GENERATORS

Facility Type	Legal Definition
Large Quantity Generator	A generator is a large quantity generator if: (1) That person generates 2,200 pounds (1,000 kilograms) or more of hazardous waste in a calendar month; or (2) That person generates 2.2 pounds (1 kilogram) or more of acutely hazardous waste in a calendar month; or (3) That person generates 220 pounds (100 kilograms) or more of any residue or contaminated soil, waste, or other debris resulting from the cleanup of a discharge of any acutely hazardous waste in a calendar month; or (4) The quantity of hazardous waste accumulated on-site exceeds 13,200 pounds (6,000 kilograms) at any one time; or (5) The quantity of acutely hazardous waste accumulated on-site equals or exceeds 2.2 pounds (1 kilograms) at any one time; or (6) The quantity of any residue or contaminated soil, waste, or other debris resulting from the cleanup of a discharge of any acutely hazardous waste, accumulated onsite equals or exceeds 220 pounds (100 kilograms) at any one time.
Small Quantity Generator	A generator is a small quantity generator if: (1) That person generates greater than or equal to 220 pounds (100 kilograms) but less than 2,200 pounds (1,000 kilograms) of hazardous waste in a calendar month; and (2) The quantity of hazardous waste accumulated on-site never exceeds 13,200 pounds (6,000 kilograms).
Conditionally Exempt Small Quantity Generator	A generator is a conditionally exempt generator if that person generates less than: (1) 220 pounds (100 kilograms) of hazardous waste in a calendar month; and (2) 2.2 pounds (1 kilogram) of acutely hazardous waste in a calendar month; and (3) 220 pounds (100 kilograms) of any residue or contaminated soil, waste, or other debris resulting from the cleanup of a discharge of any acutely hazardous waste in a calendar month; and has accumulated less than 2,200 pounds (1000 kilograms) of hazardous waste, 2.2 pounds (one kilogram) of acutely hazardous waste, or 220 pounds (100 kilograms) of any residue or contaminated soil, waste, or other debris resulting from the cleanup of a discharge of any acutely hazardous waste at any time.

Before 1970, door-to-door enumerators (i.e., US Marshals and Census Agents) conducted population counts. Since then, census questionnaires have been mailed to all known residential households, with enumerators sent door-to-door to collect information from non-respondents - approximately 25 percent in 1990.[10] For reasons of economy, two survey instruments are used: 1) a short-form on 7 population and housing topics is administered to a majority of US households; and 2) a long-form on 30+ population and housing topics is sent to a sample of 1 in 6 housing units. The decennial census is the most comprehensive and important source of socio-economic data in the United States. It is used by social scientists, policy makers, and advocacy groups for evaluation of government expenditures tied to census data formulas, and analyses of general population and housing trends.

In theory, a census is a complete enumeration of the population. In reality, content and coverage errors crawl into the enumeration process. Content errors occur when respondents fail to answer specific questions, inaccurately answer certain questions because of misunderstanding or unwillingness to provide correct information, or when bureau statisticians incorrectly process census forms (i.e., coding, data entry, cleaning). According to John R. Weeks (1999: 54): "In comparison with other censuses, the United Nations rates the American census as highly accurate [on content], especially with respect to recording age, one of the most important demographic characteristics. By and large, content error is not a problem in the US census, although the data are certainly not 100 percent accurate." Coverage errors are more serious.

Post-census analyses reveal that millions of American citizens and permanent residents are uncounted or double-counted. Undercounts have decreased from 5.4 percent in 1940 to 1.1 percent of the population in 2000. Undercounted populations are disproportionately minority and poor. The 1990 Census missed 4.4% of African Americans, 5% of Hispanics, 2.3% of Asians and Pacific Islanders, and 12% of American Indians living on reservations. The consistent undercount of disadvantaged populations has caused a political conflict over census methodology because many communities are shortchanged on federal funding distributed by population. Billions of dollars are lost for much needed social programs with an estimated $2,913 dollars lost per undercount for the fiscal period of 2002-201 (Ericksen 2001: 2).

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[10] This 200 year old methodology of physical counting, according to the American Statistical Association (ASA) and the National Research Council (NRC), is too costly and unrealistic. Both organizations call for modernization of the US Census, recommending increased use of surveys and statistical estimation to reduce the scale, time, and tax dollars spent tracking non-respondents, and to increase the accuracy of population measurement (AMSTAT News 1997). The U.S. Supreme Court rejected the use of scientific sampling in a 5-4 decision (Department of Commerce v United States House of Representatives).

From a social scientific standpoint the undercount of minorities introduces a coverage error that may reduce the quality of studies that use census data. The undercount of minorities is important to environmental justice researchers that routinely rely on census data to link population characteristics to environmental burdens. Coverage biases may affect this study's validity. To bias the results of this study, coverage error must be significantly different in observed neighborhoods with and without hazardous facilities. Evidence to suggest that coverage errors behave differently across comparison groups in this study. Coverage errors may undermine the validity of results.

From 1990 US Census Bureau data, the following subset of population and housing variables are used: managerial-technical labor rate; industrial labor rate; average price of housing; average rental price; population density; percent college educated; percent without high school education; percent African American; percent Hispanic; percent American Indian; percent White; youth dependency ratio; old dependency ratio; percent housing units built before 1960 and 1970; percent households on public assistance; percent families at or below the poverty line; percent of families at 50 percent the poverty line; land area in square kilometers; water area in square kilometers; percent housing units rented; percent Black female headed households; and percent female-headed households with children.

NATIONAL CENTER FOR CHARITABLE STATISTICS CORE DATA, 1990

Non-profit organizations perform many positive functions. They enrich civic life by providing individuals and social movements with organizational resources to affect social change, and fill systemic gaps in the delivery of public and primary social goods as capital markets under-perform and governments abandon their historical function as social service providers (DiMaggio, Weiss, and Clotfelter 2002). Their presence is associated with democracy and norms of reciprocity, and their general absence symptomatic of autocracy and centralized power.

The non-profit sector in the United States has expanded significantly in the last 30 years. Scholars estimate that 25,000+ nonprofit organizations are created annually (Gronbjerg 2002). Approximately 1.6 million nonprofit organizations currently operate in the United States. Their share of gross domestic product is a remarkable 8 percent (Hammack 2002). This percentage is greater than the automotive, textile, and transportation industries combined (Bureau of Economic Analysis 2003). The nonprofit sector employs about 11 million people (Lampkin and Boris 2002: 1675) accounting for 10 percent of non-agricultural employment.

The growth of the non-profit sector in the United States is shaped by two factors: 1) the gradual withdrawal of government from the delivery of social services, and 2) an increase in charitable giving by the American bourgeoisie. On the first factor, social scientists have identified an inverse relationship between government expenditure and the size of the non-profit sector. This crowding out of voluntary activity obtains in countries with centralized governments like France, Japan, and Russia (Schofer and Fourcade-Gourinchas 2001). In the United States, the nonprofit sector increased in size as the federal government reduced expenditures on social programs. On the second factor, inflation-adjusted net income for the highest quintile in the United States increased 43 percent from 1977 to 1999. For the top 1 percent, after-tax income increased by 115 percent (Congressional Budget Office 2002). For the same period, the top fifth of Americans more than doubled their net worth, dramatically increasing their share of overall wealth. This top-heavy accumulation of income and wealth has an age dimension. Most of it has pooled at the top end of the age structure. As the American bourgeoisie ages, charity increases. In 2002 alone, Americans supplied the non-profit sector with $250 billion dollars (Internal Revenue Service 2002). According to the National Committee for Responsive Philanthropy (NCRP), this figure could reach $10 trillion dollars as wealth is passed from one generation to the next.[11]

The Internal Revenue Service (IRS) manages the non-profit sector. Non-profit organizations of tax-exempt status with $25,000 dollars in gross receipts are required to file Form 990 with the IRS. Form 990 is the only comprehensive source of financial information on nonprofits. Form 990 includes statistics on revenues, expenses, net and gross assets, balance sheets, program information, and data on lobbying and other political activities. These forms are publicly available.

The IRS complies information from 990 forms into three cumulative files: 1) the Business Master File (BMF); 2) the Return Transaction File (RTF); and 3) the Statistics of Income (SOI) file. The BMF contains basic financial data on an organization's assets and gross receipts, as well as descriptive information on an organization's name, address, exemption status, and leadership. The RTF contains information on 120 financial variables, and no identifying information except an organization's Federal Employer Identification Number (FEIN). The SOI file has information on larger organizations with $30 million

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[11] How this money is spent will indelibly stamp the political economy of American society. For example, ideologically conservative foundations (i.e., Olin, Coors, Mellon, and Scaife) have used charitable dollars to build a network of organizations and think tanks with distinctly conservative policy agendas of state minimalism, privatization of government services, deep reductions in federal anti-poverty spending, commercial deregulation, and transfer of responsibility for public welfare to lower levels of government and the nonprofit sector.

or more in assets, a third of organizations with $10 million to $30 million in assets, and a stratified sample of smaller organizations weighted by asset ownership. The SOI files include 300 financial and programmatic variables (Salamon and Dewees 2002).

The National Center for Charitable Statistics (NCCS) has painstakingly computerized and merged these IRS files into a comprehensive database called the NCCS Core File. The mission of NCCS "is to develop and disseminate high quality data on non-profit organizations and their activities for use in research on the relationship between the non-profit sector, government, the commercial sector, and the broader civil society." The Core File merges descriptive information from the BMF, and financial information from the RTF and SOI file. Because IRS files are for internal administration, and data entry methods geared for speed, they contain errors that undermine their use for research purposes. The NCCS conducts standardized checks on all information. Mistakes are flagged and corrected, making the Core File "the most complete and highest quality data source ever available on nonprofit organizations" (Lampkin and Boris 2002: 1683). To enhance the database, the NCCS adds Federal Information Processing Systems (FIPS) data at the zip code, county and state levels, and classifies each organization according to the National Taxonomy of Exempt Entities (NTTE) system.

The Core File has flaws stemming from the data sources on which it is built. Limitations include: 1) there are no data on organizations with less than $5000 in annual gross receipts because such organizations are not legally required to register as tax-exempt; 2) there is no financial, geographic, or programmatic data on organizations with annual gross receipts of less than $25,000; 3) data on religious organizations, regardless of size, are incomplete because such entities are not required to register with the IRS; and 4) because data are collected at the organization level, subsidiary enterprises are missed. Complex organizations are required to fill out only one Form 990, even if it is comprised of many enterprises and affiliated advocacy groups. This means that organizations with multiple locations may file under one consolidated Form 990. Nobody knows the extent of consolidated reporting (Salamon and Dewees 2002).

People of Color Environmental Groups Directory, 1996

The Environmental Justice Resource Center at Clark Atlanta University, a private and historically African American college, created a directory entitled The People of Color Environmental Groups Directory (PCEGD). The directory lists more than 400 groups from 40 different states, as well as 49 groups in

Canada, and 24 groups in Mexico. The goal of the directory is to provide resources and support to grassroots groups, and to help both public and private decision-makers in reaching stakeholder groups and community residents. The formation of the directory fit nicely with the commitment of Clark Atlanta University to participatory research and community engagement. Founded in 1994, the Environmental Justice Resource Center is involved in community activism, policy analysis, research to benefit the larger community, the collection of databases and information, and well as training, and conference planning. The directory of groups was created through assembling names of organizations in the U.S., Mexico and Canada known to be working on environmental justice issues, and later expanded using a snowball technique. The purpose of the directory is to act as a planning, organizing, and networking tool to empower communities and link grassroots movements that are often isolated and therefore less effective in advocating change. As well, the directory has served to involve underrepresented stakeholders in the planning of summits, conferences and workshops.

US Geological Survey Seismic Hazard Data and Grid Values, 1990

The US Geological Survey (USGS), a bureau of the US Department of the Interior, recently launched the National Seismic Hazard Mapping Project (NSHMP) to estimate ground motion hazard values that have a specified probability of being exceeded in 50 years. These ground motion values inform earthquake resistance strategies, and seismic risk assessments for economic and safety decisions on land uses. The NSHMP online database generates ground motion values expressed as percentages of the acceleration of gravity (%g) for each longitude and latitude point to three decimal points for the contiguous United States.[12] Earthquake estimates can also be generated for each Zip Code. For each Zip Code or longitude-latitude entry, several estimates of ground motion are returned, including: Peak Ground Acceleration (PGA); and 0.2, 0.3, and 1.0 second period Spectral Acceleration (SA), for 10, 5, and 2 percent probability of being exceeded (PE), in 50 years.

A strong correlation obtains between estimates of peak ground and spectral acceleration, but they measure slightly different phenomena. PGA and SA measure what an object experiences during irregular

[12] The average of the northern and southern most latitudes and the average of the eastern and western most longitudes are used to estimate the latitude and longitude values of each Zip Code unit. Such estimates may not conform to Census Bureau generated Zip Code centroid estimates. Zip Code location ground motion values are the nearest point on a grid of points 1/10 of a degree apart from ground motions calculated for the 48 adjacent states.

earth motion. The irregular movement of this object can be measured on its changing position, velocity, or acceleration as a function of time. Because building codes stipulate how much horizontal force a building must endure during earthquake motion, acceleration is the preferred measured. Peak acceleration is the maximum acceleration experienced by an object during earthquake motion. PGA is a good hazard measure for shorter buildings of 7 stories or less. SA is an approximation of what is experienced by larger buildings. Ground motion estimates are preferable because TSDFs are generally horizontally designed.

For a given site, the computer calculates the ground motion effect for all earthquake locations and magnitudes believed possible in the vicinity. Each of these magnitude-location pairs is believed to occur at some average probability per year. Small ground motions are relatively probable, and large ground motions are relatively improbable. All probabilities are given for a specific period of time.

US Geological Survey Hydrologic Unit Code Data, 1990

In 1972, U.S. Geological Survey began systematic collection of hydrologic data. The project was spearheaded by the U.S. Geological Survey's Office of Water Data Coordination and financially supported by the Survey's Resource Planning Analysis Office. The goal was a standard geographical framework to provide detailed water and land resource planning. Prior to construction of these data, planners used inconsistent criteria to name and code basins and delineate hydrologic boundaries. To create consistency and aid in organization and dissemination of data, the U.S. Geological Survey Hydrologic data are reported for regions, sub-regions, accounting units, and cataloging units. Units are arranged from smallest (cataloging units) to largest (regions).

Each hydrologic unit is identified by a 2 to 8 digit hydrologic unit code (HUC) based on the four levels of classification in the hydrologic unit system. The first level of classification divides the U.S. into 21 geographic areas, or regions based on surface topography, with each region containing either the drainage area of a major river, or the combined drainage areas of a series of smaller rivers. The second level of classification divides the 21 regions into 222 sub-regions that include an area drained by a river system, tributaries in that feed into closed basins, or a group of streams forming a coastal drainage area. The third level of classification subdivides many of the sub-regions into 352 units that nest within, or are equivalent to, sub-regions. The fourth and smallest level of classification is the cataloging unit, sometimes called a watershed, which is a geographic area representing part or all of a surface drainage basin, a combination of basins, a distinct hydrologic feature, or an area of land that catches precipitation and drains or seeps into a marsh, stream, river, lake or groundwater. Cataloging units subdivide sub-regions and accounting units into approximately 2150 smaller areas. The Geological Survey's National Water Data Exchange (NAWDEX) system as well as federal agencies, state, county, and local agencies use the hydrologic units for codifying and displaying data collected at both a local and national level.

This dissertation collects hydrologic data at the watershed (cataloging) level of analysis. To merge watershed data from the US Geological Survey with census tract level population and housing data from the US Bureau, I visited the Office of Social and Economic Data Analysis at the University of Missouri website and used their geographic correspondence engine (www.oseda.missouri.edu/). This engine enables users to estimate the percentage of a hydrologic unit code encased in a census tract. Estimation is a relatively straightforward procedure of overlapping maps. It is similar to lining up transparencies, and calculating the percentage of overlap, weighted by population size or area in square kilometers.

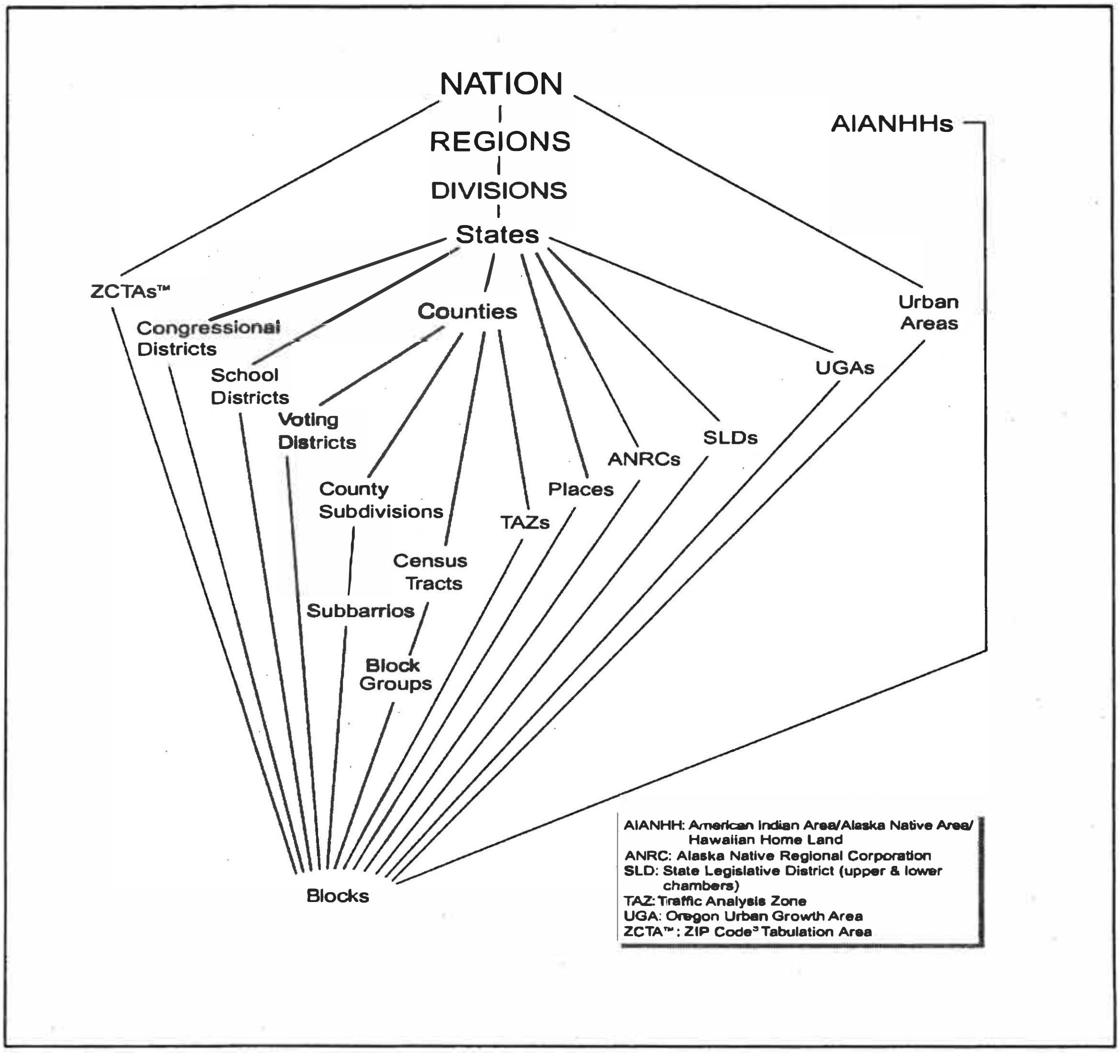
UNIT OF ANALYSIS

The proper unit of analysis is a controversial topic in environmental justice research.[13] At the center of this debate is the operational definition of community using data constructs. The US Census Bureau collects data directly at household and individual levels. To protect the privacy of respondents, data are aggregated to higher legal, administrative, and statistical levels (see Figure 3.3). Data are arranged in a geographic hierarchy. The two most popular data constructs used by environmental justice researchers are zip code areas and census tracts.

The zip code area is part of the US Postal Service's mail delivery system. The rationale for using zip code areas as indicators of community is that data are widely available at the level; zip code areas are commonly used in marketing studies to estimate consumer preferences; they are easy integrate with EPA data on hazardous facilities insofar as facilities receive mail at the site of operation; they represent a useful way to geographically partition the country; and people regularly use zip code areas to roughly estimate the quality of a residential area (Williams 1999). Most scholars reject zip code areas because they vary significantly in size and encompass too much area to adequately capture the sociological meaning of

[13] According to Zimmerman (1993:652), unit selection is "often dictated by expediency, determined by how existing databases are aggregated and which level of aggregation provides the most data at the smallest geographic scale."

FIGURE 3.3: US CENSUS BUREAU'S STANDARD HIERARCHY OF GEOGRAPHIC UNITS OF ANALYSIS



Source: Standard Hierarchy of Census Geographic Entities (from *Census 2000 Summary File 1 Technical Documentation*, prepared by the U.S. Census Bureau, 2001, p. A-25) community or be of much relevance to exposure analysis; they are prone to aggregation errors; they intersect political boundaries like cities, counties, and states, frustrating regional analyses; and they are too heterogeneous demographically, with racially distinct neighborhoods incased in the zip code area.

The census tract is more widely used data construct estimate of community. It is an observational unit delimited by the US Census Bureau. Census tracts are statistical subdivisions of a county. Local census committees, staffed by professionals with intimate knowledge of the cultural, economic, and demographic history of a metropolitan area or densely populated county, delineate tract boundaries. Census committees are required to carefully follow Census Bureau guidelines in making subdivisions. Subdivisions are to be as homogenous as possible on population and housing characteristics at the time of their creation. Population size should range from 2,500 to 8,000 inhabitants, with a preferred average of 4,000. Census tracts are relatively small neighborhood areas with a national median of .74 square miles. Census tracts in central business districts, major commercial and industrial areas, and areas containing residential settlements in multi-story, high-density buildings have populations that generally exceed this range. Census tracts must also conform to recognizable physical boundaries, street extensions, utility and transport easements, and property lines, without intersecting political and administrative boundaries.

Census tracts are superior to zip code areas for many reasons, including: they are relatively permanent and homogeneous demographically, enabling isolation and statistical comparison of relevant variables; census tracts conform to political and physical boundaries allowing for regional analysis; they are regularly used in American courts as the proper unit of analysis for neighborhood approximation; they are designed sociologically and capture cultural dimensions of community; and they vary less significantly than zip code areas in size allowing for unfettered statistical analysis (Liu 2001).

The major drawback of census tracts in environmental justice research is that hazardous facilities may be sited at the edge of a census tract. The environmental risks associated with the facility extend beyond the borders of the census tract in which it located. Residents in adjacent tracts are equally affected by the land use. This boundary effect undermines the census tract as a stand-alone analytical unit for assuming the effects of proximity. Creation of composite zones can minimize this methodological problem. The burdens generated by TSDFs are inversely related to distance. As one moves closer to a TSDF, the burdens increase. No consensus on the precise distance the environmental burdens of a TSDF dissipate. Estimates vary from one to five miles. Complications stem from cumulative burdens, varying TSDF size, and spatial effects like undulating topography that block the reach of TSDF burdens.

The most commonly used zones of impact are 1 and 1.5 miles from the TSDF (see Mohai and Bryant 1994; and Boer, Pastor, Sadd, and Snyder 1997). Evidence from risk perception, price hedonic, and contaminant studies confirm these distances as conservative zones of potential impact. This dissertation adopts these distances. Distances are measured from the centroid of a census tract to the centroid of the nearest TSDF tract. The dependent variable will include all tracts containing a TSDF, and all adjacent tracts with 1 and 1.5 miles of the suspect land use.

Statistical Tests and Methods

This section describes the statistical methods to be used. The objective is not to educate the reader on the technical aspects of tests or methods, but to substantively justify and discuss the procedures to be used. The linkages between population and housing characteristics, geological and hydrological phenomena, and environmental risk are variable and uncertain. One must select statistical methodologies that match the phenomena studied, the precision with which phenomena are measured, and the research questions to be answered. This dissertation relies on relatively simple and straightforward methods for evaluating comparisons. Affected and unaffected tracts are compared using bivariate and multivariate tests.

Bivariate hypothesis testing involves comparison of averages on theoretically relevant variables between TSDF and non-TSDF tracts. The bivariate null hypothesis is that affected and unaffected tracts are equal on selected characteristics. Rejecting the null hypothesis of equal variances supports the plausibility of claims on commercial TSDF location outcomes. Bivariate hypothesis testing is substantively important because theories of environmental justice hold that no differences should obtain between host and non-host tracts on racial and socio-economic features of a community. The t-test is used for evaluation of the bivariate null.

The t-test is the most widely used analysis of means. The main assumption of the t-test is that observations are normally distributed (Fink 1995). Violation of this assumption does not invalidate test results necessarily. The t-test is sufficiently robust to handle skewed data if sample sizes are large.[14] The main advantage of the t-test is interpretive simplicity. Non-statisticians have no trouble understanding its purpose or results.

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[14] An alternative to the t-test is the Wilcoxon rank-sum test, also known as the Mann-Whitney statistic. It is a non-parametric test of median difference. Because the median measure of centrality is less affected by skew, the test is extremely robust under circumstances of skew.

The second type of hypothesis testing is multivariate. Multivariate tests are superior to bivariate tests because of the exercise of statistical control. The ability to hold variables statistically constant approaches controlled experimentation. Bivariate comparisons may obscure relationships. Relationships behave differently under conditions of statistical control. Multivariate tests may render significant bivariate relationships spurious, or may reveal a substantive relationship actually exists. A fundamental issue in multivariate hypothesis testing is model specification, or the logic behind variable inclusion in the regression equation. Analytic economy and theoretical understanding guide model construction. Because different variable sets give rise to different results, temptation to statistically fiddle is minimized by the deductive approach of this dissertation. The multivariate test to be used is binary logistic regression.

Binary logistic regression is part of the statistical family of General Linear Modeling. This test is appropriate when the dependent variable, in this case presence of absence of a TSDF, is discrete or dichotomous. Logistic regression is a non-linear transformation of linear regression. It is an S-shaped distribution function. The interpretation of logistic coefficients for dichotomous variables is intuitively simple when log odds are expressed as an odds ratio. Instead of the slope coefficients being the rate of change in the dependent variable as independent variables change, as is the case in simple linear regression, the slope coefficient is interpreted as the rate of change in log odds as independent variables change. The conversion to an odds ratio allows one to state results meaningfully to non-statisticians. A unit increase in an independent variable can be expressed as an increase or decrease in the probability that a census tract hosts or does not host a TSDF.

For each test, interpretation will rely almost exclusively on mathematical sign and significance. This is deep enough for hypothesis testing. Reported p-values reflect two-tailed tests of significance. Directionality is unimportant because the objective is to measure differences in kind and degree. Readers can simply divide two-tailed p-values by two to figure one-tail estimates.

Chapter IV: Statistical Results

Introduction

This chapter evaluates results of statistical tests. The chapter is organized as follows. First, descriptive statistics on independent variables are used to sort and describe the data for the region as whole and the sub-regions of the South and Deep South. Next, statistical tests of comparison (t-Tests) between host and non-host neighborhoods (i.e., census tracts) are presented and interpreted. Measures of spatial risk radiate from census tract, to 1 mile from the nearest hazard, to 1.5 miles from the nearest hazard. Results are presented in table format for the entire region and sub-regions. Last, binary logistic regression results are presented with measures of spatial risk the same. Regression coefficients are transformed from log odds to odds ratios for ease of interpretation and readability, but interpretive emphasis is placed on relationship directionality and statistical significance for reduced models.

Univariate Statistics and Basic Description

The dataset contains 10,115 statistically valid neighborhoods (i.e., census tract divisions) for the Southeastern United States. Compared to the nation as whole, the Southeast region is characterized by higher than average African-American population (22 percent versus 13 percent), rate of poverty (19 percent versus 15 percent), and percent high school dropout (32 percent versus 26 percent). On other economic, demographic, and geo-physical characteristics, EPA Region IV has a social capital rate of $1686 dollars, an environmental capital rate of $306 dollars, a lower the average population density (628 persons/ per km), an industrial labor rate of 32 percent, with half the active labor force in petit bourgeois (i.e., managerial technical) occupations. The average price of an owner-occupied home is $73,335 dollars, with 40 percent of such units built before 1970. The national average for value of owner-occupied home is $104,530, a full thirty thousand dollar difference. Risk of seismological activity is low. The Peak Ground Acceleration (PGA) average is 4.5%g. The US Geological Survey has a 10 percent PGA threshold for likely destruction of physical property (see Table 4.1).

Following Mary Rogge's (1996) example, if we sub-divide EPA Region IV into South (Florida, Kentucky, North Carolina, and Tennessee) and Deep South (i.e., Alabama, Georgia, Mississippi, and South Carolina), notable sub-regional variation emerges. Compared to the Region as whole, the Deep South (see Table 4.2) has lower social capital assets ($3,441,863 dollars), a lower social capital asset rate ($1,473), a dismally low environmental capital average of $5.53 per person, a higher rate of industrial labor, a greater

TABLE 4.1: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR EPA REGION IV

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	10115	-131231	1736539201	3890675.13	28473413.39
Social Capital Rate	10115	-15.44	2414954.11	1686.2850	28704.3544
Environmental Capital Assets	10115	.00	48101437.00	40693.4220	1023446.6953
Environmental Capital Rate	10115	.00	3006339.81	306.0710	29892.4785
Population Density	10115	.00	12120.18	628.6058	924.1274
Young Dependency Ratio	10115	.00	1.46	.3464	.1132
Old Dependency Ratio	10115	.00	12.73	.2476	.3025
BUSINESS RATIONALITY					
Large Quantity Generators	10115	.00	13.00	.2030	.6632
% Industrial Labor	10115	.00	100.00	32.1996	13.9766
% Managerial Technical Labor	10115	.00	100.00	50.6774	16.7367
Mean Value of Household	10115	9000.00	600000.00	73355.6140	48064.0521
Median Gross Rent	10115	.0	1001.0	368.070	155.525
% Units Built Before 1960	10115	.00	100.00	31.9898	21.7290
% Units Built before 1970	10115	.00	100.00	49.4120	23.2807
SCIENTIFIC RATIONALITY					
Land Area Sq Km	10115	.00	2857.04	94.5769	162.0969
Water Area Sq Km	10115	.00	2794.48	6.1011	49.2324
Peak Ground Acceleration	10115	.5000000	23.8058500	4.468188782	3.683263255
% Hydrologic Code in Tract	10115	.0000000	2.0483100	3.993124E-02	9.895685E-02
RACE, CLASS, GENDER					
% White Persons	10115	.00	100.00	76.1751	27.2461
% Black Persons	10115	.00	100.00	22.0844	27.3127
% Hispanic Persons	10115	.00	100.00	2.9512	9.3725
% Non-Hispanic White Persons	10115	.00	100.00	73.9755	27.8787
% Non-Hispanic Black Persons	10115	.00	100.00	21.9277	27.2045
% American Indian	10115	.00	88.93	.4236	2.4616
% Families 50% Below Poverty	10115	.00	100.00	8.0345	7.9051
% Families at or Below Poverty	10115	.00	100.00	19.2333	13.7000
% Public Assistance in 1989	10115	.00	100.00	8.9292	7.6232
% Female Households w/ Kids	10115	.00	100.00	7.3644	5.4483
% Black Female Households	10115	.00	100.00	25.7420	16.9140
% Renter Occupied Units	10115	.00	100.00	32.3289	20.0432
% 18+ Without High School	10115	.00	100.00	31.9848	15.0358
% 18+ With 1 year of College	10115	.00	100.00	37.7926	18.2178
Total Persons	10115	.00	71872.00	4419.9472	2755.0495
Valid N	10115				

percentage of housing units constructed before 1970, lower population density (454 persons/sq km), more than one-fifth of the population below the official poverty line, a higher percentage of persons on public assistance (10 percent), substantially higher percentage of African-Americans (30 percent) and a sizably larger average of land area in sq km (121). These economic and demographic disadvantages in the Deep South render it especially susceptible to TSDF siting, should the racial and economic inequality hypothesis hold true (see Table 4.2). The one factor in favor of the Deep South is the lower percent of large quantity generator activity, making it commercially unsuitable as the cost-reduction thesis suggests.

As evidenced in Table 4.3, the Southern States of Florida, Kentucky, North Carolina, and Tennessee, are comparatively better off than the Deep South. Southern states contain more statistical neighborhoods (N=6148 versus N=3967). On social capital variables, the South has an enormous advantage in assets. Neighborhoods in the South have, on average, a $1.5 million dollar advantage in social capital assets. The environmental capital rate in the South is $499. In fact, almost all non-profit organizations with a declared environmental focus are located in the sub-region of the South. The South is also significantly older population, with an old age dependency ratio of 27 percent. Compared to the Deep South, data on economic variables reveal a $13,000 dollar difference in average price of owner-occupied housing, a higher percentage of the workforce in technical-managerial occupations, and a lower percentage of workers in blue-collar jobs. The South has a slightly higher than average percentage of large quantity generator activity. The slight mismatch between higher LQG activity and lower industrial labor rate may be explainable by the relative capital intensity of LQG production in the South. The most pronounced differences between sub-regions are on demographic variables. The South has almost 50 percent less African-Americans (16.4 percent versus 30.9 percent), considerably more Hispanic identified persons (4 percent), a lower rate of poverty, a lower percentage of persons in extreme poverty (7.3 percent versus 8.1), and a higher percentage of adults with at least 1 year of college training. Overall, conditions in the South are mixed. The higher than average concentration of LQG operations make the South vulnerable to commercial TSDF siting, but higher scores on social, economic, and human capital ought to shield Southern residents from environmentally risky technologies like commercial TSD installations.

As Table 4.4 indicates, state level distribution of TSD installations deviates slightly from census tract totals, with installations unevenly spread across EPA Region IV. First, let us examine the total of statistical neighborhoods by state, then the allocation of TSD facilities. More than 24 percent (N=2448) of

TABLE 4.2: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR DEEP SOUTH STATES OF ALABAMA, GEORGIA, MISSISSIPPI, AND SOUTH CAROLINA

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	3967	-4919	1736539201	3441863.88	34981073.25
Social Capital Rate	3967	-2.49	986744.69	1472.6187	20931.8130
Environmental Capital Assets	3967	.00	40681228.00	26716.8563	745850.6952
Environmental Capital Rate	3967	.00	6292.53	5.5365	126.9527
Population Density	3967	.00	11261.26	454.9715	722.2404
Young Dependency Ratio	3967	.00	1.46	.3750	.1142
Old Dependency Ratio	3967	.00	2.20	.2040	.1158
BUSINESS RATIONALITY					
Large Quantity Generators	3967	.00	9.00	.1986	.6355
% Industrial Labor	3967	.00	100.00	34.4087	13.9501
% Managerial Technical Labor	3967	.00	100.00	49.0445	16.8206
Mean Value of Household	3967	12500.00	461719.59	65586.9937	38810.9175
Median Gross Rent	3967	.0	1001.0	336.285	145.838
% Units Built Before 1960	3967	.00	100.00	32.7336	20.5121
% Units Built before 1970	3967	.00	100.00	50.4365	21.6339
SCIENTIFIC RATIONALITY					
Land Area Sq Km	3967	.00	1338.47	121.2369	171.7325
Water Area Sq Km	3967	.00	480.31	4.2317	23.0716
Peak Ground Acceleration	3967	1.3589930	18.9090300	5.022093510	3.197330161
% Hydrologic Code in Tract	3967	.0000000	2.0483100	4.842939E-02	.109698754
RACE, CLASS, GENDER					
% White Persons	3967	.00	100.00	67.8015	28.5313
% Black Persons	3967	.00	100.00	30.8982	28.7977
% Hispanic Persons	3967	.00	100.00	1.0091	2.8131
% Non-Hispanic White Persons	3967	.00	100.00	67.2243	28.4126
% Non-Hispanic Black Persons	3967	.00	100.00	30.7888	28.7287
% American Indian	3967	.00	88.93	.3254	1.6742
% Families 50% Below Poverty	3967	.00	100.00	9.1694	8.7087
% Families at or Below Poverty	3967	.00	100.00	21.1081	14.4444
% Public Assistance in 1989	3967	.00	70.51	10.3358	8.2846
% Female Households w/ Kids	3967	.00	100.00	8.3851	6.1026
% Black Female Households	3967	.00	100.00	27.6821	14.9430
% Renter Occupied Units	3967	.00	100.00	32.0336	20.1478
% 18+ Without High School	3967	.00	100.00	33.7144	14.9771
% 18+ With 1 year of College	3967	.00	100.00	36.4681	18.3924
Total Persons	3967	.00	18081.00	4179.1586	2394.3225
Valid N	3967				

TABLE 4.3: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR SOUTHERN STATES OF FLORIDA, KENTUCKY, NORTH CAROLINA, AND TENNESSEE

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	6148	-131231	806594674	4180270.80	23328678.53
Social Capital Rate	6148	-15.44	2414954.11	1824.1533	32755.7684
Environmental Capital Assets	6148	.00	48101437.00	49711.8079	1168029.3148
Environmental Capital Rate	6148	.00	3006339.81	499.9911	38342.1174
Population Density	6148	.00	12120.18	740.6434	1018.1299
Young Dependency Ratio	6148	.00	1.26	.3279	.1086
Old Dependency Ratio	6148	.00	12.73	.2758	.3740
BUSINESS RATIONALITY					
Large Quantity Generators	6148	.00	13.00	.2058	.6805
% Industrial Labor	6148	.00	100.00	30.7742	13.8084
% Managerial Technical Labor	6148	.00	100.00	51.7310	16.5987
Mean Value of Household	6148	9000.00	600000.00	78368.3200	52584.1980
Median Gross Rent	6148	.0	1001.0	388.579	158.123
% Units Built Before 1960	6148	.00	100.00	31.5099	22.4679
% Units Built before 1970	6148	.00	100.00	48.7510	24.2629
SCIENTIFIC RATIONALITY					
Land Area Sq Km	6148	.00	2857.04	77.3744	153.1329
Water Area Sq Km	6148	.00	2794.48	7.3073	60.3400
Peak Ground Acceleration	6148	.5000000	23.8058500	4.110781485	3.924293553
% Hydrologic Code in Tract	6148	.0000000	1.4148080	3.444780E-02	9.094649E-02
RACE, CLASS, GENDER					
% White Persons	6148	.00	100.00	81.5781	24.9354
% Black Persons	6148	.00	100.00	16.3974	24.6955
% Hispanic Persons	6148	.00	100.00	4.2044	11.6372
% Non-Hispanic White Persons	6148	.00	100.00	78.3317	26.6377
% Non-Hispanic Black Persons	6148	.00	100.00	16.2100	24.5323
% American Indian	6148	.00	86.39	.4870	2.8550
% Families 50% Below Poverty	6148	.00	100.00	7.3022	7.2470
% Families at or Below Poverty	6148	.00	100.00	18.0236	13.0565
% Public Assistance in 1989	6148	.00	100.00	8.0215	7.0166
% Female Households w/ Kids	6148	.00	41.60	6.7058	4.8689
% Black Female Households	6148	.00	100.00	24.4901	17.9623
% Renter Occupied Units	6148	.00	100.00	32.5194	19.9747
% 18+ Without High School	6148	.00	100.00	30.8687	14.9690
% 18+ With 1 year of College	6148	.00	100.00	38.6472	18.0543
Total Persons	6148	.00	71872.00	4575.3162	2954.3915
Valid N	6148				

TABLE 4.4: CROSS-TABULATION OF STATE BY ZONES OF TSDF ENVIRONMENTAL IMPACT

	1.5 Miles		1 Mile		TSDF		Total
	No	Yes	No	Yes	No	Yes	
Alabama	1038	24	1045	17	1050	12	1062
	10.5%	9.2%	10.5%	11.3%	10.5%	12.0%	10.5%
Florida	2420	28	2431	17	2436	12	2448
	24.6%	10.8%	24.4%	11.3%	24.3%	12.0%	24.2%
Georgia	1447	23	1454	16	1457	13	1470
	14.7%	8.8%	14.6%	10.6%	14.5%	13.0%	14.5%
Kentucky	955	42	974	23	986	11	997
	9.7%	16.2%	9.8%	15.2%	9.8%	11.0%	9.9%
Mississippi	570	11	577	4	577	4	581
	5.8%	4.2%	5.8%	2.6%	5.8%	4.0%	5.7%
North Carolina	1428	54	1455	27	1467	15	1482
	14.5%	20.8%	14.6%	17.9%	14.6%	15.0%	14.7%
South Carolina	828	26	836	18	838	16	854
	8.4%	10.0%	8.4%	11.9%	8.4%	16.0%	8.4%
Tennessee	1169	52	1192	29	1204	17	1221
	11.9%	20.0%	12.0%	19.2%	12.0%	17.0%	12.1%
Total	9855	260	9964	151	10015	100	10115

census tracts are located in Florida. After Florida, in rank order from highest to lowest: North Carolina (N=1482), Georgia (N=1470), Tennessee (N=1221), Alabama (N=1062), Kentucky (N=997), South Carolina (N=854), and Mississippi (N=581). Of the 100 commercial TSD installations in EPA Region IV, 17 are located in Tennessee, followed by South Carolina (N=16), North Carolina (N=15), Georgia (N=13), Florida (N=12), Alabama (N=12), Kentucky (N=11), and Mississippi (N=4).

What may account for Florida's proportionally lower presence of TSD installations? Florida has about a quarter of regional neighborhoods available for TSD facility siting, and hosts only 12 percent of fully operational TSDFs in the region. Consistent with hypotheses delineated in Chapter III, Florida ranks second regionally in average social capital assets ($4,683,983), first in average environmental capital assets, average value of owner-occupied housing, population density, percentage white persons, percent college educated, percent of workers in managerial-technical occupations, and percentage water area in square miles. Also, Florida has the lowest regional poverty rate, percent renter occupied units, industrial labor rate, percent African-Americans, and activity of large quantity generators of hazardous waste (see Appendix for complete state by state descriptive statistics). Conversely, what may explain Tennessee's proportionally higher presence of commercial TSD installations? The high presence of TSDFs in Tennessee corresponds with the highest regional average of LQG operations (.3415). No other theoretically relevant characteristic distinguishes Tennessee from the rest of the region, except it is second to Kentucky on hydrologic suitability (i.e., water area in sq km, 1.97).

If we expand the zone of potentially catastrophic environment risk to 1 Mile, state level data behave similarly, but differences are more amplified (see Table 4.4). Again, Tennessee leads all states with 29 affected neighborhoods or 19 percent of the regional total, followed by North Carolina (N=27), Kentucky (N=23), South Carolina (N=18), Alabama (N=17), Florida (N=17), Georgia (N=16), and finally Mississippi (N=4). For Deep South states, the number of affected communities increases marginally. In Mississippi, the expanded zone of impact is inconsequential. In South Carolina, the number of affected neighborhoods increases slightly from 16 to 18. This pattern of marginal difference is explainable by the average size of neighborhoods in the Deep South (121 square Km). Florida's share of the region's environmental burdens remains proportionally low at 11.3 percent.

At 1.5 miles to the nearest TSD installation, North Carolina surpasses Tennessee as the most burdened state in EPA Region IV, with 54 affected neighborhoods. Combined, North Carolina and Tennessee have about 40 percent of the Region's environmentally affected neighborhoods. Following

North Carolina, in descending order of burden, are Tennessee (N=52), Kentucky (N=42), Florida (N=28), South Carolina (N=26), Alabama (N=24), Georgia (N=23), and Mississippi (N=11). At the impact zone of 1.5 miles, Southern states finish in the top four slots. This is explainable by the higher average population density in Southern states. By expanding the zone of environmental risk from 1 to 1.5 miles, the number of affected neighborhoods increases from 151 to 260. The increase in affected neighborhoods from in-tract (N=100) to 1 mile (N=151) to 1.5 miles (N=260) to 2 miles (N=398), conforms coincidentally with the Fibonacci sequence used in theoretical mathematics in which each term is the sum of the two preceding terms. Overall, the distribution of commercial TSD installations in EPA Region IV, at whatever spatial measure of environmental risk, are more concentrated in the Southern sub-region states of Tennessee, Kentucky and North Carolina. As noted in Chapter III, these Southern states have emerged as nascent centers of routine production activities. The generally higher average of LQG activity creates a need for proper treatment, storage, and disposal of hazardous waste. As production gravitates further South, distribution patterns of commercial TSD installations ought to change correspondingly.

DIFFERENCES IN MEANS AND INDEPENDENT SAMPLES T-TESTS

In this section, bivariate comparisons for neighborhoods with and without TSD installations, across theoretically relevant demographic, economic, and geo-physical characteristics are presented and discussed. As stated in Chapter III, this section uses the t-test statistical methodology. The t-test requires interval-ratio data that are relatively normally distributed. The t-test is used to detect differences between means obtaining for independent groups. Three elements of statistical output are emphasized in the interpretation: 1) mathematical sign; 2) the p-value (i.e., Sig.), estimating "the probability of obtaining the results of a statistical test by chance" (Fink 1995: 45); and 3) mean differences.

Before moving to the data, for analytic clarity, let us recapitulate the four hypotheses tested. Hypothesis I, *economic rationality*, maintains that TSD facility operators, like regular economic actors, are utility maximizing agents. They use a cost-reduction rationale for site selection, searching for areas with adequately skilled labor supply (i.e., industrial proletariat, and technical managerial labor) affordable land, and accessibility to hazardous waste for processing. Seven variables are examined to approximate the economic rationality argument: the number of large quantity generators; percent industrial labor; percent managerial-technical labor; mean value of owner occupied household; median gross rent; percent of housing units built before 1960; and percent of housing units built before 1970 (see Table 3.1 for variable definition statements). Examination of economically relevant neighborhood data allow for logical inferences on TSDF operator decision-making.

Hypothesis II, *scientific rationality*, examines the TSDF location dilemma from the standpoint of physical science. The Environmental Protection Agency has produced clear guidelines for TSDF siting based on geological and hydrological criteria. TSD installation operators are encouraged strongly to avoid earthquake zones and watershed areas. To approximate the influence of these criteria on TSD installation outcomes, the following variables are examined: census tract land area in square Km; water area in square Km; peak ground acceleration; and the percent of hydrologic unit code overlap with census tract (see Table 3.1 for variable definition statements). Examination of the physical characteristics of a neighborhood allows one to comment on TSDF conformity with EPA siting guidelines.

Hypothesis III, *neighborhood social capital*, holds that siting outcomes are a function of neighborhood capacity to organize and repel undesirable land uses. Neighborhoods with a vibrant civic life and substantial social capital, characterized by norms of social reciprocity and trust, are more able than civically starved neighborhoods to mobilize for collective action. Presence of nonprofit organizations and voluntary associations, high population density, and dependent strata of the population to be assisted characterize vibrant civic life. To estimate neighborhood social capital, the following variables are examined: social capital assets; social capital rate; environmental capital assets; environmental capital rate; population density; youth dependency ratio; and old dependency ratio. Single measures on neighborhood social capital and TSDF location outcomes enable logical inferences on phenomena relations synchronically.

Finally, hypothesis IV, *race, class, and gender inequality*, holds that distribution of commercial treatment, storage, and disposal installations is non-random, with social disadvantaged neighborhoods burdened disproportionately by such environmentally risky technologies. According to environmental justice scholars, discriminatory outcomes by race, class, and gender are systemically caused (Stretesky and Hogan 1998; Bullard 1990; and Pulido 1996). Socio-economic forces like institutional discrimination, social stratification, residential segregation by race and class, and market allocation of goods and services intertwine to shape life chances and destinies. Like goods of educational access, income, and life expectancy, environmental "bads" are distributed unevenly. Population strata occupying lower rungs in the American stratification system are more susceptible to toxic exposure, insofar as "bads" flow downward in the system. The following twelve neighborhood variables are measured to test the inequality argument: percent Hispanic persons; percent non-Hispanic White persons; percent non-Hispanic Black persons;

percent American Indian persons; percent families at 50 percent below the official poverty line; percent families at or below the official poverty line; percent persons on public assistance; percent female headed households; percent renter occupied housing units; percent adults without a high school diploma; and percent adults with college education (see Table 3.1 for variable definition statements).

Bivariate Results for EPA Region IV

Tables 4.5 and 4.6 detail statistical differences between TSDF host and non-host neighborhoods for EPA Region IV as a whole. On social capital variables, mean differences between host and non-host neighborhoods are sizable. Host neighborhoods have lower social capital assets ($191,194 versus $3,927,614), a lower social capital rate ($49 versus $1702), lower environmental capital assets ($956 versus $41,090), and a lower environmental capital rate (18 cents versus $309). None of these differences supercede statistical chance. Only the youth dependency ratio is positively significant (t= 2.758, p=.006) with TSDF presence. There is minimal statistical support for the social capital argument at this level of analysis and spatial conception of environmental risk, using the bivariate comparison methodology.

All economic rationality variables, but median gross rent, are statistically significant at the .01 level. Host neighborhoods have significantly more LQG activity (t=14.19), a larger industrial labor force (t=2.86), lower petit bourgeois labor (t= -2.83), cheaper private property ($14,489 dollars lower than non-host neighborhoods), and a greater percentage of housing units built decades ago. The economic rationality argument as whole receives strong statistical confirmation. On scientific rationality measures, two variables are statistically significant, with both variables behaving unexpectedly. TSDF host neighborhoods have smaller land area in square kilometers (67.1km versus 94.9km), and have higher peak ground acceleration figures (6.1%g versus 4.5%g) . Though seismological activity is the Southeastern United States is comparatively low, it is surprising to discover TSD installations, on average, located in significantly higher earthquake risk zones. On hydrology measures, as expected, host communities have lower water area in square km (1.6km versus 6.2km), and a lower percentage of watersheds encased in neighborhoods (3.1% versus 4.0 percent). These mean differences are statistically insignificant.

Examination of demographic inequality variables reveals that host neighborhoods have a significantly higher percentage of African-Americans (34 percent versus 22 percent; t= -4.26, p=.000), a greater percentage of families living in extreme poverty (t=2.03, p=.042) and at or below the official poverty line (t= 1.71, p=.088), and a larger percentage of households on public assistance (t=2.72, p=.007).

Table 4.5: Mean Comparisons of Variables for TSDF Host and Non-Host Tracts for EPA Region IV

	TSDF Host	N	Mean	Std. Deviation	Std. Error Mean
Social Capital Assets	Yes	100	191194.58	409713.87	40971.39
	No	10015	3927614.52	28612787.24	285913.52
Social Capital Rate	Yes	100	49.2327	131.2371	13.1237
	No	10015	1702.6310	28846.8481	288.2524
Environmental Capital Assets	Yes	100	956.0400	9560.4000	956.0400
	No	10015	41090.2007	1028535.8993	10277.6536
Environmental Capital Rate	Yes	100	.1747	1.7468	.1747
	No	10015	309.1254	30041.3455	300.1884
Population Density	Yes	100	513.4280	580.9228	58.0923
	No	10015	629.7558	926.8600	9.2617
Young Dependency Ratio	Yes	100	.3774	.1051	1.051E-02
	No	10015	.3461	.1132	1.131E-03
Old Dependency Ratio	Yes	100	.2000	.1339	1.339E-02
	No	10015	.2481	.3037	3.034E-03
Large Quantity Generators	Yes	100	1.1300	1.5677	.1568
	No	10015	.1937	.6413	6.408E-03
% Industrial Labor	Yes	100	36.2239	10.8513	1.0851
	No	10015	32.1594	13.9988	.1399
% Managerial Technical Labor	Yes	100	45.9589	13.1395	1.3140
	No	10015	50.7245	16.7625	.1675
Mean Value of Household	Yes	100	59009.2044	25021.1735	2502.1173
	No	10015	73498.8632	48217.8098	481.8169
Median Gross Rent	Yes	100	347.250	118.966	11.897
	No	10015	368.278	155.837	1.557
% Units Built Before 1960	Yes	100	37.4157	22.8121	2.2812
	No	10015	31.9357	21.7123	.2170
% Units Built before 1970	Yes	100	55.2976	23.4910	2.3491
	No	10015	49.3533	23.2723	.2325
Land Area Sq Km	Yes	100	67.1188	127.5593	12.7559
	No	10015	94.8510	162.3864	1.6226
Water Area Sq Km	Yes	100	1.6474	5.2302	.5230
	No	10015	6.1456	49.4728	.4944
Peak Ground Acceleration	Yes	100	6.122902433	4.463682588	.446368259
	No	10015	4.451666429	3.671145721	3.66839546E-02
% Hydrologic in Tract	Yes	100	3.06281E-02	7.30055E-02	7.30055E-03
	No	10015	4.00241E-02	9.918005E-02	9.910575E-04
% Hispanic Persons	Yes	100	2.0146	5.9859	.5986
	No	10015	2.9606	9.3999	9.393E-02
% Non-Hispanic White Persons	Yes	100	62.1600	31.5375	3.1537
	No	10015	74.0935	27.8162	.2780
% Non-Hispanic Black Persons	Yes	100	34.3577	32.1967	3.2197
	No	10015	21.8035	27.1233	.2710
% American Indian	Yes	100	.5919	2.2318	.2232
	No	10015	.4219	2.4638	2.462E-02
% Families 50% Below Poverty	Yes	100	9.6334	8.4342	.8434
	No	10015	8.0185	7.8984	7.893E-02
% Families at or Below Poverty	Yes	100	21.5617	13.5391	1.3539
	No	10015	19.2101	13.7003	.1369
% Public Assistance in 1989	Yes	100	10.9926	8.3700	.8370
	No	10015	8.9086	7.6130	7.607E-02
% Female Household w/ Kids	Yes	100	10.1983	6.0938	.6094
	No	10015	7.3361	5.4343	5.430E-02
% Black Female Household	Yes	100	28.7115	15.0685	1.5069
	No	10015	25.7123	16.9294	.1692
% Renter Occupied Units	Yes	100	35.3119	17.6454	1.7645
	No	10015	32.2991	20.0642	.2005
% 18+ Without High School	Yes	100	36.1089	12.1638	1.2164
	No	10015	31.9436	15.0565	.1505
% 18+ With 1 year of College	Yes	100	32.1807	13.1339	1.3134
	No	10015	37.8486	18.2532	.1824
Total Persons	Yes	100	5034.5900	3037.5889	303.7589
	No	10015	4413.8100	2751.5569	27.4950

TABLE 4.6: INDEPENDENT SAMPLES T-TEST FOR TSDF HOST AND NON-HOST TRACTS FOR EPA REGION IV

	F	Sig.	T-Test	DF	(2-tailed)	Mean Difference	Std. Error Difference
SOCIAL CAPITAL							
Social Capital Assets	5.188	.023	-1.306	10113	.192	-3736419.94	2861421.67
Social Capital Rate	1.028	.311	-.573	10113	.567	-1653.3983	2884.8263
Environment Capital Assets	.588	.443	-.390	10113	.696	-40134.1607	102858.6682
Environmental Capital Rate	.042	.838	-.103	10113	.918	-308.9507	3004.2816
Population Density	6.866	.009	-1.253	10113	.210	-116.3279	92.8704
Young Dependency Ratio	1.755	.185	2.758***	10113	.006	3.136E-02	1.137E-02
Old Dependency Ratio	2.409	.121	-1.584	10113	.113	-4.8164E-02	3.040E-02
BUSINESS RATIONALITY							
Large Quantity Generators	168.182	.000	14.19***	10113	.000	.9363	6.600E-02
% Industrial Labor	10.350	.001	2.895***	10113	.004	4.0645	1.4041
% Managerial Labor	9.511	.002	-2.83***	10113	.005	-4.7656	1.6814
Mean Value of Household	8.960	.003	-3.00***	10113	.003	-14489.6588	4828.4311
Median Gross Rent	8.470	.004	-1.345	10113	.179	-21.028	15.629
% Units Built Before 1960	2.047	.153	2.510***	10113	.012	5.4801	2.1832
% Units Built before 1970	.101	.751	2.541***	10113	.011	5.9444	2.3390
SCIENTIFIC RATIONALITY							
Land Area Sq Km	6.945	.008	-1.703*	10113	.089	-27.7322	16.2889
Water Area Sq Km	2.401	.121	-.909	10113	.363	-4.4981	4.9478
Peak Ground Acceleration	8.466	.004	4.519***	10113	.000	1.671236004	.369805705
% Hydrologic in Tract	1.942	.164	-.945	10113	.345	-9.3959E-03	9.94502E-03
RACE, CLASS, GENDER							
% Hispanic Persons	1.729	.189	-1.004	10113	.315	-.9460	.9419
% Non-Hispanic White	7.312	.007	-4.26***	10113	.000	-11.9335	2.7994
% Non-Hispanic Black	12.854	.000	4.60***	10113	.000	12.5542	2.7313
% American Indian	.976	.323	.687	10113	.492	.1700	.2474
% Families 50% of Poverty	.456	.500	2.033**	10113	.042	1.6149	.7943
% Families Below Poverty	.072	.789	1.708*	10113	.088	2.3517	1.3767
% Public Assistance in 1989	2.070	.150	2.721***	10113	.007	2.0841	.7659
% Female House w/ Kids	5.872	.015	5.234***	10113	.000	2.8623	.5468
% Black Female House	2.285	.131	1.765*	10113	.078	2.9992	1.6996
% Renter Occupied Units	1.562	.211	1.496	10113	.135	3.0128	2.0142
% 18+ w/out High School	9.124	.003	2.757***	10113	.006	4.1653	1.5106
% 18+ 1 year of College	14.942	.000	-3.10***	10113	.002	-5.6679	1.8301
Total Persons	.224	.636	2.243**	10113	.025	620.7800	276.8219

*** p <.10; ** p <.05; *** p <.01**

Host neighborhoods have a lower percentage of college-educated adults, and a greater percentage of high school dropouts. Tables 4.5 and 4.6 also indicate that gender matters, with the most socially vulnerable gender groupings – female headed households with children, and African-American, female headed households - burdened unequally. Overall, there is strong and consistent statistical confirmation for demographic inequality arguments at the regional level and in-tract measure of environmental encumbrance.

Tables 4.7 and 4.8 feature statistical differences between environmentally affected and unaffected neighborhoods for EPA Region IV as a whole, at the 1 Mile concentric zone of environmental impact . Of social capital variables, population density (t=3.01, p=.003), the youth dependency ratio (t=2.32, p=.20), and old dependency ratio (t=-1.72, p=.085) are significant. Affected neighborhoods have higher population density, a higher rate of dependent youth, and a lower rate of dependent elderly. At the 1 Mile zone of environmental impact for EPA Region IV, all economic rationality variables show non-random differences between affected and unaffected neighborhoods. Large quantity generator activity is powerfully positively related to TSDF caused environmental impact (t=14.279, p=.000). In fact, LQG presence is the sharpest distinguishing characteristic between affected and unaffected neighborhoods. As predicted, affected neighborhoods have cheaper average property prices ($55,743 versus $73,623) , higher rates of industrial labor (36 percent versus 32 percent), lower rates of managerial-technical labor (45 percent versus 51 percent), and a greater percentage of older housing units. Overall, the commercial suitability argument for TSD installation siting appears valid.

Again, scientific rationality measures, as a whole, behave unpredictably. Average PGA is higher, not lower, in affected neighborhoods, as is the average land area in square km (i.e., 50 km less). The only variable to unfold as expected is the percent hydrologic unit code encased in the neighborhood. Unaffected tracts have a greater percentage of watershed activity. Conversely, inequality variables perform strongly and predictably. Affected neighborhoods are unambiguously poorer, have a higher percentage of African-Americans, and a greater percentage of female-headed households with children. Of inequality measures, the later variable performed sharpest, with more than 11.5 percent of households in affected neighborhoods headed by women with children.

Tables 4.9 and 4.10, compare neighborhoods within and outside 1.5 miles to the nearest commercial TSD installation. Mean differences between affected and unaffected neighborhoods on social capital and environmental capital indicators are considerable, but statistically insignificant. Unaffected neighborhoods have a substantially higher environmental capital rate ($41,481 versus $3.04).

TABLE 4.7: MEAN COMPARISONS OF VARIABLES AT IMPACT ZONE OF 1 MILE FOR EPA REGION IV

	Zone 1 Mile	N	Mean	Std. Deviation	Std. Error Mean
Social Capital Assets	Yes	151	2689594.27	15714483.73	1278826.55
	No	9964	3908876.97	28623114.95	286747.76
Social Capital Rate	Yes	151	1238.8771	8915.1733	725.5065
	No	9964	1693.0653	28900.3105	289.5247
Environmental Capital Assets	Yes	151	17245.6093	196855.2173	16019.8504
	No	9964	41048.7632	1030886.2061	10327.4683
Environmental Capital Rate	Yes	151	4.5575	49.6581	4.0411
	No	9964	310.6403	30118.1292	301.7249
Population Density	Yes	151	853.2300	882.6583	71.8297
	No	9964	625.2017	924.3640	9.2603
Young Dependency Ratio	Yes	151	.3676	.1209	9.842E-03
	No	9964	.3461	.1130	1.132E-03
Old Dependency Ratio	Yes	151	.2055	.1221	9.934E-03
	No	9964	.2483	.3044	3.049E-03
Large Quantity Generators	Yes	151	.9603	1.5444	.1257
	No	9964	.1915	.6338	6.350E-03
% Industrial Labor	Yes	151	35.7272	12.0670	.9820
	No	9964	32.1461	13.9972	.1402
% Managerial Technical Labor	Yes	151	44.9135	14.0639	1.1445
	No	9964	50.7647	16.7593	.1679
Mean Value of Household	Yes	151	55743.0067	25668.5037	2088.8732
	No	9964	73622.5253	48274.9776	483.6211
Median Gross Rent	Yes	151	337.993	113.280	9.219
	No	9964	368.526	156.037	1.563
% Units Built Before 1960	Yes	151	45.0317	25.9127	2.1087
	No	9964	31.7922	21.6005	.2164
% Units Built before 1970	Yes	151	62.1642	24.9099	2.0271
	No	9964	49.2188	23.2026	.2324
Land Area Sq Km	Yes	151	45.3333	108.0638	8.7941
	No	9964	95.3231	162.6669	1.6296
Water Area Sq Km	Yes	151	1.1321	4.3158	.3512
	No	9964	6.1764	49.5974	.4969
Peak Ground Acceleration	Yes	151	5.970115294	4.136493725	.336623085
	No	9964	4.445427752	3.671474258	3.67810081E-02
% Hydrologic in Tract	Yes	151	2.08542E-02	6.090545E-02	4.95641572E-03
	No	9964	4.02203E-02	9.939530E-02	9.95747016E-04
% Hispanic Persons	Yes	151	1.8086	5.3305	.4338
	No	9964	2.9685	9.4195	9.437E-02
% Non-Hispanic White Persons	Yes	151	57.0133	34.6227	2.8176
	No	9964	74.2325	27.6862	.2774
% Non-Hispanic Black Persons	Yes	151	39.5660	35.2979	2.8725
	No	9964	21.6603	26.9770	.2703
% American Indian	Yes	151	.5306	1.8743	.1525
	No	9964	.4220	2.4694	2.474E-02
% Families 50% Below Poverty	Yes	151	11.1357	9.2423	.7521
	No	9964	7.9875	7.8742	7.888E-02
% Families at or Below Poverty	Yes	151	24.7253	14.9200	1.2142
	No	9964	19.1501	13.6646	.1369
% Public Assistance in 1989	Yes	151	12.4935	9.1460	.7443
	No	9964	8.8752	7.5854	7.599E-02
% Female Household w/ Kids	Yes	151	11.5572	6.9954	.5693
	No	9964	7.3008	5.3969	5.407E-02
% Black Female Household	Yes	151	29.9702	15.4084	1.2539
	No	9964	25.6779	16.9283	.1696
% Renter Occupied Units	Yes	151	40.7676	19.9432	1.6230
	No	9964	32.2010	20.0183	.2005
% 18+ Without High School	Yes	151	37.5835	13.5997	1.1067
	No	9964	31.8999	15.0411	.1507
% 18+ With 1 year of College	Yes	151	32.2788	15.3695	1.2508
	No	9964	37.8761	18.2454	.1828
Total Persons	Yes	151	4312.6093	2816.6015	229.2118
	No	9964	4421.5739	2754.2184	27.5919

TABLE 4.8: INDEPENDENT SAMPLES T-TEST FOR EPA REGION IV WITH AN IMPACT ZONE OF 1 MILE

	F	Sig.	T-Test	DF	(2-tailed)	Mean Difference	Std. Error Difference
SOCIAL CAPITAL							
Social Capital Assets	.734	.392	-.522	10113	.602	-1219282	2334709.01
Social Capital Rate	.109	.741	-.193	10113	.847	-454.1882	2353.6727
Environmental Assets	.311	.577	-.284	10113	.777	-23803.10	83919.4409
Environment Capital Rate	.062	.804	-.125	10113	.901	-306.0828	2451.0980
Population Density	.086	.770	3.011***	10113	.003	228.0283	75.7419
Young Dependency Ratio	.092	.761	2.321**	10113	.020	2.154E-02	9.278E-03
Old Dependency Ratio	3.591	.058	-1.724*	10113	.085	-4.27E-02	2.480E-02
BUSINESS RATIONALITY							
Large Quantity Generators	235.985	.000	14.279***	10113	.000	.7688	5.384E-02
% Industrial Labor	13.294	.000	3.126***	10113	.002	3.5811	1.1455
% Managerial Labor	9.624	.002	-4.267***	10113	.000	-5.8513	1.3711
Mean Value of Household	12.896	.000	-4.541***	10113	.000	-17879.51	3937.1058
Median Gross Rent	17.493	.000	-2.395**	10113	.017	-30.532	12.749
% Units Built Before 1960	22.867	.000	7.451***	10113	.000	13.2395	1.7768
% Units Built before 1970	5.079	.024	6.797***	10113	.000	12.9455	1.9046
SCIENTIFIC RATIONALITY							
Land Area Sq Km	25.795	.000	-3.764***	10113	.000	-49.9898	13.2822
Water Area Sq Km	4.316	.038	-1.250	10113	.211	-5.0443	4.0366
Peak Ground Acceleration	6.854	.009	5.055***	10113	.000	1.52468	.301636518
% Hydrologic in Tract	8.950	.003	-2.387**	10113	.017	-1.93E-02	8.11190E-03
RACE, CLASS, GENDER							
% Hispanic Persons	3.887	.049	-1.510	10113	.131	-1.1600	.7684
% Non-Hispanic White	36.747	.000	-7.554***	10113	.000	-17.2192	2.2796
% Non-Hispanic Black	52.206	.000	8.053***	10113	.000	17.9057	2.2236
% American Indian	.671	.413	.538	10113	.590	.1086	.2018
% Families 50% Poverty	11.421	.001	4.863***	10113	.000	3.1482	.6474
% Families Below Poverty	5.219	.022	4.969***	10113	.000	5.5753	1.1220
% Public Assistance 1989	16.405	.000	5.798***	10113	.000	3.6183	.6240
% Female House w/ Kids	39.894	.000	9.571***	10113	.000	4.2564	.4447
% Black Female House	2.401	.121	3.096***	10113	.002	4.2923	1.3862
% Renter Occupied Units	.200	.654	5.219***	10113	.000	8.5666	1.6413
% 18+ w/out High School	5.958	.015	4.615***	10113	.000	5.6836	1.2316
% 18+ 1 year of College	12.922	.000	-3.750***	10113	.000	-5.5973	1.4928
Total Persons	.005	.943	-.482	10113	.630	-108.9646	225.9038

*** p <.10; ** p <.05; *** p <.01**

TABLE 4.9: MEAN COMPARISONS OF VARIABLES AT IMPACT ZONE OF 1.5 MILES FOR EPA REGION IV

	Zone 1.5 miles	N	Mean	Std. Deviation	Std. Error Mean
Social Capital Assets	Yes	260	3610721.57	17616767.23	1092545.52
	No	9855	3898061.01	28704832.47	289152.33
Social Capital Rate	Yes	260	1382.9133	7544.9540	467.9182
	No	9855	1694.2888	29054.7943	292.6776
Environmental Capital Assets	Yes	260	10806.1038	150284.0454	9320.2208
	No	9855	41481.9256	1036562.7544	10441.6056
Environmental Capital Rate	Yes	260	3.0359	38.2081	2.3696
	No	9855	314.0658	30284.2291	305.0621
Population Density	Yes	260	1103.3557	919.4186	57.0199
	No	9855	616.0807	920.9899	9.2774
Young Dependency Ratio	Yes	260	.3714	.1311	8.129E-03
	No	9855	.3457	.1126	1.134E-03
Old Dependency Ratio	Yes	260	.2099	.1178	7.305E-03
	No	9855	.2486	.3058	3.080E-03
Large Quantity Generators	Yes	260	.7462	1.3659	8.471E-02
	No	9855	.1886	.6280	6.326E-03
% Industrial Labor	Yes	260	34.2751	11.3156	.7018
	No	9855	32.1448	14.0363	.1414
% Managerial Technical Labor	Yes	260	44.5749	14.3769	.8916
	No	9855	50.8384	16.7650	.1689
Mean Value of Household	Yes	260	53679.2164	25071.3993	1554.8622
	No	9855	73874.7275	48415.9156	487.7080
Median Gross Rent	Yes	260	341.200	111.034	6.886
	No	9855	368.779	156.469	1.576
% Units Built Before 1960	Yes	260	48.6495	26.6249	1.6512
	No	9855	31.5503	21.4117	.2157
% Units Built before 1970	Yes	260	67.1805	24.1211	1.4959
	No	9855	48.9433	23.0748	.2324
Land Area Sq Km	Yes	260	27.6275	84.8587	5.2627
	No	9855	96.3431	163.2729	1.6447
Water Area Sq Km	Yes	260	.7025	3.3335	.2067
	No	9855	6.2435	49.8668	.5023
Peak Ground Acceleration	Yes	260	5.559779671	3.807126992	.236107993
	No	9855	4.439389834	3.675751609	3.702694E-02
% Hydrologic in Tract	Yes	260	1.28787E-02	4.73375E-02	2.93575E-03
	No	9855	4.06449E-02	9.98604E-02	1.0059E-03
% Hispanic Persons	Yes	260	1.5421	4.6164	.2863
	No	9855	2.9884	9.4630	9.532E-02
% Non-Hispanic White Persons	Yes	260	48.6022	36.2078	2.2455
	No	9855	74.6449	27.3100	.2751
% Non-Hispanic Black Persons	Yes	260	48.3543	37.3672	2.3174
	No	9855	21.2304	26.5330	.2673
% American Indian	Yes	260	.4676	1.5078	9.351E-02
	No	9855	.4224	2.4818	2.500E-02
% Families 50% Below Poverty	Yes	260	12.2712	9.9853	.6193
	No	9855	7.9227	7.8123	7.870E-02
% Families at or Below Poverty	Yes	260	26.7983	16.3328	1.0129
	No	9855	19.0337	13.5677	.1367
% Public Assistance in 1989	Yes	260	13.1960	9.3996	.5829
	No	9855	8.8166	7.5386	7.594E-02
% Female Household w/ Kids	Yes	260	12.8104	7.4555	.4624
	No	9855	7.2207	5.3106	5.350E-02
% Black Female Household	Yes	260	30.1463	14.4936	.8989
	No	9855	25.6258	16.9583	.1708
% Renter Occupied Units	Yes	260	44.2309	20.3715	1.2634
	No	9855	32.0149	19.9395	.2009
% 18+ Without High School	Yes	260	38.1992	14.0355	.8704
	No	9855	31.8208	15.0272	.1514
% 18+ With 1 year of College	Yes	260	32.3130	15.6080	.9680
	No	9855	37.9371	18.2601	.1839
Total Persons	Yes	260	3972.6885	2537.5050	157.3694
	No	9855	4431.7470	2759.6944	27.7992

TABLE 4.10: INDEPENDENT SAMPLES T-TEST FOR EPA REGION IV WITH AN IMPACT ZONE OF 1.5 MILES

	F-Test	Sig.	T-Test	DF	(2-tailed)	Mean Difference	Std. Error Difference
SOCIAL CAPITAL							
Social Capital Assets	.112	.738	-.161	10113	.872	-287339.4	1789074.42
Social Capital Rate	.131	.718	-.173	10113	.863	-311.3755	1803.5848
Environmental Assets	.882	.348	-.477	10113	.633	-30675.82	64305.7441
Environment Capital Rate	.108	.742	-.166	10113	.868	-311.0299	1878.2386
Population Density	3.242	.072	8.421***	10113	.000	487.2750	57.8634
Young Dependency Ratio	5.664	.017	3.610***	10113	.000	2.566E-02	7.107E-03
Old Dependency Ratio	5.453	.020	-2.036**	10113	.042	-3.86E-02	1.900E-02
BUSINESS RATIONALITY							
Large Quantity Generators	294.0	.000	13.499***	10113	.000	.5575	4.130E-02
% Industrial Labor	35.6	.000	2.426**	10113	.015	2.1302	.8779
% Managerial Labor	14.02	.000	-5.967***	10113	.000	-6.2635	1.0498
Mean Value of Household	22.6	.000	-6.702***	10113	.000	-20195.51	3013.3354
Median Gross Rent	29.99	.000	-2.823***	10113	.005	-27.579	9.768
% Units Built Before 1960	55.5	.000	12.622***	10113	.000	17.0992	1.3547
% Units Built before 1970	5.99	.014	12.564***	10113	.000	18.2373	1.4515
SCIENTIFIC RATIONALITY							
Land Area Sq Km	86.04	.000	-6.762***	10113	.000	-68.7157	10.1621
Water Area Sq Km	8.656	.003	-1.792*	10113	.073	-5.5410	3.0929
Peak Ground Acceleration	1.89	.170	4.847***	10113	.000	1.12039	.231163026
% Hydrologic in Tract	32.91	.000	-4.470***	10113	.000	-2.77E-02	6.21164E-03
RACE, CLASS, GENDER							
% Hispanic Persons	10.71	.001	-2.457***	10113	.014	-1.4463	.5887
% Non-Hispanic White	111.6	.000	-15.032***	10113	.000	-26.0427	1.7325
% Non-Hispanic Black	162.7	.000	16.069***	10113	.000	27.1238	1.6879
% American Indian	.319	.572	.292	10113	.770	4.517E-02	.1547
% Family 50% Poverty	48.7	.000	8.788***	10113	.000	4.3485	.4948
% Families Below Poverty	28.36	.000	9.056***	10113	.000	7.7645	.8573
% Public Assistance 1989	39.22	.000	9.181***	10113	.000	4.3794	.4770
% Female House w/ Kids	119.7	.000	16.548***	10113	.000	5.5898	.3378
% Black Female House	5.195	.023	4.257***	10113	.000	4.5205	1.0618
% Renter Occupied Units	1.903	.168	9.745***	10113	.000	12.2160	1.2535
% 18+ w/out High School	5.033	.025	6.767***	10113	.000	6.3784	.9426
% 18+ 1 year of College	15.62	.000	-4.919***	10113	.000	-5.6241	1.1433
Total Persons	.715	.398	-2.653***	10113	.008	-459.0586	173.0485

* p <.10; ** p <.05; *** p <.01

In fact, only six of the 260 affected neighborhoods have an environmental organization present. However, mean differences between affected and unaffected neighborhoods on environmental capital measures do not eclipse statistical error. Age-based measures of social capital potential are true to form. The youth dependency is positively directed (t=3.610, p=.000), and old dependency ratio is negatively associated with environmental risk (t=-2.036, p=.042).

At the 1.5 Mile radius of impact, no surprises detected on economic rationality indicators. All measures perform significantly and mathematical signs behaving as expected. Environmentally affected neighborhoods have a larger industrial workforce (34 percent versus 32 percent), a lower percentage of laborers in managerial-technical occupations (44 percent versus 50 percent), more affordable private property ($25,071 versus $48,416) and significantly more LQG activity (.746 versus .189). For all economic rationality variables, the null hypothesis of no difference between neighborhoods within and outside 1.5 Miles the nearest commercial TSD installation is rejected.

On measures of the hydrologic suitably of a residential area, unaffected neighborhoods have greater water area in square kilometers, and significantly more watershed activity (4.06 percent versus 1.29 percent; t= -4.470, p=.000). Once more, earthquake potential is appreciably higher in affected neighborhoods (5.6%g versus 4.1%g), deepening suspicion that TSDF siting outcomes may not be scientifically driven as routinely claimed by industry insiders and federal regulators.

Race, class, and gender inequality valuations show that affected neighborhoods have a higher percentage of African-Americans (48.4 percent versus 21.2 percent), a greater percentage of persons in extreme poverty (12 percent versus 8 percent; t=8.79, p=.000), and almost 40 percent of persons without a high school diploma. The sharp rise across all measures of demographic inequality as the zone of environmental impact is expanded to 1.5 miles is puzzling. Examination of population density figures for affected communities across estimates of environmental risk – in-tract; 1 mile; and 1.5 miles – shows a gradual increase from 513 to 853 to 1103 persons. This may provide a clue.

Patterns of residential settlement by race reveal that African-Americans are crowded into multi-story, high-density housing projects (Massey and Denton 1993). Many of these housing projects were erected during the heyday of American industrialism, when a sizable proportion of Black males were employed in routine production (Wilson 1987). From coal camps to on-site factory housing, industrialists and state functionaries, to steady the rate of surplus extraction, induced laborers to live close to the shop floor. It is reasonable to assume this norm obtained for African-American labor. Given the persistent history of differential treatment of African-Americans in housing markets, it is likely such residential settlements remain stubbornly in place. The very high presence African-American persons within 1.5 miles of a commercial TSD facility is possibly attributable to housing discrimination, Black spatial isolation and concentration, and historically persistent residential settlements traceable to the 20th Century long swing of American industrialism. Insofar as class and gender hierarchy intersect with race, the explanation for spikes in other inequality measures obtains.

BIVARIATE RESULTS FOR SUB-REGIONS

As done with descriptive statistics, EPA Region IV is subdivided into Deep South and Southern states, and similar tests of mean comparison are conducted. Tables 4.11 to 4.16 present results of bivariate tests comparing TSDF host and non-host communities on theoretically pertinent attributes for the Deep South states of Alabama, Georgia, Mississippi, and South Carolina. Tables 4.17 to 4.22 do the same for the Southern states of Florida, Kentucky, North Carolina, and Tennessee. Again, interpretative emphasis is on directionality of signs and values of significance.

As Tables 4.11 to 4.16 uniformly indicate, at-risk neighborhoods in the Deep South have a greater percentage of African-Americans, a higher percentage of LQG activity, more female-headed households with children, and significantly higher Peak Ground Acceleration averages. Overall, the variable pool for the Deep South sub-region under performs. Not until the analysis is moved to the 1.5 Mile radius of TSD installation impact do mean differences for other variables become significant. Lower population density in the Deep South may be behind variable underperformance. As with test results for EPA Region IV, mean differences between affected and unaffected neighborhoods on the variable of percent African-American increases incrementally as radii of collateral damage expand to 1.5 miles from the nearest commercial TSD installation (t-values =1.85; 3.28; and 6.09).

At the 1.5mile zone of TSDF impact, affected neighborhoods are characterized by higher population density (733 versus 449, t=3.57, p=.000), concentration of large quantity generators of hazardous waste (t= 8.64, p=.000), percent housing units built before 1970 (t=.289, p=.004), peak ground acceleration (t=2.32, p=.020), percent African-American persons (t=6.09, p=.000), percent of families living in extreme poverty (t=2.21, p=.027), percent of families at or below the official poverty line (t=2.86, p=.004), percent of persons on public assistance (t=2.18, p=.004), percent female-headed households (t=5.98, p=.000), percent

TABLE 4.11: MEAN COMPARISONS OF VARIABLES FOR TSDF HOST AND NON-HOST TRACTS FOR DEEP SOUTH

	TSDF Host	N	Mean	Std. Deviation	Std. Error Mean
Social Capital Assets	Yes	45	191327.84	453077.47	67540.80
	No	3922	3479159.68	35179457.66	561739.99
Social Capital Rate	Yes	45	37.9591	79.3688	11.8316
	No	3922	1489.0797	21051.0149	336.1393
Environmental Capital Assets	Yes	45	.0000	.0000	.0000
	No	3922	27023.3985	750112.9011	11977.6837
Environmental Capital Rate	Yes	45	.0000	.0000	.0000
	No	3922	5.6000	127.6777	2.0387
Population Density	Yes	45	387.1667	376.3852	56.1082
	No	3922	455.7494	725.2411	11.5805
Young Dependency Ratio	Yes	45	.3956	8.488E-02	1.265E-02
	No	3922	.3747	.1145	1.828E-03
Old Dependency Ratio	Yes	45	.1846	9.346E-02	1.393E-02
	No	3922	.2042	.1160	1.853E-03
Large Quantity Generators	Yes	45	1.2444	1.4948	.2228
	No	3922	.1866	.6088	9.722E-03
% Industrial Labor	Yes	45	34.9508	11.2324	1.6744
	No	3922	34.4024	13.9793	.2232
% Managerial Technical Labor	Yes	45	47.9910	14.3088	2.1330
	No	3922	49.0566	16.8484	.2690
Mean Value of Household	Yes	45	62621.9194	28458.2162	4242.3004
	No	3922	65621.0142	38915.0916	621.3900
Median Gross Rent	Yes	45	344.022	125.448	18.701
	No	3922	336.196	146.067	2.332
% Units Built Before 1960	Yes	45	29.1021	17.5836	2.6212
	No	3922	32.7753	20.5415	.3280
% Units Built before 1970	Yes	45	48.1320	19.6679	2.9319
	No	3922	50.4629	21.6562	.3458
Land Area Sq Km	Yes	45	84.9905	165.9091	24.7323
	No	3922	121.6528	171.7743	2.7429
Water Area Sq Km	Yes	45	1.5410	5.7150	.8519
	No	3922	4.2626	23.1939	.3704
Peak Ground Acceleration	Yes	45	6.733011400	4.029371265	.600663204
	No	3922	5.002462887	3.181834739	5.08070319E-02
% Hydrologic in Tract	Yes	45	4.60481556E-02	.103736989	1.54641973E-02
	No	3922	4.84567183E-02	.109777498	1.75290965E-03
% Hispanic Persons	Yes	45	1.2616	2.6440	.3941
	No	3922	1.0062	2.8152	4.495E-02
% Non-Hispanic White Persons	Yes	45	59.0124	30.3215	4.5201
	No	3922	67.3185	28.3803	.4532
% Non-Hispanic Black Persons	Yes	45	38.6706	31.1928	4.6499
	No	3922	30.6983	28.6910	.4581
% American Indian	Yes	45	.2656	.4123	6.146E-02
	No	3922	.3260	1.6832	2.688E-02
% Families 50% Below Poverty	Yes	45	9.0811	7.3273	1.0923
	No	3922	9.1704	8.7240	.1393
% Families at or Below Poverty	Yes	45	20.3760	12.3889	1.8468
	No	3922	21.1165	14.4675	.2310
% Public Assistance In 1989	Yes	45	10.4305	7.7628	1.1572
	No	3922	10.3347	8.2913	.1324
% Female Household w/ Kids	Yes	45	10.0518	5.3383	.7958
	No	3922	8.3659	6.1087	9.754E-02
% Black Female Household	Yes	45	27.8175	12.1619	1.8130
	No	3922	27.6805	14.9732	.2391
% Renter Occupied Units	Yes	45	33.5802	15.1894	2.2643
	No	3922	32.0159	20.1984	.3225
% 18+ Without High School	Yes	45	33.2596	11.8518	1.7668
	No	3922	33.7196	15.0103	.2397
% 18+ With 1 year of College	Yes	45	35.5768	14.1929	2.1158
	No	3922	36.4783	18.4362	.2944
Total Persons	Yes	45	5155.3778	2524.4308	376.3199
	No	3922	4167.9577	2390.8153	38.1762

TABLE 4.12: INDEPENDENT SAMPLES T-TEST FOR HOST AND NON-HOST TRACTS FOR DEEP SOUTH STATES

	F	Sig.	T-Test	DF	(2-tailed)	Mean Difference	Std. Error Difference
SOCIAL CAPITAL							
Social Capital Assets	1.265	.261	-.627	3965	.531	-3287831.84	5244902.49
Social Capital Rate	.710	.399	-.462	3965	.644	-1451.1205	3138.4914
Environment Capital Assets	.226	.635	-.242	3965	.809	-27023.3985	111834.1674
Environmental Capital Rate	.335	.563	-.294	3965	.769	-5.6000	19.0354
Population Density	4.332	.037	-.633	3965	.527	-68.5827	108.2893
Young Dependency Ratio	1.277	.259	1.217	3965	.224	2.083E-02	1.712E-02
Old Dependency Ratio	.313	.576	-1.129	3965	.259	-1.9600E-02	1.736E-02
BUSINESS RATIONALITY							
Large Quantity Generators	62.156	.000	11.28***	3965	.000	1.0578	9.379E-02
% Industrial Labor	3.375	.066	.262	3965	.793	.5484	2.0917
% Managerial Labor	1.311	.252	-.423	3965	.673	-1.0657	2.5221
Mean Value of Household	.927	.336	-.515	3965	.606	-2999.0948	5819.2253
Median Gross Rent	.501	.479	.358	3965	.720	7.826	21.867
% Units Built Before 1960	.744	.388	-1.194	3965	.232	-3.6732	3.0751
% Units Built before 1970	.493	.483	-.719	3965	.472	-2.3309	3.2436
SCIENTIFIC RATIONALITY							
Land Area Sq Km	2.515	.113	-1.424	3965	.154	-36.6623	25.7435
Water Area Sq Km	1.538	.215	-.787	3965	.431	-2.7216	3.4591
Peak Ground Acceleration	5.472	.019	3.616***	3965	.000	1.730548513	.478628463
% Hydrologic in Tract	.074	.785	-.146	3965	.884	-2.40856E-03	1.64485E-02
RACE, CLASS, GENDER							
% Hispanic Persons	.923	.337	.606	3965	.545	.2554	.4218
% Non-Hispanic White	.452	.501	-1.95**	3965	.051	-8.3062	4.2582
% Non-Hispanic Black	1.009	.315	1.85*	3965	.064	7.9723	4.3058
% American Indian	.193	.661	-.241	3965	.810	-6.0413E-02	.2510
% Families 50% of Poverty	.237	.627	-.068	3965	.945	-8.9317E-02	1.3058
% Families Below Poverty	.639	.424	-.342	3965	.732	-.7405	2.1658
% Public Assistance in 1989	.002	.969	.077	3965	.939	9.579E-02	1.2422
% Female House w/ Kids	.035	.851	1.843*	3965	.065	1.6859	.9146
% Black Female House	2.064	.151	.061	3965	.951	.1370	2.2406
% Renter Occupied Units	3.713	.054	.518	3965	.605	1.5644	3.0209
% 18+ w/out High School	2.542	.111	-.205	3965	.838	-.4600	2.2457
% 18+ 1 year of College	2.292	.130	-.327	3965	.744	-.9015	2.7578
Total Persons	.000	.996	2.753***	3965	.006	987.4201	358.6689

*** p <.10; ** p <.05; *** p <.01**

TABLE 4.13: MEAN COMPARISONS OF VARIABLES AT IMPACT ZONE OF 1 MILE FOR DEEP SOUTH STATES

	Zone 1 mile	N	Mean	Std. Deviation	Std. Error Mean
Social Capital Assets	Yes	55	3578052.87	15845499.44	2136606.71
	No	3912	3439949.16	35176937.54	562417.21
Social Capital Rate	Yes	55	931.7349	3883.4402	523.6430
	No	3912	1480.2232	21073.4412	336.9272
Environmental Capital Assets	Yes	55	.0000	.0000	.0000
	No	3912	27092.4767	751070.0211	12008.2855
Environmental Capital Rate	Yes	55	.0000	.0000	.0000
	No	3912	5.6143	127.8405	2.0439
Population Density	Yes	55	500.0127	432.8032	58.3592
	No	3912	454.3382	725.5009	11.5995
Young Dependency Ratio	Yes	55	.3895	8.967E-02	1.209E-02
	No	3912	.3748	.1145	1.831E-03
Old Dependency Ratio	Yes	55	.1940	8.914E-02	1.202E-02
	No	3912	.2041	.1162	1.857E-03
Large Quantity Generators	Yes	55	1.1091	1.4360	.1936
	No	3912	.1858	.6076	9.715E-03
% Industrial Labor	Yes	55	33.8989	11.1069	1.4976
	No	3912	34.4158	13.9870	.2236
% Managerial Technical Labor	Yes	55	47.6408	15.2424	2.0553
	No	3912	49.0643	16.8426	.2693
Mean Value of Household	Yes	55	61577.8318	29793.5805	4017.3656
	No	3912	65643.3598	38922.8056	622.3070
Median Gross Rent	Yes	55	338.800	121.944	16.443
	No	3912	336.249	146.159	2.337
% Units Built Before 1960	Yes	55	33.3359	19.9809	2.6942
	No	3912	32.7251	20.5218	.3281
% Units Built before 1970	Yes	55	53.5412	21.8589	2.9474
	No	3912	50.3928	21.6303	.3458
Land Area Sq Km	Yes	55	70.1998	153.0733	20.6404
	No	3912	121.9545	171.8899	2.7482
Water Area Sq Km	Yes	55	1.2629	5.1930	.7002
	No	3912	4.2735	23.2225	.3713
Peak Ground Acceleration	Yes	55	6.433386800	3.887747384	.524223750
	No	3912	5.002251708	3.182701732	5.08857895E-02
% Hydrologic in Tract	Yes	55	3.79060364E-02	9.52492914E-02	1.28434118E-02
	No	3912	4.85773477E-02	.109891778	1.75697579E-03
% Hispanic Persons	Yes	55	1.2999	2.7258	.3675
	No	3912	1.0050	2.8145	4.500E-02
% Non-Hispanic White Persons	Yes	55	54.2375	32.3645	4.3640
	No	3912	67.4069	28.3154	.4527
% Non-Hispanic Black Persons	Yes	55	43.4035	33.6171	4.5329
	No	3912	30.6114	28.6194	.4576
% American Indian	Yes	55	.2326	.3817	5.147E-02
	No	3912	.3267	1.6853	2.694E-02
% Families 50% Below Poverty	Yes	55	10.1907	7.9855	1.0768
	No	3912	9.1551	8.7185	.1394
% Families at or Below Poverty	Yes	55	22.6247	14.5578	1.9630
	No	3912	21.0868	14.4436	.2309
% Public Assistance in 1989	Yes	55	11.5034	8.6786	1.1702
	No	3912	10.3194	8.2789	.1324
% Female Household w/ Kids	Yes	55	11.3952	6.5274	.8802
	No	3912	8.3427	6.0867	9.731E-02
% Black Female Household	Yes	55	27.8090	12.6614	1.7073
	No	3912	27.6803	14.9740	.2394
% Renter Occupied Units	Yes	55	35.2950	15.2701	2.0590
	No	3912	31.9878	20.2057	.3231
% 18+ Without High School	Yes	55	34.3311	13.1681	1.7756
	No	3912	33.7057	15.0023	.2399
% 18+ With 1 year of College	Yes	55	35.3106	15.4682	2.0857
	No	3912	36.4844	18.4314	.2947
Total Persons	Yes	55	4883.2727	2436.3527	328.5177
	No	3912	4169.2592	2392.5661	38.2529

TABLE 4.14: INDEPENDENT SAMPLES T-TEST FOR DEEP SOUTH STATES WITH AN IMPACT ZONE OF 1 MILE

	F	Sig.	T-Test	DF	2-tailed	Mean Difference	Std. Error Difference
SOCIAL CAPITAL							
Social Capital Assets	.001	.969	.029	3965	.977	138103.71	4750487.45
Social Capital Rate	.134	.714	-.193	3965	.847	-548.4883	2842.5617
Environment Capital Assets	.277	.599	-.267	3965	.789	-27092.4767	101286.8517
Environmental Capital Rate	.411	.522	-.326	3965	.745	-5.6143	17.2402
Population Density	2.200	.138	.466	3965	.641	45.6745	98.0788
Young Dependency Ratio	.991	.319	.949	3965	.343	1.471E-02	1.551E-02
Old Dependency Ratio	.483	.487	-.645	3965	.519	-1.0140E-02	1.573E-02
BUSINESS RATIONALITY							
Large Quantity Generators	64.266	.000	10.86***	3965	.000	.9233	8.504E-02
% Industrial Labor	4.863	.027	-.273	3965	.785	-.5169	1.8944
% Managerial Labor	.551	.458	-.623	3965	.533	-1.4234	2.2841
Mean Value of Household	.509	.476	-.771	3965	.441	-4065.5279	5270.1917
Median Gross Rent	.949	.330	.129	3965	.898	2.551	19.805
% Units Built Before 1960	.196	.658	.219	3965	.826	.6108	2.7856
% Units Built before 1970	.175	.676	1.072	3965	.284	3.1483	2.9375
SCIENTIFIC RATIONALITY							
Land Area Sq Km	7.140	.008	-2.22**	3965	.026	-51.7547	23.3071
Water Area Sq Km	2.242	.134	-.961	3965	.337	-3.0105	3.1328
Peak Ground Acceleration	4.890	.027	3.301***	3965	.001	1.431135092	.433607515
% Hydrologic in Tract	.122	.727	-.716	3965	.474	-1.0671E-02	1.48963E-02
RACE, CLASS, GENDER							
% Hispanic Persons	1.707	.191	.772	3965	.440	.2949	.3820
% Non-Hispanic White	3.962	.047	-3.42***	3965	.001	-13.1695	3.8528
% Non-Hispanic Black	6.254	.012	3.283***	3965	.001	12.7921	3.8961
% American Indian	.379	.538	-.414	3965	.679	-9.4111E-02	.2274
% Families 50% of Poverty	.365	.546	.876	3965	.381	1.0356	1.1825
% Families Below Poverty	.803	.370	.784	3965	.433	1.5379	1.9614
% Public Assistance in 1989	1.458	.227	1.053	3965	.293	1.1840	1.1249
% Female House w/ Kids	1.392	.238	3.690***	3965	.000	3.0525	.8273
% Black Female House	1.535	.216	.063	3965	.949	.1288	2.0293
% Renter Occupied Units	3.707	.054	1.209	3965	.227	3.3073	2.7356
% 18+ w/out High School	1.118	.290	.307	3965	.759	.6254	2.0339
% 18+ 1 year of College	1.369	.242	-.470	3965	.638	-1.1738	2.4976
Total Persons	.145	.703	2.197**	3965	.028	714.0135	324.9552

*** p <.10; ** p <.05; *** p <.01**

TABLE 4.15: MEAN COMPARISONS OF VARIABLES AT IMPACT ZONE OF 1.5 MILES FOR DEEP SOUTH STATES

	Zone 1.5 miles	N	Mean	Std. Deviation	Std. Error Mean
Social Capital Assets	Yes	84	2423569.35	12887840.69	1406178.70
	No	3883	3463892.40	35306934.09	566599.66
Social Capital Rate	Yes	84	636.8521	3162.5590	345.0635
	No	3883	1490.6987	21151.6464	339.4380
Environmental Capital Assets	Yes	84	756.5714	4968.6333	542.1223
	No	3883	27278.4489	753866.7594	12097.9253
Environmental Capital Rate	Yes	84	.1832	1.1815	.1289
	No	3883	5.6523	128.3163	2.0592
Population Density	Yes	84	732.5593	645.7148	70.4533
	No	3883	448.9665	722.7035	11.5978
Young Dependency Ratio	Yes	84	.3890	.1118	1.219E-02
	No	3883	.3747	.1143	1.833E-03
Old Dependency Ratio	Yes	84	.1979	9.456E-02	1.032E-02
	No	3883	.2041	.1162	1.866E-03
Large Quantity Generators	Yes	84	.7857	1.2713	.1387
	No	3883	.1859	.6086	9.766E-03
% Industrial Labor	Yes	84	33.0961	10.9744	1.1974
	No	3883	34.4371	14.0073	.2248
% Managerial Technical Labor	Yes	84	47.1777	15.8958	1.7344
	No	3883	49.0849	16.8397	.2702
Mean Value of Household	Yes	84	59289.3541	29537.0251	3222.7536
	No	3883	65723.2290	38978.8506	625.5260
Median Gross Rent	Yes	84	344.286	124.667	13.602
	No	3883	336.112	146.271	2.347
% Units Built Before 1960	Yes	84	35.7926	21.4519	2.3406
	No	3883	32.6674	20.4891	.3288
% Units Built before 1970	Yes	84	57.1769	23.7141	2.5874
	No	3883	50.2907	21.5667	.3461
Land Area Sq Km	Yes	84	47.3297	127.4779	13.9090
	No	3883	122.8357	172.2267	2.7639
Water Area Sq Km	Yes	84	.8319	4.2311	.4617
	No	3883	4.3053	23.3061	.3740
Peak Ground Acceleration	Yes	84	5.822294631	3.654301330	.398716963
	No	3883	5.004782953	3.185036156	5.11129176E-02
% Hydrologic in Tract	Yes	84	2.553697E-02	7.876388E-02	8.593844E-03
	No	3883	4.892462E-02	.110226959	1.768903E-03
% Hispanic Persons	Yes	84	1.1672	2.3692	.2585
	No	3883	1.0057	2.8221	4.529E-02
% Non-Hispanic White Persons	Yes	84	47.9832	34.2126	3.7329
	No	3883	67.6406	28.1342	.4515
% Non-Hispanic Black Persons	Yes	84	49.6034	35.6432	3.8890
	No	3883	30.3818	28.4290	.4562
% American Indian	Yes	84	.2546	.6032	6.581E-02
	No	3883	.3269	1.6899	2.712E-02
% Families 50% Below Poverty	Yes	84	11.2424	8.4874	.9260
	No	3883	9.1246	8.7090	.1398
% Families at or Below Poverty	Yes	84	25.5682	16.9351	1.8478
	No	3883	21.0116	14.3730	.2307
% Public Assistance in 1989	Yes	84	12.2802	8.7466	.9543
	No	3883	10.2938	8.2704	.1327
% Female Household w/ Kids	Yes	84	12.3047	7.3610	.8031
	No	3883	8.3003	6.0456	9.702E-02
% Black Female Household	Yes	84	29.6842	13.1135	1.4308
	No	3883	27.6387	14.9786	.2404
% Renter Occupied Units	Yes	84	37.6655	16.4742	1.7975
	No	3883	31.9118	20.2043	.3242
% 18+ Without High School	Yes	84	35.4831	14.9570	1.6319
	No	3883	33.6761	14.9772	.2404
% 18+ With 1 year of College	Yes	84	34.9835	16.9942	1.8542
	No	3883	36.5002	18.4222	.2956
Total Persons	Yes	84	4495.1071	2403.4969	262.2430
	No	3883	4172.3237	2393.9735	38.4181

TABLE 4.16: INDEPENDENT SAMPLES T-TEST FOR DEEP SOUTH STATES AT IMPACT ZONE OF 1.5 MILES

	F	Sig.	T-Test	DF	(2-tailed)	Mean Difference	Std. Error Difference
SOCIAL CAPITAL							
Social Capital Assets	.236	.627	-.270	3965	.787	-1040323.06	3858261.59
Social Capital Rate	.469	.493	-.370	3965	.712	-853.8466	2308.6701
Environment Capital Assets	.402	.526	-.322	3965	.747	-26521.8775	82263.7925
Environmental Capital Rate	.591	.442	-.391	3965	.696	-5.4690	14.0022
Population Density	.007	.934	3.566***	3965	.000	283.5928	79.5333
Young Dependency Ratio	.394	.530	1.138	3965	.255	1.433E-02	1.259E-02
Old Dependency Ratio	.152	.697	-.487	3965	.626	-6.2222E-03	1.277E-02
BUSINESS RATIONALITY							
Large Quantity Generators	78.941	.000	8.638***	3965	.000	.5998	6.944E-02
% Industrial Labor	8.455	.004	-.872	3965	.383	-1.3410	1.5385
% Managerial Labor	.500	.480	-1.028	3965	.304	-1.9072	1.8550
Mean Value of Household	.638	.424	-1.503	3965	.133	-6433.8750	4279.4965
Median Gross Rent	1.440	.230	.508	3965	.611	8.174	16.085
% Units Built Before 1960	2.878	.090	1.382	3965	.167	3.1252	2.2619
% Units Built before 1970	3.694	.055	2.889***	3965	.004	6.8863	2.3836
SCIENTIFIC RATIONALITY							
Land Area Sq Km	27.665	.000	-3.99***	3965	.000	-75.5060	18.9035
Water Area Sq Km	4.468	.035	-1.365	3965	.172	-3.4733	2.5441
Peak Ground Acceleration	4.805	.028	2.320**	3965	.020	.817511678	.352415905
% Hydrologic in Tract	3.334	.068	-1.934**	3965	.053	-2.3387E-02	1.209370E-02
RACE, CLASS, GENDER							
% Hispanic Persons	1.135	.287	.521	3965	.603	.1615	.3103
% Non-Hispanic White	16.366	.000	-6.30***	3965	.000	-19.6574	3.1182
% Non-Hispanic Black	22.532	.000	6.094***	3965	.000	19.2216	3.1539
% American Indian	.229	.632	-.392	3965	.695	-7.2320E-02	.1847
% Families 50% of Poverty	2.543	.111	2.206**	3965	.027	2.1178	.9599
% Families Below Poverty	7.452	.006	2.863***	3965	.004	4.5566	1.5915
% Public Assistance in 1989	3.907	.048	2.175**	3965	.030	1.9864	.9132
% Female House w/ Kids	12.332	.000	5.976***	3965	.000	4.0044	.6701
% Black Female House	1.805	.179	1.241	3965	.215	2.0455	1.6478
% Renter Occupied Units	2.335	.127	2.591***	3965	.010	5.7537	2.2204
% 18+ w/out High School	.004	.948	1.094	3965	.274	1.8070	1.6517
% 18+ 1 year of College	.321	.571	-.748	3965	.455	-1.5167	2.0285
Total Persons	.004	.953	1.222	3965	.222	322.7834	264.0361

*** p <.10; ** p <.05; *** p <.01**

renter occupied housing units (t=2.59, p=.010), and significantly smaller land area in square Km (t=-3.99, p=.000), and percentage of watershed overlap with census tract boundaries. Overall, the behavior of demographic inequality indicators in the Deep South supports the environmental justice movement accusation that socially marginalized strata of the population shoulder a disproportionate share of hazardous waste facilities. Environmentally compromised neighborhoods in the Deep South (1.5 Mile zone of impact) are undeniable impoverished and Black.

As Tables 4.11, 4.13, and 4.15 reveal, the Deep South is almost completely void of environmental capital assets. Not one of the 55 affected neighborhoods at the 1 Mile radius measure of environmental risk, has an environmental organization. Of the 84 at-risk neighborhoods at the 1.5 Mile measure of environmental impact, only two have an environmental organizational presence. Though notable analytically, the absence of environmental organizations in the Deep South is irrelevant statistically. Mean differences between affected and unaffected neighborhoods could be a function of statistical chance.

The picture of environmental risk is considerably different for the Southern States of Florida, Kentucky, North Carolina, and Tennessee. Whereas economic rationality variables perform relatively poorly in the Deep South, they hop off the page for the Southern sub-region. As Tables 4.17 and 4.18 indicate, host communities are significantly different than non-host communities on every measure of economic suitability for TSDF operations. Host communities are characterized by higher LQG activity (t=9.15, p=.000), a greater percentage of the workforce in industrial occupations (t=3.51, p=.000), private property that is, on average, $22,500 dollars cheaper, and a higher percentage of homes built in decades past (see Table 4.19 and 4.20 for descriptive statistics).

Estimates of social capital, across spatial measures of environmental risk, show sizable mean differences between affected and unaffected neighborhoods, but none that rise above statistical error. Again, at whatever spatial operationalization of environmental hazard, differences on environmental capital assets and rates are large, but insignificant statistically. It may be fruitful to probe these manifest differences qualitatively.

On scientific rationality variables, as with the Deep South, affected communities in the South have higher average peak ground acceleration figures, smaller land area in square km, and larger percentages of watershed overlap. As Table 4.21 and 4.22 show, neighborhoods within 1.5 miles of a commercial TSD installation are more suitable on hydrologic criteria (.006 percent versus 3.5 percent; t=-4.09, p=.000), than neighborhoods outside this zone of impact. Overall, t-test results on scientific rationality variables for

TABLE 4.17: MEAN COMPARISONS OF VARIABLES ON TSDF HOST COMMUNITIES FOR SOUTHERN STATES

	TSDF Host	N	Mean	Std. Deviation	Std. Error Mean
Social Capital Assets	Yes	55	191085.55	374818.32	50540.49
	No	6093	4216280.18	23430630.36	300170.76
Social Capital Rate	Yes	55	58.4566	162.0197	21.8467
	No	6093	1840.0918	32902.8644	421.5199
Environmental Capital Assets	Yes	55	1738.2545	12891.2407	1738.2545
	No	6093	50144.8533	1173280.5261	15030.9446
Environmental Capital Rate	Yes	55	.3176	2.3554	.3176
	No	6093	504.5015	38514.7798	493.4144
Population Density	Yes	55	616.7326	692.1788	93.3334
	No	6093	741.7619	1020.5686	13.0745
Young Dependency Ratio	Yes	55	.3626	.1179	1.590E-02
	No	6093	.3276	.1085	1.390E-03
Old Dependency Ratio	Yes	55	.2125	.1593	2.148E-02
	No	6093	.2764	.3753	4.808E-03
Large Quantity Generators	Yes	55	1.0364	1.6326	.2201
	No	6093	.1983	.6613	8.473E-03
% Industrial Labor	Yes	55	37.2655	10.5176	1.4182
	No	6093	30.7156	13.8213	.1771
% Managerial Technical Labor	Yes	55	44.2963	11.9765	1.6149
	No	6093	51.7981	16.6201	.2129
Mean Value of Household	Yes	55	56053.3467	21635.7484	2917.3637
	No	6093	78569.7518	52738.7546	675.6383
Median Gross Rent	Yes	55	349.891	114.492	15.438
	No	6093	388.928	158.425	2.030
% Units Built Before 1960	Yes	55	44.2178	24.4418	3.2957
	No	6093	31.3952	22.4187	.2872
% Units Built before 1970	Yes	55	61.1604	24.8735	3.3539
	No	6093	48.6390	24.2304	.3104
Land Area Sq Km	Yes	55	52.4965	83.1773	11.2156
	No	6093	77.5990	153.6047	1.9678
Water Area Sq Km	Yes	55	1.7345	4.8498	.6539
	No	6093	7.3576	60.6077	.7764
Peak Ground Acceleration	Yes	55	5.623722369	4.768122730	.642933538
	No	6093	4.097124543	3.913660490	5.013806E-02
% Hydrologic in Tract	Yes	55	1.801180E-02	2.534834E-02	3.417970E-03
	No	6093	3.459617E-02	9.131146E-02	1.169794E-03
% Hispanic Persons	Yes	55	2.6307	7.6899	1.0369
	No	6093	4.2186	11.6662	.1495
% Non-Hispanic White Persons	Yes	55	64.7352	32.5470	4.3886
	No	6093	78.4544	26.5499	.3401
% Non-Hispanic Black Persons	Yes	55	30.8290	32.8557	4.4303
	No	6093	16.0780	24.4080	.3127
% American Indian	Yes	55	.8589	2.9719	.4007
	No	6093	.4836	2.8540	3.656E-02
% Families 50% Below Poverty	Yes	55	10.0853	9.2847	1.2520
	No	6093	7.2771	7.2221	9.252E-02
% Families at or Below Poverty	Yes	55	22.5319	14.4524	1.9488
	No	6093	17.9829	13.0375	.1670
% Public Assistance in 1989	Yes	55	11.4525	8.8802	1.1974
	No	6093	7.9906	6.9908	8.956E-02
% Female Household w/ Kids	Yes	55	10.3182	6.6953	.9028
	No	6093	6.6732	4.8378	6.198E-02
% Black Female Household	Yes	55	29.4430	17.1623	2.3142
	No	6093	24.4454	17.9644	.2301
% Renter Occupied Units	Yes	55	36.7288	19.4498	2.6226
	No	6093	32.4814	19.9769	.2559
% 18+ Without High School	Yes	55	38.4401	12.0210	1.6209
	No	6093	30.8004	14.9764	.1919
% 18+ With 1 year of College	Yes	55	29.4021	11.6033	1.5646
	No	6093	38.7306	18.0811	.2316
Total Persons	Yes	55	4935.7636	3420.7238	461.2503
	No	6093	4572.0625	2949.9705	37.7922

Table 4.18: Independent Samples T-Test Host and Non-Host Tracts for Southern States

	F	Sig.	T-Test	DF	(2-tailed)	Mean Difference	Std. Error Difference
SOCIAL CAPITAL							
Social Capital Assets	4.873	.027	-1.274	6146	.203	-4025194.64	3159643.83
Social Capital Rate	.488	.485	-.402	6146	.688	-1781.6352	4436.9795
Environment Capital Assets	.361	.548	-.306	6146	.760	-48406.5987	158217.9524
Environmental Capital Rate	.037	.847	-.097	6146	.923	-504.1839	5193.7505
Population Density	2.440	.118	-.907	6146	.365	-125.0293	137.9048
Young Dependency Ratio	.741	.389	2.379**	6146	.017	3.498E-02	1.471E-02
Old Dependency Ratio	2.220	.136	-1.261	6146	.207	-6.3867E-02	5.065E-02
BUSINESS RATIONALITY							
Large Quantity Generators	107.341	.000	9.154***	6146	.000	.8381	9.156E-02
% Industrial Labor	6.337	.012	3.505***	6146	.000	6.5499	1.8686
% Managerial Labor	10.925	.001	-3.34***	6146	.001	-7.5018	2.2464
Mean Value of Household	8.249	.004	-3.16***	6146	.002	-22516.4051	7117.1684
Median Gross Rent	8.451	.004	-1.823*	6146	.068	-39.038	21.413
% Units Built Before 1960	2.191	.139	4.219***	6146	.000	12.8226	3.0391
% Units Built before 1970	.305	.581	3.814***	6146	.000	12.5214	3.2827
SCIENTIFIC RATIONALITY							
Land Area Sq Km	4.468	.035	-1.210	6146	.226	-25.1025	20.7406
Water Area Sq Km	1.469	.226	-.688	6146	.491	-5.6231	8.1732
Peak Ground Acceleration	2.777	.096	2.874***	6146	.004	1.526597826	.531220986
% Hydrologic in Tract	5.257	.022	-1.346	6146	.178	-1.6584E-02	1.23176E-02
RACE, CLASS, GENDER							
% Hispanic Persons	1.473	.225	-1.007	6146	.314	-1.5879	1.5762
% Non-Hispanic White	10.600	.001	-3.81***	6146	.000	-13.7192	3.6040
% Non-Hispanic Black	18.463	.000	4.446***	6146	.000	14.7510	3.3178
% American Indian	2.208	.137	.970	6146	.332	.3752	.3867
% Families 50% of Poverty	2.332	.127	2.863***	6146	.004	2.8082	.9810
% Families Below Poverty	.183	.669	2.573***	6146	.010	4.5490	1.7677
% Public Assistance in 1989	4.688	.030	3.646***	6146	.000	3.4620	.9494
% Female House w/ Kids	14.661	.000	5.541***	6146	.000	3.6451	.6579
% Black Female House	.715	.398	2.055**	6146	.040	4.9976	2.4323
% Renter Occupied Units	.029	.866	1.570	6146	.116	4.2474	2.7052
% 18+ w/out High School	5.541	.019	3.772***	6146	.000	7.6397	2.0253
% 18+ 1 year of College	16.013	.000	-3.82***	6146	.000	-9.3285	2.4427
Total Persons	.431	.512	.909	6146	.363	363.7011	400.1697

*** p <.10; ** p <.05; *** p <.01**

TABLE 4.19: MEAN COMPARISONS OF VARIABLES AT IMPACT ZONE OF 1 MILE FOR SOUTHERN STATES

	Zone 1 mile	N	Mean	Std. Deviation	Std. Error Mean
Social Capital Assets	Yes	96	2180581.53	15699530.69	1602326.64
	No	6052	4211990.92	23429199.87	301167.43
Social Capital Rate	Yes	96	1414.8440	10809.1123	1103.2004
	No	6052	1830.6460	32986.7503	424.0236
Environmental Capital Assets	Yes	96	27125.9063	246812.6784	25190.2135
	No	6052	50070.0773	1176848.5784	15127.6381
Environmental Capital Rate	Yes	96	7.1686	62.2467	6.3530
	No	6052	507.8085	38645.0208	496.7571
Population Density	Yes	96	1055.5941	1005.0106	102.5735
	No	6052	735.6475	1017.6334	13.0810
Young Dependency Ratio	Yes	96	.3551	.1345	1.373E-02
	No	6052	.3275	.1081	1.390E-03
Old Dependency Ratio	Yes	96	.2122	.1374	1.403E-02
	No	6052	.2768	.3765	4.839E-03
Large Quantity Generators	Yes	96	.8750	1.6043	.1637
	No	6052	.1951	.6503	8.359E-03
% Industrial Labor	Yes	96	36.7747	12.5200	1.2778
	No	6052	30.6790	13.8078	.1775
% Managerial Technical Labor	Yes	96	43.3509	13.1708	1.3442
	No	6052	51.8639	16.6142	.2136
Mean Value of Household	Yes	96	52400.1381	22466.8287	2293.0111
	No	6052	78780.2410	52822.0938	678.9943
Median Gross Rent	Yes	96	337.531	108.667	11.091
	No	6052	389.389	158.657	2.039
% Units Built Before 1960	Yes	96	51.7324	26.6216	2.7171
	No	6052	31.1892	22.2508	.2860
% Units Built before 1970	Yes	96	67.1046	25.3068	2.5829
	No	6052	48.4599	24.1359	.3103
Land Area Sq Km	Yes	96	31.0869	67.5025	6.8894
	No	6052	78.1087	153.9988	1.9796
Water Area Sq Km	Yes	96	1.0571	3.7503	.3828
	No	6052	7.4064	60.8098	.7817
Peak Ground Acceleration	Yes	96	5.704699327	4.269639252	.435768231
	No	6052	4.085497924	3.913726155	5.030845E-02
% Hydrologic in Tract	Yes	96	1.108496E-02	2.086447E-02	2.129471E-03
	No	6052	3.481840E-02	9.157979E-02	1.177199E-03
% Hispanic Persons	Yes	96	2.1000	6.3566	.6488
	No	6052	4.2378	11.6990	.1504
% Non-Hispanic White Persons	Yes	96	58.6037	35.9211	3.6662
	No	6052	78.6446	26.3494	.3387
% Non-Hispanic Black Persons	Yes	96	37.3675	36.2146	3.6961
	No	6052	15.8744	24.1574	.3105
% American Indian	Yes	96	.7014	2.3202	.2368
	No	6052	.4836	2.8627	3.680E-02
% Families 50% Below Poverty	Yes	96	11.6772	9.8901	1.0094
	No	6052	7.2328	7.1769	9.225E-02
% Families at or Below Poverty	Yes	96	25.9288	15.0665	1.5377
	No	6052	17.8982	12.9849	.1669
% Public Assistance in 1989	Yes	96	13.0607	9.4008	.9595
	No	6052	7.9416	6.9439	8.926E-02
% Female Household w/ Kids	Yes	96	11.6501	7.2818	.7432
	No	6052	6.6273	4.7808	6.145E-02
% Black Female Household	Yes	96	31.2083	16.7181	1.7063
	No	6052	24.3836	17.9624	.2309
% Renter Occupied Units	Yes	96	43.9030	21.6375	2.2084
	No	6052	32.3389	19.8968	.2558
% 18+ Without High School	Yes	96	39.4469	13.5585	1.3838
	No	6052	30.7327	14.9518	.1922
% 18+ With 1 year of College	Yes	96	30.5418	15.1197	1.5432
	No	6052	38.7758	18.0688	.2323
Total Persons	Yes	96	3985.6667	2975.8323	303.7196
	No	6052	4584.6695	2953.3492	37.9634

TABLE 4.20: INDEPENDENT SAMPLES T-TEST FOR SOUTHERN STATES AT IMPACT ZONE 1 MILE

	F	Sig.	T-Test	DF	(2-tailed)	Mean Difference	Std. Error Difference
SOCIAL CAPITAL							
Social Capital Assets	1.952	.162	-.846	6146	.397	-2031409.39	2399838.44
Social Capital Rate	.035	.851	-.123	6146	.902	-415.8020	3369.8024
Environment Capital Assets	.145	.704	-.191	6146	.849	-22944.1711	120162.6884
Environmental Capital Rate	.064	.801	-.127	6146	.899	-500.6399	3944.5068
Population Density	.714	.398	3.057***	6146	.002	319.9466	104.6623
Young Dependency Ratio	2.027	.155	2.468***	6146	.014	2.756E-02	1.117E-02
Old Dependency Ratio	3.866	.049	-1.682*	6146	.093	-6.4687E-02	3.847E-02
BUSINESS RATIONALITY							
Large Quantity Generators	174.353	.000	9.786***	6146	.000	.6799	6.947E-02
% Industrial Labor	7.400	.007	4.297***	6146	.000	6.0957	1.4184
% Managerial Labor	11.002	.001	-4.99***	6146	.000	-8.5130	1.7042
Mean Value of Household	14.001	.000	-4.89***	6146	.000	-26380.1028	5399.2151
Median Gross Rent	17.877	.000	-3.19***	6146	.001	-51.858	16.254
% Units Built Before 1960	14.277	.000	8.945***	6146	.000	20.5432	2.2965
% Units Built before 1970	1.550	.213	7.504***	6146	.000	18.6447	2.4847
SCIENTIFIC RATIONALITY							
Land Area Sq Km	16.535	.000	-2.99***	6146	.003	-47.0218	15.7424
Water Area Sq Km	3.028	.082	-1.023	6146	.306	-6.3493	6.2071
Peak Ground Acceleration	1.910	.167	4.016***	6146	.000	1.619201403	.403189846
% Hydrologic in Tract	13.520	.000	-2.54***	6146	.011	-2.3733E-02	9.35138E-03
RACE, CLASS, GENDER							
% Hispanic Persons	5.354	.021	-1.786*	6146	.074	-2.1378	1.1969
% Non-Hispanic White	44.496	.000	-7.35***	6146	.000	-20.0410	2.7284
% Non-Hispanic Black	70.430	.000	8.57***	6146	.000	21.4931	2.5089
% American Indian	1.227	.268	.742	6146	.458	.2178	.2937
% Families 50% of Poverty	17.900	.000	5.98***	6146	.000	4.4444	.7434
% Families Below Poverty	5.149	.023	5.99***	6146	.000	8.0306	1.3393
% Public Assistance in 1989	22.638	.000	7.121***	6146	.000	5.1191	.7189
% Female House w/ Kids	65.425	.000	10.11***	6146	.000	5.0227	.4968
% Black Female House	1.314	.252	3.697***	6146	.000	6.8248	1.8458
% Renter Occupied Units	2.699	.100	5.642***	6146	.000	11.5641	2.0496
% 18+ w/out High School	4.714	.030	5.673***	6146	.000	8.7142	1.5359
% 18+ 1 year of College	13.626	.000	-4.44***	6146	.000	-8.2339	1.8544
Total Persons	.089	.766	-1.971**	6146	.049	-599.0029	303.8421

*** p <.10; ** p <.05; *** p <.01**

Table 4.21: Mean Comparisons of Variables at Impact Zone of 1.5 Miles for Southern States

	Zone 1.5 miles	N	Mean	Std. Deviation	Std. Error Mean
Social Capital Assets	Yes	176	4177316.94	19481843.10	1468499.18
	No	5972	4180357.85	23433843.67	303238.00
Social Capital Rate	Yes	176	1738.9879	8894.5254	670.4501
	No	5972	1826.6632	33200.1094	429.6152
Environmental Capital Assets	Yes	176	15602.4716	182600.4202	13764.0246
	No	5972	50717.0395	1184691.3366	15330.1115
Environmental Capital Rate	Yes	176	4.3974	46.4130	3.4985
	No	5972	514.5966	38902.9993	503.4116
Population Density	Yes	176	1280.3267	977.6727	73.6949
	No	5972	724.7385	1015.0322	13.1347
Young Dependency Ratio	Yes	176	.3630	.1389	1.047E-02
	No	5972	.3269	.1074	1.390E-03
Old Dependency Ratio	Yes	176	.2157	.1272	9.592E-03
	No	5972	.2776	.3787	4.900E-03
Large Quantity Generators	Yes	176	.7273	1.4120	.1064
	No	5972	.1904	.6404	8.286E-03
% Industrial Labor	Yes	176	34.8378	11.4629	.8640
	No	5972	30.6544	13.8542	.1793
% Managerial Technical Labor	Yes	176	43.3326	13.4634	1.0148
	No	5972	51.9785	16.6188	.2150
Mean Value of Household	Yes	176	51001.6507	22230.3747	1675.6775
	No	5972	79174.8394	53003.6928	685.8770
Median Gross Rent	Yes	176	339.727	104.250	7.858
	No	5972	390.019	159.213	2.060
% Units Built Before 1960	Yes	176	54.7857	26.7148	2.0137
	No	5972	30.8240	21.9620	.2842
% Units Built before 1970	Yes	176	71.9550	22.8785	1.7245
	No	5972	48.0672	23.9658	.3101
Land Area Sq Km	Yes	176	18.2241	51.7184	3.8984
	No	5972	79.1176	154.7783	2.0029
Water Area Sq Km	Yes	176	.6407	2.8183	.2124
	No	5972	7.5038	61.2099	.7921
Peak Ground Acceleration	Yes	176	5.434488440	3.881881061	.292607795
	No	5972	4.071770698	3.919080609	5.071358E-02
% Hydrologic in Tract	Yes	176	6.837295E-03	1.61395477E-02	1.216564E-03
	No	5972	3.526151E-02	9.21102633E-02	1.191922E-03
% Hispanic Persons	Yes	176	1.7210	5.3646	.4044
	No	5972	4.2776	11.7637	.1522
% Non-Hispanic White Persons	Yes	176	48.8976	37.2137	2.8051
	No	5972	79.1991	25.7605	.3333
% Non-Hispanic Black Persons	Yes	176	47.7581	38.2475	2.8830
	No	5972	15.2803	23.3773	.3025
% American Indian	Yes	176	.5693	1.7776	.1340
	No	5972	.4846	2.8807	3.728E-02
% Families 50% Below Poverty	Yes	176	12.7623	10.6136	.8000
	No	5972	7.1413	7.0612	9.137E-02
% Families at or Below Poverty	Yes	176	27.3853	16.0532	1.2101
	No	5972	17.7477	12.8563	.1664
% Public Assistance in 1989	Yes	176	13.6331	9.6893	.7304
	No	5972	7.8562	6.8540	8.869E-02
% Female Household w/ Kids	Yes	176	13.0518	7.5090	.5660
	No	5972	6.5187	4.6401	6.004E-02
% Black Female Household	Yes	176	30.3669	15.1388	1.1411
	No	5972	24.3170	18.0108	.2331
% Renter Occupied Units	Yes	176	47.3643	21.3287	1.6077
	No	5972	32.0819	19.7669	.2558
% 18+ Without High School	Yes	176	39.4956	13.4246	1.0119
	No	5972	30.6145	14.9378	.1933
% 18+ With 1 year of College	Yes	176	31.0385	14.7821	1.1142
	No	5972	38.8714	18.0943	.2341
Total Persons	Yes	176	3723.3523	2568.3147	193.5940
	No	5972	4600.4243	2961.4787	38.3220

TABLE 4.22: INDEPENDENT SAMPLES TEST FOR SOUTHERN STATES AT IMPACT ZONE 1.5 MILES

	F	Sig.	T-Test	DF	(2-tailed)	Mean Difference	Std. Error Difference
SOCIAL CAPITAL							
Social Capital Assets	.005	.946	-.002	6146	.999	-3040.91	1784334.05
Social Capital Rate	.014	.905	-.035	6146	.972	-87.6753	2505.3810
Environment Capital Assets	.598	.439	-.393	6146	.694	-35114.5679	89337.6057
Environmental Capital Rate	.120	.729	-.174	6146	.862	-510.1992	2932.6555
Population Density	.874	.350	7.164***	6146	.000	555.5882	77.5503
Young Dependency Ratio	8.122	.004	4.348***	6146	.000	3.606E-02	8.294E-03
Old Dependency Ratio	6.921	.009	-2.164**	6146	.030	-6.1889E-02	2.859E-02
BUSINESS RATIONALITY							
Large Quantity Generators	208.396	.000	10.41***	6146	.000	.5369	5.160E-02
% Industrial Labor	24.443	.000	3.97***	6146	.000	4.1833	1.0548
% Managerial Labor	16.497	.000	-6.84***	6146	.000	-8.6459	1.2648
Mean Value of Household	25.219	.000	-7.03***	6146	.000	-28173.1887	4005.9056
Median Gross Rent	30.935	.000	-4.16***	6146	.000	-50.292	12.077
% Units Built Before 1960	30.862	.000	14.17***	6146	.000	23.9617	1.6911
% Units Built before 1970	.152	.696	13.05***	6146	.000	23.8878	1.8306
SCIENTIFIC RATIONALITY							
Land Area Sq Km	51.822	.000	-5.21***	6146	.000	-60.8935	11.6868
Water Area Sq Km	6.240	.013	-1.487	6146	.137	-6.8631	4.6144
Peak Ground Acceleration	.004	.952	4.55***	6146	.000	1.362717743	.299652593
% Hydrologic in Tract	33.165	.000	-4.09***	6146	.000	-2.8424E-02	6.94674E-03
RACE, CLASS, GENDER							
% Hispanic Persons	14.814	.000	-2.87***	6146	.004	-2.5565	.8895
% Non-Hispanic White	124.552	.000	-15.2***	6146	.000	-30.3015	2.0004
% Non-Hispanic Black	214.725	.000	17.75***	6146	.000	32.4779	1.8301
% American Indian	.388	.533	.388	6146	.698	8.472E-02	.2184
% Families 50% of Poverty	73.649	.000	10.23***	6146	.000	5.6210	.5496
% Families Below Poverty	26.284	.000	9.73***	6146	.000	9.6377	.9911
% Public Assistance in 1989	54.509	.000	10.87***	6146	.000	5.7769	.5316
% Female House w/ Kids	161.281	.000	17.99***	6146	.000	6.5331	.3630
% Black Female House	4.626	.032	4.410***	6146	.000	6.0499	1.3717
% Renter Occupied Units	4.330	.037	10.09***	6146	.000	15.2824	1.5153
% 18+ w/out High School	6.459	.011	7.795***	6146	.000	8.8811	1.1393
% 18+ 1 year of College	19.865	.000	-5.69***	6146	.000	-7.8329	1.3773
Total Persons	2.497	.114	-3.89***	6146	.000	-877.0720	225.6946

*** p <.10; ** p <.05; *** p <.01**

Southern states are mixed. Measures of hydrologic suitability behave predictably on directionality, but measures of seismology play in the opposite direction hypothesized. Bivariate test results suggest that commercial TSD installations are more likely to appear in relatively more dangerous earthquake zones than not, partially disconfirming the scientific rationality argument.

As for demographic variables in the South, we find strong bivariate confirmation of the inequality hypothesis. As in the Deep South and EPA Region IV as whole, environmentally burdened neighborhoods have a significantly higher percentage of African-Americans. At the 1.5mile zone of environmental impact, the variable of percent non-Hispanic Black emerges as the most important distinguishing feature between affected and unaffected neighborhoods (48 percent versus 15 percent; t=17.75, p=.000). At this distance from the nearest commercial TSD installation, the percentage of African Americans in a neighborhood surpasses the explanatory power of all economic rationality variables, including the consistently strong LQG activity measure. As for other inequality indicators, affected neighborhoods in the South, at every spatial measure of TSDF impact, are unvaryingly poor and uneducated. Impacted areas have higher rates of family poverty, rates of public assistance, and larger percentages of female-headed households.

SUMMARY OF t-TEST RESULTS

Table 4.23 is a summary of all tests of mean comparison. Emphasis is placed on directionality and statistical significance. Only those variables significant at the .10 level or better are indicated. Beginning with measures of social capital, we find no statistically significant differences between TSDF host and non-host neighborhoods on social capital assets and rates, as well as environmental capital assets and rates. Again, differences on civic vitality, as measured by nonprofit organization counts, are large but insignificantly related to TSDF presence. Population density and age dependency ratios perform decently.

Population density is significant in five of the nine t-tests conducted. However, the density variable behaves in the theoretically incorrect direction. Two reasons for the surprise: 1) commercial TSD installations are said to locate to rural, sparsely populated areas (Oakes 1997), and 2) population density is said to enhance social intercourse, build trust, and increase social capital potential (Fukuyama 1995; Durkheim 1933). The old dependency ratio is significant in four of nine tests, and the youth dependency ratio is significant in six of nine tests. Mathematical signs for both dependency ratios behave as predicted. Overall, environmentally burdened neighborhoods in EPA Region IV, the Deep South, and South, have

TABLE 4.23: SUMMARY OF STATISTICALLY SIGNIFICANT VARIABLES FROM INDEPENDENT SAMPLES TESTS FOR THE DEEP SOUTH, SOUTH, AND EPA REGION IV

SOCIAL CAPITAL	Deep South TSDF	Deep South 1 Mile	Deep South 1.5 Miles	South TSDF	South 1 Mile	South 1.5 Miles	EPA IV TSDF	EPA IV 1 Mile	EPA 1.5 Miles
Social Capital Assets									
Social Capital Rate									
Environmental Assets									
Environment Capital Rate									
Population Density			+		+	+		+	+
Young Dependency Ratio				+	+	+	+	+	+
Old Dependency Ratio					-	-		-	-
BUSINESS RATIONALITY									
Large Quantity Generators	+	+	+	+	+	+	+	+	+
% Industrial Labor				+	+	+	+	+	+
% Managerial Labor				-	-	-	-	-	-
Mean Value of Household				-	-	-	-	-	-
Median Gross Rent				-	-	-	-	-	-
% Units Built Before 1960				+	+	+	+	+	+
% Units Built before 1970			+	+	+	+		+	+
SCIENTIFIC RATIONALITY									
Land Area Sq Km		-	-		-	-	-	-	-
Water Area Sq Km								-	-
Peak Ground Acceleration	+	+	+	+	+	+	+	+	+
% Hydrologic in Tract			-		-	-		-	-
RACE, CLASS, GENDER									
% Hispanic Persons					-	-		-	-
% Non-Hispanic White	-	-	-	-	-	-	-	-	-
% Non-Hispanic Black	+	+	+	+	+	+	+	+	+
% American Indian									
% Family 50% Poverty			+	+	+	+	+	+	+
% Families Below Poverty			+	+	+	+	+	+	+
% Public Assistance 1989			+	+	+	+	+	+	+
% Female House w/ Kids	+	+	+	+	+	+	+	+	+
% Black Female House				+	+	+	+	+	+
% Renter Occupied Units			+		+	+		+	+
% 18+ w/out High School				+	+	+	+	+	+
% 18+ 1 year of College				-	-	-	-	-	-
Total Persons	+	+			-	-	+		-

higher population density, a lower percentage of workforce inactive elderly, and a higher percentage of workforce inactive youth.

Business rationality measures do much better than social capital variables. LQG presence is consistently *the* distinguishing feature between environmentally burdened and unburdened neighborhoods. On this neighborhood characteristic, differences are significant in all tests. Weber's theory of cost minimization appears correct. Commercial TSD installations gravitate to areas with heavy LQG activity, cheaper land, and suitably skilled labor. In all tests, but the Deep South, the business rationality variables behave as predicted – unaffected neighborhoods are shielded by higher property values, higher rates of managerial-technical labor, and physically younger neighborhoods. Overall, patterns of land use in EPA Region IV, and the sub-regions of the South and Deep South, are shaped strongly be commercial interests, even land uses for environmentally risky technologies as TSD installations.

Differences between host and non-host neighborhoods on scientific rationality estimates are mixed. Peak ground acceleration is the strongest performing variable among scientific rationality measures. Host communities have, invariably, higher seismological risk. This finding of non-random earthquake risk is a punishing blow to industry and state claims that TSD installation siting is a scientific matter. Land area in square km is significant in six of nine tests. Predictions, culled from the scientific literature, on the behavior of this variable were incorrect. Land area in square km is negatively related to TSDF location outcomes. The hydrology variables performed as predicted, with environmentally affected neighborhoods having less water area in square km, and less watershed overlap. Apparent TSDF indifference to seismology is potentially offset by consideration of human water sources in location outcomes.

As for demographic inequality, host communities are disproportionately African-American, poverty stricken, less educated, and have a higher percentage of female-headed households with children. Bivariate results, almost uniformly, confirm the environmental inequality hypothesis. The Southeast remains a place of disproportionate dumping of toxic hazards by race, class, and gender. The theoretical guess provided the literature by the Robert Bullard and wife Linda McKeever in the early 1980s on discriminatory outcomes obtain years later.

Methodological Preliminaries for Regression Analysis

Bivariate comparisons are the first stage in this dissertation's evaluation of competing explanations for the distribution of commercial TSD installations in the Southeastern United States. Bivariate test results are important, but possibly misleading. Bivariate comparisons, if done correctly, could meet the first two conditions of probabilistic causation – time-order and association. To meet the third condition in non-experimental research – elimination of alternative explanations - one must exercise statistical control. For example, suppose we determine statistically the placement of a commercial TSD installation in Tennessee is correlated positively with the percentage of African-Americans living in the area. Now, suppose we have reason to believe that the observed correlation between race and toxic exposure may be caused or influenced by the variable of economic class. This requires we retest the original relationship, controlling for the influence of class. This can be achieved by dividing our unit of analysis into economic class categories, and examining the original association between X and Y in each category separately. If results indicate the covariance insignificant, we can conclude the original association between the placement of an undesirable land-use and race as spurious. By dividing our unit of analysis into separate categories to measure the effect of X (race) on Y (placement), net the effect of Z (economic class), we are exercising what scientists call statistical control.

Multivariate comparisons are required to determine if neighborhood characteristics are related to TSD installation location, net other controlled characteristics. Because TSD installation presence or absence is measured nominally, bivariate logistic regression is a suitable statistical methodology. The logistic regression tables asses whether or not, social capital, economic rationality, scientific rationality, and demographic inequality variables, are good predictors of TSD installation siting, net all variables.

Unlike regular multiple regression, the logistic regression method makes no assumption about the scattering of independent variables. Predictors do not have to be normally distributed, nor related linearly to the response variable. Logistic regression does require safeguard against high variable inter-correlation. Use of highly correlated variables in model specification could artificially inflate or deflate relations between predictors and the response variable. To guarantee conformity with this requirement, a correlation matrix was created. Following Allison's (1999: 141) advise, independent variables were dropped from the analysis if correlated highly (i.e., .650) with other variables. Decisions about which variable to drop were guided analytic economy and theoretical considerations. For example, the variable of managerial-technical labor rate was dropped from the analysis because of high collinearly with: industrial labor rate (-.876); housing price (.653); percent high school dropout (-.852); percent college educated (.886); and percent of families at or below the poverty line (-.618). Removal of the managerial-technical labor rate does not significantly compromise the economic rationality argument. Similar decisions were made for other variables.

Like t-tests above, binary logistic regression models were run for EPA Region IV as whole and the sub-regions of the Deep South and South, at three approximations of spatial risk. Each table presents results for fully saturated and reduced models, with variables marked for statistical significance. The Backward Wald Test was used to taper the cluster of variables to achieve predictive parsimony. Tapered models generally explain less variation in the response variable, but have the analytic advantage of interpretive simplicity. Again, interpretative emphasis is on mathematically sign and level of statistical significance. Below is the revised diagrammatic model of the argument, and re-articulation of variable definition statements (see Table 4.24; Figure 4.1).

BINARY LOGISTIC REGRESSION RESULTS FOR EPA REGION IV[1]

Beginning with Table 4.25, commercial TSD installation presence in EPA Region IV is predicted by the following neighborhood characteristics: social capital assets, population density, large quantity generator activity, age of physical neighborhood, size of land area, area seismology, total persons, and the percentage of African-Americans. All hypotheses are partially confirmed.

Beginning with social capital variables, the social capital assets available to a community is negatively related to TSDF presence. Meaning, the more social capital assets a community possesses, the greater the likelihood that community is unburdened by hazardous waste. Other social capital measures are wiped out by statistical adjustment. The strongest predictor of the variable lot is the concentration of large quantity generators of hazardous waste (Wald=64.73). This is a statistical confirmation of Alfred Weber's theory of industrial location. As with other for-profit enterprises, commercial TSD installations are compelled apparently by a logic of accumulation.[2] Profit is maximized by cost reductions in input commodities.

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[1] Interpretation of regression tables will focus almost exclusively on parsimonious models. Fully saturated models are kept for the reader.

[2] Radical political economists (see Marx, Volume I, Capital) have developed an elegant heuristic of capital accumulation. It is expressed symbolically as M-C-M'. In step one of the circuit, entrepreneurs invest money capital in input commodities of production, including means of production (i.e., instruments and objects of labor), and human labor. In step two, these forces of production are put into action for the production of commodities to be sold in market. Upon sale of the commodity, money capital is returned to investors plus profit, and the circuit of accumulation of begins anew. The circuit heuristic can be adorned reasonably with specificity to accommodate any analysis of firm behavior.

FIGURE 4.1: REVISED MODEL OF THE DISTRIBUTION OF HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL FACILITIES IN THE SOUTHEASTERN UNITED STATES

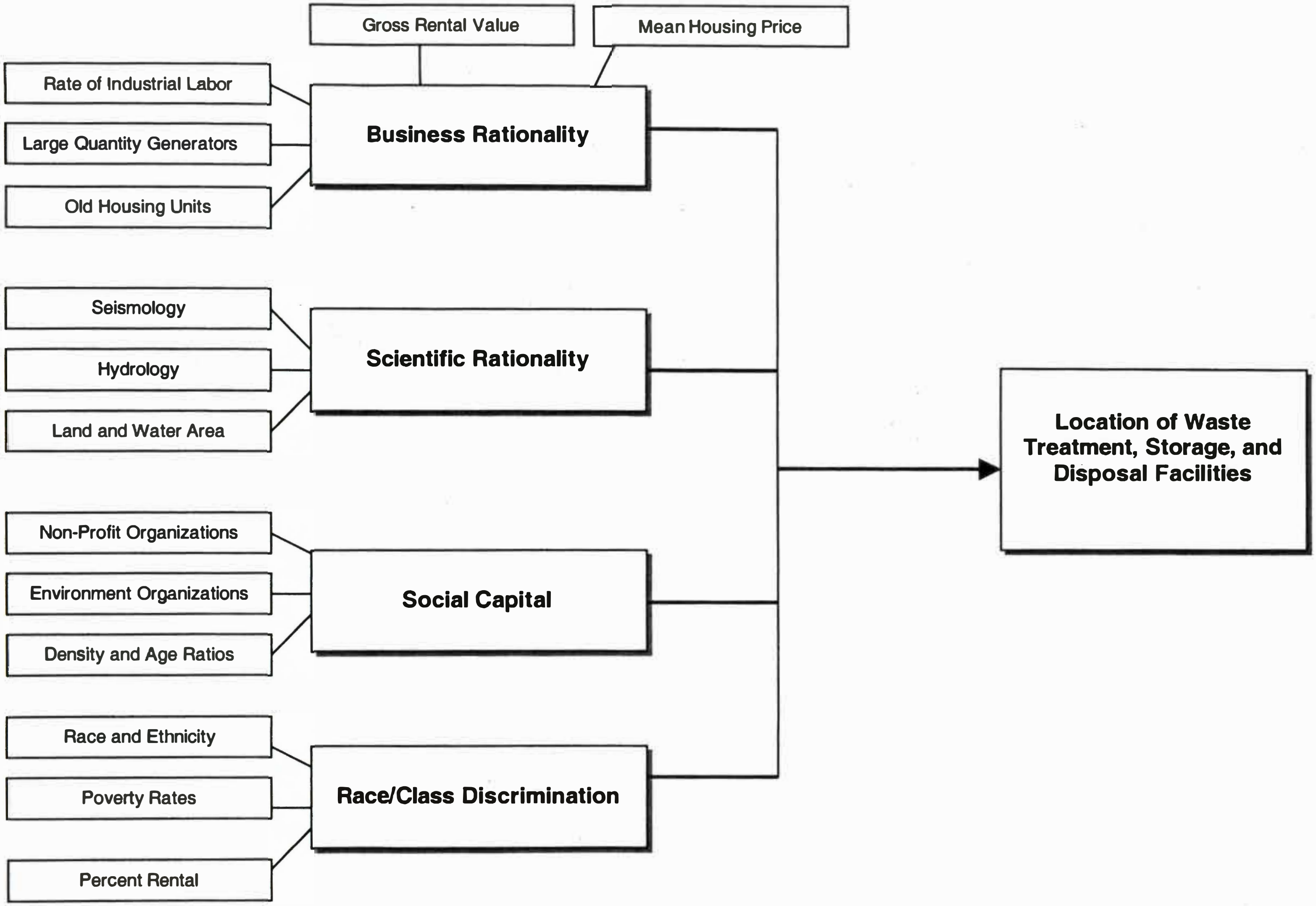

TABLE 4 .24: REVISED VARIABLE DEFINITION STATEMENTS AND HYPOTHESIZED DIRECTION OF RELATIONSHIP

Variable	Definition	Direction
Industrial Labor Rate	Number of machine operators, assemblers, and inspectors; transportation and material moving occupations; and handlers, equipment cleaners, helpers, and laborers, divided by the total number laborers, as defined by the Standard Occupational Classification system, residing in the census tract area.	+
Average Price of Housing	Aggregate price of specified owner-occupied housing units, divided by the total number of owner-occupied housing units in the census tract area. Price is based on the respondent's estimate the property's (house and lot, mobile home and lot, or condominium unit) market worth.	-
Gross Rental Value	Gross rent is the contract rent plus the estimated average monthly cost of utilities paid for by the renter.	-
Large Quantity Generators	Number of large quantity generators of waste per census tract area. A facility is classified as a large quantity generator if it: generates or imports greater than or equal to 1,000 kilograms (2,200 pounds) of hazardous waste in a calendar month; generates or accumulates at any time, more than 1 kilogram of acute hazardous waste in a calendar month; or more than 100 kilograms of residue, contaminated soil, waste, or other debris resulting from the clean-up of a spill of acute hazardous waste.	+
Percentage of Homes Built Before 1960	Number of housing units constructed before 1960, divided by the total number of housing units in census tract.	+
Peak Ground Acceleration	Maximum acceleration experienced by an object during the course of earthquake motion estimated for each census tract centroid. Acceleration estimates are calculated at the 10 percent probability of being exceeded in 50 years, and expressed as %g.	-
Hydrologic Proximity Land Area	Percentage of the Hydrologic Unit Code encased in the census tract, weighted by the size of the land area (square km).	-
Land Area Square Km	Total land area in square kilometers.	+
Water Area Square Km	Total water area in square kilometers.	-
Social Capital Assets	Total assets of all non-profit organizations as inventoried by the National Center of Charitable Statistics in a census tract area.	-
Social Capital Rate	Total assets of non-profit organizations as inventoried by the National Center of Charitable Statistics in a census tract area, divided by the total number of persons in a census tract area.	-

TABLE 4 .24: CONTINUED

Variable	Definition	Direction
Environmental Capital Assets	Total assets of non-profit organizations with a specified environmental focus in a census tract area as inventoried by the National Center of Charitable Statistics	-
Environmental Capital Rate	Total assets of non-profit organizations with a specified environmental focus in a census tract area as inventoried by the National Center of Charitable Statistics, divided by the total number of persons residing in the census tract area.	-
Population Density	Number of persons per square kilometer, calculated by the total number of persons residing in the census tract area, divided by the total land area (square km).	-
Youth Dependency Ratio	The ratio of the number of young persons of an age (under 15) when they are generally economically inactive, to the number of persons of working age (15 to 64).	+
Old Dependency Ratio	The ratio of the number of elderly persons of an age (over 65) when they are generally economically inactive, to the number of persons of working age (15 to 64).	-
Percent Hispanic	Number of persons identifying themselves as Mexican, Puerto Rican, Cuban, or other Hispanic, divided by the total number of persons residing in the census tract area.	+
Percent Non-Hispanic Black	Total number of persons identifying themselves as non-Hispanic White divided by the total number of persons.	-
Percent American Indian	Total number of persons identifying themselves as American Indian divided by the total number of persons.	+
Percent of Families Below the Poverty Line	Total number of families with income less than 1989 poverty level ($12,675, defined by 1991 Statistical Abstract of the United States), divided by the total number of families.	+
Percent Renter Occupied Units	Total number of renter occupied housing units, divided by the total of housing units in a census tract.	+
Total Persons	Total number of persons	-
Treatment, Storage, and Disposal Facilities	Measured dichotomously as presence or absence of a facility in a census tract area. Adjacent tracts within 1 and 1.5 miles of facility will be counted as affected tracts.	

TABLE 4.25: BINARY LOGISTIC REGRESSION COEFFICIENTS ESTIMATING ODDS OF TSDF PRESENCE IN EPA REGION IV, FULLY SATURATED AND PARSIMONIOUS MODELS

	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
SOCIAL CAPITAL								
Social Capital Assets	-.000***	7.133	.008	1.000	-.000***	8.936	.003	1.000
Social Capital Rate	.000	.001	.981	1.000				
Environment Capital Assets	-.000	.211	.646	1.000				
Environmental Capital Rate	.000	.026	.871	1.000				
Population Density	-.001**	5.618	.018	.999	-.001***	7.548	.006	.999
Youth Dependency Ratio	-.155	.015	.902	.857				
Old Dependency Ratio	-.665	.412	.521	.514				
BUSINESS RATIONALITY								
Large Quantity Generators	.500***	59.188	.000	1.649	.516***	64.734	.000	1.676
Industrial Labor Rate	.010	.664	.415	1.010				
Mean Home Value	-.000	.793	.373	1.000				
Median Gross Rent	.001	.161	.688	1.001				
Built before 1960	.015**	5.394	.020	1.015	.015***	7.781	.005	1.015
SCIENTIFIC RATIONALITY								
Land Area	-.003**	3.767	.052	.997	-.003**	5.531	.019	.997
Water Area	-.010	.425	.514	.990				
Peak Ground Acceleration	.067***	8.099	.004	1.069	.068***	9.117	.003	1.070
Hydrologic Unit Code	.214	.026	.872	1.238				
RACE-CLASS INEQUALITY								
Percent Hispanic	.008	.244	.621	1.008				
Percent Black	.015***	11.009	.001	1.015	.013***	14.151	.000	1.014
American Indian	.020	.621	.431	1.020				
Percent Poverty	-.013	.893	.345	.987				
Percent Renter	.002	.059	.808	1.002				
Total Persons	.000***	18.098	.000	1.000	.000***	25.751	.000	1.000
Constant	-5.77***	27.958	.000	.003	-6.013***	339.294	.000	.002
Nagelkerke R-Square				.141				.134
-2 Log Likelihood				971.779				978.789
Chi-Square				150.550***				143.540***

*** p <.10; ** p <.05; *** p <.01**

Proximity to LQGs powerfully influences location calculi of TSDF operators. TSDFs gravitate toward commercially suitable areas, all things held equal.

As with t-Test results, the scientific rationality variables of land area in square km, and peak ground acceleration behave unexpectedly. Be it full or reduced model, TSDF presence in EPA Region IV is predicted by increased risk of seismological activity. In fact, 20 of the 100 commercial TSD installations operating in the Southeastern United States are located in areas with peak ground acceleration figures of 9.5%g and above – a threshold level minimally hazardous to building structure integrity. Even more surprising, six installations sit in areas with PGA scores of 16%g and above, with one installation in Tennessee at 21.8%g. Though most installations are located in low risk earthquake areas, it is perplexing to discover a statistically valid positive, relationship between TSDF presence and seismological risk - so much for scientific rationality.

Consistent with claims of environmental injustice, African-Americans in the Southeast are burdened disproportionately by hazardous waste, all things held equal. A percentage increase in African-American composition increases the odds that a tract has a TSD installation by about 1.4 (see Exp B column in Table 4.26). Overall, model performance for prediction of TSDF presence in EPA Region IV is relatively good (.155 R-square). Meaning, almost 16 percent of environmental health destiny in the Southeast at the neighborhood level of analysis is explainable by eight variables. At the individual level, the environmental health of approximately 7 million people is captured by the reduced model.

By expanding the definition of at-risk areas to include neighborhoods within 1 and 1.5 miles of a commercial TSDF, predictors behave somewhat differently. At the 1Mile zone of impact, social capital variables all but disappear in significance (see Table 4.26). Only the old dependency ratio is significantly related to TSDF impact. As Robert Putnam (2000) documents in *Bowling Alone: The Collapse and Revival of American Community*, norms of reciprocity, trust, and expressive exchange have an age dimension. The elderly are more likely than young persons to cohere for collective action. As predicted, the higher the old dependency ratio, the lower the likelihood of TSDF impact (b= -2.078, p= .015).

At 1Mile of impact, LQG activity dwarfs the explanatory power of all predictors (Wald= 70.406).[3] Again, the commercial motive seemingly prevails. Supplementary evidence is found in other economic rationality variables: industrial labor rate (p=.026), mean house value (.108), and percent of units

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[3] The Wald statistic (or Z-score squared) is analogous to the standardized beta weight in the more commonly used multiple linear regression method. It allows one to compare the explanatory value of variables on a common unit of measurement.

TABLE 4.26: BINARY LOGISTIC REGRESSION COEFFICIENTS ESTIMATING ODDS OF TSDF IMPACT OF 1 MILE IN EPA REGION IV, FULLY SATURATED AND PARSIMONIOUS MODELS

	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
SOCIAL CAPITAL								
Social Capital Assets	-.000	.488	.485	1.000				
Social Capital Rate	.000	.003	.956	1.000				
Environment Capital Assets	-.000	.047	.829	1.000				
Environmental Capital Rate	-.000	.001	.979	1.000				
Population Density	.000	.010	.922	1.000				
Youth Dependency Ratio	-1.184	1.757	.185	.306	-1.275	2.576	.108	.279
Old Dependency Ratio	-1.932**	4.646	.031	.145	-2.078**	5.877	.015	.125
BUSINESS RATIONALITY								
Large Quantity Generators	.466***	65.917	.000	1.593	.469***	70.406	.000	1.598
Industrial Labor Rate	.019**	4.602	.032	1.019	.018**	4.984	.026	1.018
Mean Home Value	-.000	2.612	.106	1.000	-.000	2.590	.108	1.000
Median Gross Rent	.000	.137	.711	1.000				
Built before 1960	.018***	14.209	.000	1.019	.017***	15.388	.000	1.018
SCIENTIFIC RATIONALITY								
Land Area	-.003**	5.408	.020	.997	-.004***	10.001	.002	.996
Water Area	-.008	.342	.559	.992				
Peak Ground Acceleration	.057***	8.290	.004	1.058	.057***	9.103	.003	1.059
Hydrologic Unit Code	-.162	.015	.903	.850				
RACE-CLASS INEQUALITY								
Percent Hispanic	-.010	.435	.510	.990				
Percent Black	.012***	12.429	.000	1.012	.011***	12.362	.000	1.011
American Indian	.020	.794	.373	1.021				
Percent Poverty	-.008	.577	.447	.992				
Percent Renter	.002	.094	.759	1.002				
Total Persons	.000**	5.601	.018	1.000	.000***	7.200	.007	1.000
Constant	-5.13***	35.002	.000	.006***	-4.998	52.193	.000	.007
Nagelkerke R-Square				.135				.132
-2 Log Likelihood				1371.385				1375.498
Chi-Square				198.107***				193.994***

p <.10; ** p <.05; *** p <.01

constructed before 1960 (.000). All business rationality variables behave as predicted. The scientific rationality measures of land area (b=-.004, p=.002), and peak ground acceleration (b=.057, p=.003) are significantly related to TSD installation environmental impact of 1 Mile.

On race-class inequality measures, percent African-American matters. The blackness of a neighborhood is positively related to TSDF impact, net the effect of all other predictors. Meaning, the greater the percentage of African-Americans in a neighborhood, the greater the likelihood of TSDF-related environmental impact. With a Wald statistic of 12.362, the variable of percent African-American finishes third among ten variables in predictive power. Model performance at the 1 Mile zone of TSDF impact decrease slightly, with 13 percent of variation in commercial TSDF location explained by the reduced variable set. The decrease in model performance is likely a function of the disappearance of social capital assets from the explanation.

At the 1.5mile zone of impact (Table 4.27), percent African-American rivals LQG presence in predictive power (Wald=55.015 versus 72.029). Surprisingly, the percentage of families at or below the official poverty line is negatively related to TSDF presence, holding statistically constant other predictors. This disconfirms popular claims of environmental classicism – insofar as the rate of poverty is congruent with ones conception of social class. In regular language, the higher the rate of poverty in a neighborhood, the lower the probability of exposure to hazardous waste emanating from commercial TSDF operations.

The social variables of population, youth dependency, and old dependency are significantly associated with TSDF impact. Population density is positively related, and dependency ratios negatively related. Only the old dependency ratio behaves as predicted, indirectly confirming Robert Putnam's (2000) claim that the elderly are more civically involved than other strata of the population.

Economic rationality and scientific rationality predictors perform similarly across spatial measures of environmental risk. At 1.5 Miles from the nearest commercial TSD installation, LQG activity, industrial labor rate, percent housing units built before 1960, and peak ground acceleration are positively related to TSDF impact, holding other variables constant. Mean household price and land area in square km are negatively associated. Results indicate the commercial suitability of an area renders it susceptible to TSDF siting, holding all else constant. Conversely, the geological and hydrological features of a neighborhood are insignificant predictors, and if statistically significant, perform in the opposite direction predicted by the scientific literature.

TABLE 4.27: BINARY LOGISTIC REGRESSION COEFFICIENTS ESTIMATING ODDS OF TSDF IMPACT OF 1.5 MILES IN EPA REGION IV, FULLY SATURATED AND PARSIMONIOUS MODELS

	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
SOCIAL CAPITAL								
Social Capital Assets	-.000	.057	.811	1.000				
Social Capital Rate	-.000	.120	.729	1.000				
Environment Capital Assets	-.000	.171	.680	1.000				
Environmental Capital Rate	-.000	.000	.994	1.000				
Population Density	.000*	3.029	.082	1.000	.000**	5.272	.022	1.000
Youth Dependency Ratio	-1.67***	6.081	.014	.188	-1.384**	5.025	.025	.251
Old Dependency Ratio	-1.70***	6.669	.010	.183	-1.829***	8.021	.005	.161
BUSINESS RATIONALITY								
Large Quantity Generators	.435***	67.810	.000	1.546	.445***	72.029	.000	1.560
Industrial Labor Rate	.016**	5.155	.023	1.016	.014**	4.439	.035	1.014
Mean Home Value	-.000***	8.850	.003	1.000	-.000***	9.004	.003	1.000
Median Gross Rent	.001	1.480	.224	1.001				
Built before 1960	.016***	18.763	.000	1.016	.014***	16.891	.000	1.015
SCIENTIFIC RATIONALITY								
Land Area	-.005***	13.895	.000	.995	-.006***	22.483	.000	.994
Water Area	-.010	.511	.475	.990				
Peak Ground Acceleration	.036**	4.786	.029	1.036	.033**	4.264	.039	1.034
Hydrologic Unit Code	-.233	.034	.853	.792				
RACE-CLASS INEQUALITY								
Percent Hispanic	-.026*	2.840	.092	.974	-.023	2.462	.117	.977
Percent Black	.019***	53.439	.000	1.019	.019***	55.015	.000	1.019
American Indian	.027	1.898	.168	1.027				
Percent Poverty	-.012	2.336	.126	.988	-.016***	6.592	.010	.984
Percent Renter	.002	.229	.632	1.002				
Total Persons	.000	.573	.449	1.000				
Constant	-4.06***	35.059	.000	.017	-3.426***	40.532	.000	.033
Nagelkerke R-Square				.193				.190
-2 Log Likelihood				1993.679				2000.128
Chi-Square				423.348***				416.899***

*** p <.10; ** p <.05; *** p <.01**

Apart from the variable of percent African-American, at the 1.5 Mile measure of environmental risk, the rate of poverty and percent Hispanic persons in a neighborhood are negatively related to TSDF impact. Meaning, the lower the rate of poverty, and the lower the presence of Hispanic persons, the greater the probability of TSDF-related environmental impact. Thus, in the Southeast, environmental racism is a strictly African-American phenomenon. In other regions of the United States like the West Coast, the variable of percent Hispanic persons may behave differently on directionality (see Pastor et al 2001).

Overall, at the 1.5mile zone of TSD installation impact for RPA Region IV, model performance is relatively strong, with almost 20 percent of variation in TSDF siting explained. The R-square figure is an improvement over published studies, even outperforming mathematically inclined, environmental justice research teams on the West Coast (see Pastor, Sadd, and Hipp 2001), and the East Coast (see Anderton et al. 1994).

Binary Logistic Regression Results for the South and Deep South

Tables 4.28, 4.29, and 4.30 present binary logistic regression coefficients estimating odds of commercial TSDF impact for three spatial conceptions of environmental risk for the Deep South. As with t-test results, the variable set does comparatively worst in the Deep South. Social capital measures are statistically insignificant cross the board. This is explainable by the relative absence of nonprofit organization in the Deep South of large enough size to be counted by the IRS and the National Center for Charitable Statistics.

Of economic rationality predictors, only the variable of LQG activity is significantly and positively associated with TSDF impact. At the in-tract measure, LQG presence has a Wald statistic of 46.848, stronger than all other variables combined (see Table 4.28). As we expand the zone of impact to 1 and 1.5 Miles, the predictive power of LQG concentration diminishes slightly. Still, the explanatory weight of Alfred Weber's industrial location theory is undeniable. The presence of an LQG in a neighborhood increases the odds of commercial TSD installation siting by 61 to 87 percent, depending on the measure of spatial risk. Again, the scientific rationality variables behave peculiarly. PGA is positively associated with TSDF impact, and land are in square km is negatively associated. Claims by TSDF regulators that site selection is guided strictly by geological, physical, and hydrological considerations are, according to the data, disingenuous.

TABLE 4.28: BINARY LOGISTIC REGRESSION COEFFICIENTS ESTIMATING ODDS OF TSDF PRESENCE IN DEEP SOUTH STATES OF ALABAMA, GEORGIA, MISSISSIPPI, AND SOUTH CAROLINA, FULLY SATURATED AND PARSIMONIOUS MODELS

	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
SOCIAL CAPITAL								
Social Capital Assets	-.000	.381	.537	1.000				
Social Capital Rate	-.000	.025	.875	1.000				
Environment Capital Assets	-.000	.012	.914	1.000				
Environmental Capital Rate	-.015	.000	.999	.985				
Population Density	-.000	.789	.374	1.000				
Youth Dependency Ratio	-.086	.002	.963	.918				
BUSINESS RATIONALITY								
Large Quantity Generators	.648***	37.494	.000	1.912	.623***	46.848	.000	1.864
Industrial Labor Rate	-.007	.119	.731	.993				
Mean Home Value	-.000	.533	.466	1.000				
Median Gross Rent	-.001	.394	.530	.999				
Built before 1960	-.006	.308	.579	.994				
SCIENTIFIC RATIONALITY								
Land Area	-.002	1.743	.187	.998				
Water Area	-.025	.562	.454	.975				
Peak Ground Acceleration	.096***	6.794	.009	1.100	.095***	7.622	.006	1.099
Hydrologic Unit Code	1.155	1.120	.290	3.173				
RACE-CLASS INEQUALITY								
Percent Hispanic	.017	.290	.590	1.018				
Percent Black	.019**	5.893	.015	1.019	.010*	3.517	.061	1.010
American Indian	-.171	.291	.589	.842				
Percent Poverty	-.026	1.181	.277	.975				
Percent Renter	-.000	.001	.977	1.000				
Total Persons	.000*	3.684	.055	1.000	.000***	5.987	.014	1.000
Constant	-4.134**	6.463	.011	.016	-6.257**	193.257	.000	.002
Nagelkerke R-Square				.159				.119
-2 Log Likelihood				418.325				436.943
Chi-Square				74.281***				55.664***

*** p <.10; ** p <.05; *** p <.01**

TABLE 4.29: BINARY LOGISTIC REGRESSION COEFFICIENTS ESTIMATING ODDS OF TSDF IMPACT OF 1 MILE IN DEEP SOUTH STATES OF ALABAMA, GEORGIA, MISSISSIPPI, AND SOUTH CAROLINA, FULLY SATURATED AND PARSIMONIOUS MODELS

	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
SOCIAL CAPITAL								
Social Capital Assets	-.000	.056	.813	1.000				
Social Capital Rate	-.000	.030	.862	1.000				
Environment Capital Assets	-.000	.002	.969	1.000				
Environmental Capital Rate	-1.263	.003	.958	.283				
Population Density	-.000	.693	.405	1.000				
Youth Dependency Ratio	-1.001	.348	.555	.367				
Old Dependency Ratio	.482	.102	.750	1.620				
BUSINESS RATIONALITY								
Large Quantity Generators	.626***	38.982	.000	1.870	.580***	42.870	.000	1.786
Industrial Labor Rate	-.012	.459	.498	.988				
Mean Home Value	-.000	.536	.464	1.000				
Median Gross Rent	-.001	.270	.603	.999				
Built before 1960	-.001	.011	.916	.999				
SCIENTIFIC RATIONALITY								
Land Area	-.003*	2.941	.086	.997	-.002	2.345	.126	.998
Water Area	-.028	.670	.413	.973				
Peak Ground Acceleration	.090***	6.788	.009	1.094	.077**	5.630	.018	1.080
Hydrologic Unit Code	1.072	.951	.330	2.920				
RACE-CLASS INEQUALITY								
Percent Hispanic	.017	.459	.498	1.018				
Percent Black	.019***	7.968	.005	1.019	.014***	9.990	.002	1.014
American Indian	-.158	.275	.600	.853				
Percent Poverty	-.007	.124	.724	.993				
Percent Renter	-.008	.608	.436	.992				
Total Persons	.000**	3.936	.047	1.000	.000**	4.887	.027	1.000
Constant	-3.99***	7.396	.007	.018	-5.797***	180.715	.000	.003
Nagelkerke R-Square				.138				.115
-2 Log Likelihood				504.506				517.254
Chi-Square				75.355***				62.608***

*** p <.10; ** p <.05; *** p <.01**

TABLE 4.30: BINARY LOGISTIC REGRESSION COEFFICIENTS ESTIMATING ODDS OF TSDF IMPACT OF 1.5 MILES IN DEEP SOUTH STATES OF ALABAMA, GEORGIA, MISSISSIPPI, AND SOUTH CAROLINA, FULLY SATURATED AND PARSIMONIOUS MODELS

	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
SOCIAL CAPITAL								
Social Capital Assets	.000	.038	.845	1.000				
Social Capital Rate	-.000	.153	.695	1.000				
Environment Capital Assets	.000	.274	.601	1.000				
Environmental Capital Rate	-.092	.717	.397	.912				
Population Density	.000	.283	.594	1.000				
Youth Dependency Ratio	-2.078*	2.862	.091	.125				
Old Dependency Ratio	.536	.210	.647	1.709				
BUSINESS RATIONALITY								
Large Quantity Generators	.520***	33.663	.000	1.682	.478***	32.582	.000	1.614
Industrial Labor Rate	-.004	.098	.755	.996				
Mean Home Value	-.000	.985	.321	1.000				
Median Gross Rent	.000	.070	.792	1.000				
Built before 1960	-.010	1.769	.183	.990				
SCIENTIFIC RATIONALITY								
Land Area	-.005***	8.286	.004	.995	-.005***	12.226	.000	.995
Water Area	-.034	.917	.338	.967				
Peak Ground Acceleration	.055*	3.287	.070	1.057	.048*	2.687	.101	1.049
Hydrologic Unit Code	.804	.512	.474	2.235				
RACE-CLASS INEQUALITY								
Percent Hispanic	.016	.454	.501	1.016				
Percent Black	.020***	17.023	.000	1.020	.021***	32.485	.000	1.021
American Indian	.010	.013	.911	1.010				
Percent Poverty	.014	1.171	.279	1.014				
Percent Renter	-.017**	4.274	.039	.983	-.012*	3.162	.075	.988
Total Persons	.000	1.828	.176	1.000	.000*	2.619	.106	1.000
Constant	-3.31***	8.372	.004	.036	-4.609***	124.935	.000	.010
Nagelkerke R-Square				.138				.118
-2 Log Likelihood				504.506				725.903
Chi-Square				75.355***				87.937***

*** p <.10; ** p <.05; *** p <.01**

Compared to the region as a whole, scientific rationality predictors perform similarly in the Deep South. Peak ground acceleration is significantly and positively associated with commercial TSDF presence. Land area in square km is negatively related with TSDF impact at 1 (b=-.002, p= .126) and 1.5 miles (-.005, p=.000) of environmental damage. The peak ground acceleration figure deflates in predictive power as the zone of negative externality is expanded. At the 1.5 Mile zone, the predictive quality of peak ground acceleration weakens to the .10 significance level.

On demographic inequality variables, all but percent African-American and total persons in a neighborhood are insignificant across tables. The positive association between total persons and TSDF impact runs counter to industry claims that TSDF neighborhoods are uninhabited rural areas (see Hess 1998). Opposite the behavior of the LQG variable, as the field of negative externality is stretched to 1 and 1.5 miles, percent African-American increases in explanatory power. At the in-tract measure, the Wald Statistic is 3.52; at the 1 Mile measure, the Wald statistic increases to 9.99; and finally, at the 1.5 Mile measure, percent African-American has a Wald Statistic that rivals LQG concentration in size (32.49 versus 32.58). At the 1.5 Mile impact zone, a unit increase in African-American composition increases the odds of TSDF siting by 2.1. As Table 4.30 shows, percent of housing units rented is negatively related with TSDF impact. As an estimate of social class, the variable disconfirms the environmental classism argument. As with other distribution issues – level of education, incarceration, home ownership, and income – there is strong debate in the environmental justice literature on the predictive powers of race versus class (see Downey 1998). Bivariate tests in the previous section confirm statistical associations between hazardous waste exposure and measures of social class, but these bivariate results disappear as other variables are factored. The relationship between social class and exposure to hazardous waste in the Deep South is rubbed out by statistical controls, suggesting the correlation is spurious.

Overall, reduced model performance in the Deep South is weaker than the EPA Region IV as whole. R-square varies from .115 to .119, meaning slightly more than 11 percent of the variation in TSDF location and impact is predictable by the variable set assembled.

Tables 4.31, 4.32, and 4.33 examine commercial TSDF impact in the Southern states of Florida, Kentucky, North Carolina, and Tennessee. As Table 4.31 indicates, social capital assets are negatively related with TSDF presence (Wald= 6.207). Meaning, the more social capital assets a neighborhood has, the more likely that neighborhood can fend off an undesirable land use. Population density is negatively related to TSDF impact, invalidating the popular belief TSD operations locate to rural areas and small

TABLE 4.31: BINARY LOGISTIC REGRESSION COEFFICIENTS ESTIMATING ODDS OF TSDF PRESENCE IN SOUTHERN STATES OF FLORIDA, KENTUCKY, NORTH CAROLINA, AND TENNESSEE, FULLY SATURATED AND PARSIMONIOUS MODELS

	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
SOCIAL CAPITAL								
Social Capital Assets	-.000**	4.825	.028	1.000	-.000***	6.207	.013	1.000
Social Capital Rate	-.000	.004	.951	1.000				
Environment Capital Assets	-.000	.045	.831	1.000				
Environmental Capital Rate	.000	.000	.996	1.000				
Population Density	-.001**	6.059	.014	.999	-.001***	6.369	.012	.999
Youth Dependency Ratio	-.669	.128	.720	.512				
Old Dependency Ratio	-1.365	.962	.327	.255				
BUSINESS RATIONALITY								
Large Quantity Generators	.393***	19.487	.000	1.481	.423***	22.239	.000	1.526
Industrial Labor Rate	.018	1.402	.236	1.018	.023*	3.519	.061	1.023
Mean Home Value	-.000	.774	.379	1.000				
Median Gross Rent	.002	1.114	.291	1.002				
Built before 1960	.029***	12.066	.001	1.029	.029****	15.919	.000	1.029
SCIENTIFIC RATIONALITY								
Land Area	-.001	.070	.792	.999				
Water Area	-.002	.020	.887	.998				
Peak Ground Acceleration	.041	1.464	.226	1.042				
Hydrologic Unit Code	-9.480	1.349	.245	.000	-10.625**	4.193	.041	.000
RACE-CLASS INEQUALITY								
Percent Hispanic	.002	.006	.937	1.002				
Percent Black	.012**	3.867	.049	1.012	.013***	7.485	.006	1.013
American Indian	.020	.608	.435	1.020				
Percent Poverty	.005	.080	.777	1.005				
Percent Renter	-.002	.041	.840	.998				
Total Persons	.000***	12.524	.000	1.000	.000***	18.178	.000	1.000
Constant	-6.45***	17.428	.000	.002	-6.814***	129.679	.000	.001
Nagelkerke R-Square				.164				.155
-2 Log Likelihood				529.676				534.792
Chi-Square				98.651***				93.535****

*** p <.10; ** p <.05; *** p <.01**

TABLE 4.32: BINARY LOGISTIC REGRESSION COEFFICIENTS ESTIMATING ODDS OF TSDF IMPACT OF 1 MILE IN SOUTHERN STATES OF FLORIDA, KENTUCKY, NORTH CAROLINA, AND TENNESSEE, FULLY SATURATED AND PARSIMONIOUS MODELS

	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
SOCIAL CAPITAL								
Social Capital Assets	-.000	1.160	.282	1.000				
Social Capital Rate	.000	.609	.435	1.000				
Environment Capital Assets	-.000	.020	.888	1.000				
Environmental Capital Rate	-.000	.000	.982	1.000				
Population Density	.000	.043	.836	1.000				
Youth Dependency Ratio	-1.870	2.576	.108	.154	-1.682*	2.958	.085	.186
Old Dependency Ratio	-2.437**	4.777	.029	.087	-2.800***	6.485	.011	.061
BUSINESS RATIONALITY								
Large Quantity Generators	.389***	26.120	.000	1.476	.401***	29.054	.000	1.493
Industrial Labor Rate	.031***	8.431	.004	1.031	.026***	7.791	.005	1.027
Mean Home Value	-.000*	2.974	.085	1.000	-.000*	3.036	.081	1.000
Median Gross Rent	.001	.782	.376	1.001				
Built before 1960	.024***	17.241	.000	1.025	.024***	20.149	.000	1.024
SCIENTIFIC RATIONALITY								
Land Area	-.001	.102	.750	.999				
Water Area	.000	.000	.986	1.000				
Peak Ground Acceleration	.048*	3.415	.065	1.049	.044*	3.310	.069	1.045
Hydrologic Unit Code	-10.310	1.572	.210	.000	-13.60***	7.030	.008	.000
RACE-CLASS INEQUALITY								
Percent Hispanic	-.019	1.125	.289	.982				
Percent Black	.010***	6.054	.014	1.010	.011***	8.327	.004	1.011
American Indian	.021	.817	.366	1.021				
Percent Poverty	-.002	.027	.869	.998				
Percent Renter	.006	.625	.429	1.006				
Total Persons	.000	1.737	.188	1.000				
Constant	-5.46***	21.388	.000	.004	-4.515***	27.081	.000	.011
Nagelkerke R-Square				.184				.177
-2 Log Likelihood				818.384				825.583
Chi-Square				170.740***				163.540***

*** p <.10; ** p <.05; *** p <.01**

TABLE 4.33: BINARY LOGISTIC REGRESSION COEFFICIENTS ESTIMATING ODDS OF TSDF IMPACT OF 1.5 MILES IN SOUTHERN STATES OF FLORIDA, KENTUCKY, NORTH CAROLINA, AND TENNESSEE, FULLY SATURATED AND PARSIMONIOUS MODELS

	B	Wald	Sig.	Exp (B)	B	Wald	Sig.	Exp (B)
SOCIAL CAPITAL								
Social Capital Assets	.000	.013	.910	1.000				
Social Capital Rate	-.000	.270	.604	1.000				
Environment Capital Assets	-.000	.105	.745	1.000				
Environmental Capital Rate	-.000	.006	.941	1.000				
Population Density	.000	1.712	.191	1.000	.000*	2.886	.089	1.000
Youth Dependency Ratio	-1.864**	4.517	.034	.155	-1.956***	6.080	.014	.141
Old Dependency Ratio	-2.06***	6.208	.013	.128	-2.296***	7.943	.005	.101
BUSINESS RATIONALITY								
Large Quantity Generators	.396***	32.905	.000	1.486	.422***	37.660	.000	1.524
Industrial Labor Rate	.023***	7.340	.007	1.023	.020***	5.994	.014	1.020
Mean Home Value	-.000***	9.142	.002	1.000	-.000***	8.669	.003	1.000
Median Gross Rent	.001	1.418	.234	1.001				
Built before 1960	.023***	26.153	.000	1.023	.023***	28.181	.000	1.023
SCIENTIFIC RATIONALITY								
Land Area	-.003	.599	.439	.997				
Water Area	-.001	.006	.936	.999				
Peak Ground Acceleration	.028	1.839	.175	1.028				
Hydrologic Unit Code	-10.007	1.359	.244	.000	-17.845***	11.111	.001	.000
RACE-CLASS INEQUALITY								
Percent Hispanic	-.036*	3.549	.060	.964	-.038**	4.068	.044	.963
Percent Black	.020***	46.268	.000	1.021	.021***	52.078	.000	1.021
American Indian	.027	1.621	.203	1.028				
Percent Poverty	-.018*	3.337	.068	.982	-.016**	4.202	.040	.984
Percent Renter	.009	2.581	.108	1.009				
Total Persons	-.000	.003	.958	1.000				
Constant	-4.11***	20.519	.000	.016	-3.145***	20.400	.000	.043
Nagelkerke R-Square				.272				.266
-2 Log Likelihood				1203.178				1211.397
Chi-Square				394.531***				386.312***

- **p <.10; ** p <.05; *** p <.01**

population centers. In Tables 4.32 and 4.33, we find negative associations between age ratios and TSDF impact. Meaning, neighborhoods with higher dependency ratios, are less likely to host a commercial TSD installation.

Scientific rationality variables behave more predictably in the American South. The effect of peak ground acceleration is statistically insignificant, less the 1 Mile estimation of spatial risk. The hydrology variable is robust. Predictive power for this variable is strong across statistical models. As hypothesized, TSD installations are less likely to locate in watershed areas. For reasons unknown, unlike the Deep South and EPA Region IV as whole, the geological and hydrological suitability of residential areas in the South predict the absence or presence of commercial TSD installations.

As usual, the commercial motive is a solid predictor of TSDF location. Business rationality variables are significant across distance measures of environmental risk. Large quantity generator activity, the industrial labor rate, and percent of housing units constructed before 1960, are positively coupled with TSDF impact. Mean housing value, an estimate property cost, is negatively related to TSDF presence. Meaning, as the price of property decreases, all things held equal, the odds of TSDF siting increase. With one exception, the bin of business rationality variables outperforms variables linked to competing hypotheses.

That exception is the variable of percent African-American. Adjusting for other variables, African-American neighborhood composition is positively tied to environmental risk. Environmental burdens in the American South, as in the Deep South and EPA Region IV as a whole, are predictable by race. As Table 4.33 reveals, percent African-American is the strongest predictor of TSDF impact, even surpassing the seemingly insurmountable measure of LQG activity (52.08 versus 37.660, on the Wald Statistic). At the 1.5 Mile evaluation of environmental risk, percent Hispanic is significant, but negatively correlated. The same can be said of the percent of families at or below the official poverty line. Binary logistic regression results disconfirm the environmental classism argument. Bivariate evidence for the class argument is rendered spurious by application of statistical controls.

Overall, the variable set performs best in the American South, with R-square figures ranging from .155 to .266. Such scores are a strong improvement over previous TSDF studies (see Table 2.2). The relative strength of model performance in the American South is an intriguing finding to be probed at a later date. For now, it is likely that improved model performance in the South is driven by the relative strength of social capital measures. Because social capital assets are dramatically higher in the sub-region of the

South, and presuming environmental concern is higher in the South than Deep South, evident by the higher presence of environmental organizations and higher profile environmental conflicts that have erupted in the region (i.e., Warren County), it is reasonable to assume social capital measure are behind improved model performance.

SUMMARY OF LOGISTIC REGRESSION RESULTS

Table 4.34 is a summary of all binary logistic regression tests. Again, emphasis is placed on directionality and statistical significance. Only those variables significant at the .10 level of confidence or better are indicated. Beginning with social capital variables. The social capital assets variable is a solid predictor of TSDF impact, if the conception of spatial risk tight. Directly targeted neighborhoods with low social capital assets are vulnerable. It is theoretically sensible to assume that the more closely situated a neighborhood is to an undesirable land-use, the feistier the resistance. Other social capital measures, mostly structural estimates of social capital potential, behave irregularly. For example, population density is negatively related in some circumstances and positively related in others. This variable of population per square km of land is circumstantially relevant. As predicted, the old dependency ratio is negatively related to TSDF impact in four of the nine models executed. Meaning, the greater the ratio of persons of retired age to persons of working age, the lower the likelihood of commercial TSDF environmental risk.

On estimates of economic rationality, LQG activity is consistently positively associated with TSDF presence. No matter the spatial conception of risk, this variable outperforms all others all the time, less percent African-American composition. In five of nine models, the percent of sufficiently skilled industrial labor is positively related with TSDF impact, all things equal. Meaning, the higher the percentage of industrial labor, the greater the odds of TSDF impact. Similarly, in six of the nine logistic regression models executed, the percentage of housing unit built before 1960 is a positive predictor of the geography of environmental risk.

As with bivariate comparisons, scientific rationality measures behave inconsistently with expected directionality. Peak ground acceleration is positively associated with TSDF impact, not negatively as hypothesized. TSD installations are located in more risky earthquake zones, not less risky ones in seven of nine models. In three of nine models the hydrology variable performs robustly, and as anticipated.

Last, of demographic inequality measures, percent African American is the only variable to be positively and statistically significant across all models. In fact, only the LQG concentration variable

TABLE 4.36: SUMMARY OF STATISTICALLY SIGNIFICANT VARIABLES FROM PARSIMONIOUS LOGISTIC REGRESSION MODELS FOR DEEP SOUTH, SOUTH, AND EPA REGION IV

SOCIAL CAPITAL	Deep South TSDF	Deep South 1 Mile	Deep South 1.5 Miles	South TSDF	South 1 Mile	South 1.5 Miles	EPA IV TSDF	EPA IV 1 Mile	EPA IV 1.5 Miles
Social Capital Assets				-			-		
Social Capital Rate									
Environment Capital Assets									
Environmental Capital Rate									
Population Density				-		+	-		+
Youth Dependency Ratio					-	-		-	-
Old Dependency Ratio					-	-		-	-
BUSINESS RATIONALITY									
Large Quantity Generators	+	+	+	+	+	+	+	+	+
Industrial Labor Rate				+	+	+		+	+
Mean Home Value					-	-			+
Median Gross Rent									
Built before 1960				+	+	+	+	+	+
SCIENTIFIC RATIONALITY									
Land Area			-				-	-	-
Water Area									
Peak Ground Acceleration	+	+	+		+		+	+	+
Hydrologic Unit Code				-	-	-			
RACE-CLASS INEQUALITY									
Percent Hispanic						-			
Percent Black	+	+	+	+	+	+	+	+	+
American Indian									
Percent Poverty						-			-
Percent Renter			-						
Total Persons	+	+	+	+			+	+	

performs similarly. Other inequality variables figure modestly in the final picture. The percent of families in poverty, and the percentage of Hispanic persons are negative predictors of TSDF impact in two and one of nine regression models respectively.

In essence, this meta-summary validates the notion of a systemic contradiction between demographic equity and economic liberty on the distribution of commercial TSD installations in the Southeastern United States. This tension, as discussed in Chapter I, is reflected in and generated by the conflicting imperatives of the modern capitalist state. Recall, political economists of the environment note that the state performs two master functions: enabling capital accumulation and maintaining public harmony. Accumulation incentives provided by the state essentially serve the interests of entrepreneurial classes. Public harmony incentives essentially serve the interests of middle and lower class groupings. The state functions of accumulation and legitimization, Cable and Cable (1995) show, serve different socio-economic groupings on environmental issues. For example, damage done to the environment by industry in the name of accumulation disproportionately serves the bourgeoisie. This same damage, more likely than not, jeopardizes the life settings of poor minorities of color, compromising state management of public harmony and delivery of individual primary goods.

Insofar as the conflicting imperatives of the modern capitalist state, but heads on the issue of distribution of environmental health risks stemming for TSD installation operations, evidence from binary logistic regression models suggests that the accumulation function is dominant. This apparent dominance is correctable through reform. The question of how to balance the functions of the state on geographic distribution of locally unwanted, environmental risky technologies is tackled in Chapter V.

Chapter V: Summary, Discussion, and Environmental Policy

Introduction

In this final chapter, hypotheses are recapitulated in relation to statistical results. The implications of results are discussed on environmental policy regarding fair and equitable distribution of environmental hazards as expressed in President William Clinton's Executive Order 12898 on environmental justice. A hazard allocation system is proposed to achieve procedural and distributional justice. The mechanics and benefits of the hazard allocation system are described and summarized in table format.

Summary and Discussion

This dissertation sought to answer two questions: *where are commercial TSD installations located, and why?* These questions were applied to EPA Region IV, and to the sub-regions of the American Deep South and South. Four hypotheses – business rationality, social capital, scientific rationality, and demographic inequality - were tested empirically, using bivariate and multivariate statistical methodologies. Three of these hypotheses are original contributions to the scientific literature.

This dissertation is the first to spatially link commercial TSDF location outcomes to large quantity generator activity, measure neighborhood social and environmental capital assets, and concretely estimate the geological and hydrological suitability of neighborhoods for TSD installation siting. The fundamental contributions of this dissertation to social science are expansion of explanatory possibilities for TSDF location outcomes. What appear as speculations in the scientific literature, are refined and tested objectively in this dissertation. Perhaps most rewarding is that all hypotheses are partially confirmed, with substantial improvement to existing prediction models of commercial TSDF location outcomes.

Summarizing statistical findings briefly. Beginning with the business rationality argument, evidence suggests commercial TSD installations are fundamentally economic agents. Inferring logically from outcomes, to minimize operating costs, TSD installations locate rationally to areas with affordable property, sufficiently skilled labor, and adjacent to hazardous waste streams. The evidence suggests cost reduction is the overriding factor in the patterning of environmental health risks in the Southeastern United States.

Recall, the Resource Conservation and Recovery Act (RCRA) is the regulatory framework that encourages this commercial orientation. Though RCRA contains provisions designed to protect the public and physical environment from harm, it mandates market solutions to proper treatment, storage, and disposal of hazardous waste. Market coordination of the hazardous waste stream propels commercial

TSDF operators into an instrumental calculus that differentially harms strata of the population. More remarkable, the hazardous waste management industry is regulated by a system of voluntary compliance. This regulatory arrangement of voluntary compliance deepens the temptation to accumulate, and ignore threats to system legitimacy arising from disproportionate dumping.[1] In fact, as shown by the data, the drive to accumulate is so strong that operators locate installations in geologically questionable areas. In sum, the construction and enforcement of RCRA is manifestly tilted toward the state function of enabling capital accumulation.

Evidence for the scientific rationality hypothesis on TSDF location is mixed. Commercial TSDF operators appear sensitive to hydrological concerns. They tend locate to areas with lower then average watershed overlap. However, TSD installations appear consistently in areas with higher than average seismological risk. Two explanations may account for this distortion of scientific logic: 1) the Southeastern United States, compared to other regions of the country, has lower risk of catastrophic earthquake activity, and 2) TSDF operators have made crucial design improvements in recent years that could withstand tectonic movement, rendering geological considerations less important. Nevertheless, the fact that TSD installations are *relatively* indifferent to earthquake risk strengthens the notion that the commercial motive, if regulated too loosely, can result in potentially catastrophic outcomes. The failure to correctly predict TSDF location outcomes using seismological data amplifies environmental injustice claims, and critiques of the state as a passive regulator of industry use of the environment. Perhaps, by stretching the object of analysis to the national level the PGA figure will behave as expected.

Of the four hypotheses advanced, the social capital argument received least confirmation. Only the variable of social capital assets was statistically significant. By pooling the assets of all nonprofit organizations in a census tract, one can adequately predict the location of commercial TSDFs. Again, reasoning from period data on location outcomes, commercial TSD installations seemingly avoid neighborhoods with stronger than average potential for collective action. Whereas scientific guidelines promulgated by the EPA apparently do little to temper the profit motive, the potential for neighborhood action can. As environmental justice institutes from Ann Arbor to Atlanta have started, linking and coordinating the

[1] Of the 2256 commercial and non-commercial treatment, storage, and disposal facilities in the United States, 1113 (about 49 percent) have violated EPA law in the last 2 years. The strongest predictor of violation is EPA inspection. In 1564 onsite inspections conducted by officials in the last 2 years, 896 violations were discovered, constituting a fifty-seven percent hit rate (Zahran, Hastings, and Zilney 2003). Policies of market coordination and voluntary compliance are failing.

activities of nonprofit organizations can enliven civic concern for fair and equitable distribution of environmental health risks, and potentially offset the systemic tilt toward accumulation.

Totaling nonprofit organization assets in a neighborhood is, admittedly, an imperfect measure of social capital. Still, it represents an improvement over established measures (see Pastor et al 2001). As James Coleman and Robert Putnam use the term, social capital is located in the associational fabric of society. What better place to look for it concretely than the nonprofit sector. Of course, qualitative studies can probe more deeply the amounts of trust and reciprocity that actually obtain in a neighborhood, but the measure used in this dissertation is defendable.

As for the variable of environmental capital assets, it flopped in all statistical tests. Though one notices manifest differences between environmentally burdened and unburdened neighborhoods on the characteristic of environmental capital assets, these differences never supercede statistical chance. Perhaps by expanding the object of analysis to the continental United States, the environmental capital variable, may behave more predictably.

On measures of race, class, and gender inequality, at whatever spatial estimate of environmental impact and regional or sub-regional level of analysis, African-Americans are burdened disproportionately by environmental hazards stemming from commercial TSDF operations. Because this dissertation used a cross-sectional design, it is unclear whether this discriminatory outcome is linkable to discriminatory intent.[2] This dissertation cannot comment on possible time-sensitive dynamics related to TSDF siting. For many scholars (see Bullard 1990; Pulido 1996), is unimportant if discriminatory outcomes are intended or caused by anonymous systemic forces. These scholars emphasize differential harm. By design, this dissertation accepts the emphasis on outcomes. Be it market coordination, structured residential choice, malicious intent on the part of TSDF operators, or objective business decisions, African Americans live in environmentally higher risk locations. This fact, for the Southeastern United States, is irrefutable.

Overall, statistical models perform relatively well. Between 11 and 27 percent of variation in geographic distribution of commercial TSD installations is explainable by the reduced variable set. This is an improvement over existing models.

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[2] Stretesky and Hogan's (1998) study of Superfund sites in Florida is an excellent example of a longitudinal design strategy to distinguish discriminatory outcome from discriminatory intent. They advanced a sociological notion of "structured choice" to explain patterns of African-American residential decisions. This notion of structured choice brilliantly implicates market forces as the culprit of environmental racism. Price signals, we learn, are racially determined, and operate on the population differently. The migratory behaviors of Blacks and Whites interpenetrate, and the collateral effects of environmental risk, amplify social distancing strategies by racial groups.

To end this section, the following summary statement is ventured: the location of commercial TSD installations in the Southeastern United States is predictable by neighborhood social capital assets, large quantity generator activity, cheap property, affordable and skilled labor supply, hydrological conditions, and African American composition. This prediction is understandable in the context of a state committed more strongly to capital accumulation than protection of disadvantaged populations from disproportionate exposure to environmental hazards.

Environmental Justice Policy

For the policy-minded, the next question is how do we design procedurally fair environmental justice policy to reduce negative environmental outcomes by race, and maintain systemic commitments to economic growth and market coordination? Results from statistical tests in Chapter IV imply the current system of TSDF site selection for the Southeastern United States is broken. The hazardous waste permitting process is said to emphasize, in order of importance, scientific criteria, commercial criteria, and population criteria (see EPA 2003; Freeman 1988). Results from logistic regression models suggest this ordering of criteria in the abstract is inconsistent with the ordering of criteria in reality. Fixing this inconsistency is possible.

Maximizing Environmental Equity: A Risk Allocation Proposal

On February 11, 1994, President Clinton signed *Executive Order 12898* directing federal agencies to evaluate the environmental health policies effects on minority and low-income populations (see Appendix for text). The Order promotes fair treatment of all people in the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people should be burdened disproportionately by negative environmental consequences from industrial, municipal, and commercial operations. Of great concern to environmental justice advocates is the distribution of commercial treatment, storage, and disposal installations. This dissertation confirms widespread suspicion that poor communities of color are burdened disproportionately by environmental hazards.

The sting of a regular industrial facility is a decision generally left to business enterprises based on their own scientific and economic criteria. Public involvement is limited and generally favorable, given the anticipated economic benefits of industrial investment. The siting of a TSD installation is different: Federal law requires hazardous waste handlers obtain a permit from the EPA, and go through a lengthy process of negotiation with government officials and residents of a sited community (see EPA 1996). The reason for such differential treatment is that TSD installations handle some of the most dangerous substances known to humankind, and public concern over the potential negative effects of such facilities on human health and property.

As specified in the introduction, most individuals want the benefits of proper and safe disposal of hazardous waste, but few want to bear the burden of a TSD installation in their community. How this dilemma is managed, in the context of the proportionately criterion of Order 12989, is the purpose of this policy proposal. The proposal is more thought experiment than serious recommendation.

The proposed hazardous waste allocation system, summarized in Table 5.1, builds on the current site selection criteria. Technical and economic criteria still drive the identification of sites suitable for a commercial TSD installation, and the first step is geological and scientific evaluation. Floodplains, watersheds, seismic hazard zones, groundwater aquifer and recharge areas, and preservation areas are excluded from consideration as per existing Environmental Protection Agency guidelines. Second, areas are assessed economically. Commercially suitable areas are those zoned for industrial use, are close to major transportation routes, possess large quantity generators of hazardous waste nearby, and an adequate labor supply. Third, site-specific characteristics ought to be considered, involving the screening of sites culturally and ecologically. Considerations should include: ecological habitat and endangered species, surrounding land uses of cultural importance, and areas of archaeological significance. This site evaluation process ought to be shepherded by the EPA and handled jointly by private and public sector actors to guarantee all criteria are given fair consideration.

After the evaluation process is complete, a national list of feasible sites should be drawn, organized regionally and by facility type to give operators flexibility in site selection. The national feasibility list acts as a sampling frame, with each area on the list having an equal chance of being selected for a TSD installation. This list should be made public to allow citizens to make informed and rational residential choices. All commercial TSD operators meeting administrative and technical standards delineated in the EPA permit application would then be given a regional list of sites matching facility design specifications and commercial criteria.

Sites would then be selected randomly from regional feasibility lists. Areas not selected would be required to pay a small fee for non-selection: A $2 dollar fee per household would suffice. This fee could be

TABLE 5.1: SUMMARY OF THE BROAD MECHANICS OF THE HAZARDOUS WASTE ALLOCATION PROGRAM

1. Areas are evaluated geologically and scientifically for suitability of a treatment, storage, and disposal facility
2. Areas are evaluated commercially and economically for suitability of a treatment, storage, and disposal facility
3. Areas are evaluated culturally and ecologically for suitability of a treatment, storage, and disposal facility
4. A national feasibility list of potential areas is drawn on the basis of above criteria and made available to the public.
5. Commercial TSD operators meeting EPA-permit requirements, randomly draw sites from regional feasibility list.
6. Non-selection and generator fees are collected. Fees are pooled into a national fund for compensation to the selected community.
7. The selected community is given the right to buy-out, sell or accept selection. Communities accepting the TSD installation enter a publicly financed negotiated compensation agreement.

added to existing property assessments, and collected by municipalities. Such payment for non-selection would diffuse the cost of proper hazardous waste disposal. Large quantity generators of hazardous waste should also pay a small fee for every ton of waste generated. For example, at $1 dollar per ton, a minimum of $250 million dollars could be collected annually. If tonnage fees were collected from small quantity generators of hazardous waste, $750 million dollars could be collected annually.

Non-selection and generator fees could be pooled for a negotiated compensation agreement with the selected community. The special needs of the selected community could then be addressed to offset the direct burden of the TSD installation. Offsetting benefits may include direct payments to affected residents, grants for local health care, parks and recreational amenities, and distribution of abatement devices to reduce the risk of exposure to hazardous substances. Selected communities would also be given the option of buying-out or selling their compensation agreement to other communities desiring such facilities for economic ends. Buy-out and buy-in options harness the power of market allocation, enabling a socially optimal and equitable distribution of TSD installations.

What are the advantages of this simple hazardous waste allocation program? Seven advantages over the current system (see Table 5.2 for summary) are identified. First, the program helps guarantee fair and equitable distribution of environmental burdens as directed by Executive Order 12898. Site selection is based only on scientific, economic, and cultural criteria, not population characteristics or the propensity of groups to resist the placement of a facility in their community. Post-list assembly randomization counters the effects of random birth assignment. Second, the proposal eliminates the free-rider problem of high-income, predominantly White communities. Under this proposal, all communities are invested in the benefits of proper hazardous waste disposal, no matter income status or racial composition. The elimination of the free-rider problem will undoubtedly encourage greater public concern and involvement in management and reduction of the hazardous waste stream. Greater public involvement will deepen democratic adjudication of potentially harmful land uses.

TABLE 5.2: SUMMARY OF THE ADVANTAGES OF THE HAZARDOUS WASTE ALLOCATION PROGRAM

1. Fulfills the promise of Executive Order 12989 by guaranteeing fair and equitable distribution of environmental burdens.
2. Eliminates the free-rider problem, investing all Americans in the problem of hazardous waste management and reduction.
3. Reduces transaction costs on commercial TSD operators, enabling re-direction of energies toward engineering and scientific matters.
4. Selected communities are compensated fairly for bearing the environmental burden directly, diffusing the cost of proper management of hazardous waste.
5. The power of market allocation is harnessed to achieve a socially optimal distribution of environmental burdens.
6. Inoculates TSDF operators and government officials from accusations of discrimination, significantly reducing legal and political costs.
7. Provides poor communities of color with a procedurally fair system, freeing them of shouldering a disproportionate share of the hazardous waste stream.

Third, generator fees and public financing of the non-selection fund significantly reduces the cost of operations for TSD facilities. Under the current system, local officials and residents typically coerce TSDF operators into host fees, tonnage fees, and compensatory schemes. Such practices cause TSD operators to rationally calculate liability and compensation demands into site selection. This reasoning retards the current process, with TSD operators selecting population characteristics, not scientifically suitable areas. TSD installation operators also pass these transaction costs to hazardous waste generators. This proposal eliminates these costs, increasing incentive for proper hazardous waste disposal and commercial investment in waste conservation and recovery technologies. TSDF operators can pass transaction cost savings to hazardous waste producers to offset generator fees. This action fulfills the Resource Conservation and Recovery Act requirement of commercialization of waste management.

Fourth, selected communities are guaranteed a publicly financed compensation package for bearing the hazardous waste burden directly. The compensation agreement can offset residential instabilities arising from population out-migration, shocks to property values, and potential threats to human health. Negative economic and social burdens of facility placement can be adequately neutralized.

Fifth, buy-out and buy-in options harness the power of market allocation, giving communities a choice in the matter. High-income communities will likely purchase their way out of selection, and lower-income communities will more likely purchase selection for the economic benefits that accompany a TSD installation. Relatively poor communities court such facilities for job growth and economic gain currently. This proposal is different because high-income communities are brought into the market, and their historic non-participation is prevented. As the proposal constrains choices for free riders it expands choice making for disadvantaged populations, increasing the aggregate level of choice in the system.

Sixth, this proposal of fair and equitable distribution of environmental hazards inoculates the federal government and commercial TSD operators from accusations of discrimination. Because the current system produces uneven distribution of TSD facilities by race and community social capital, federal agencies and TSD operators are embroiled in expensive legal and political wrangling. This proposal significantly reduces these costs, enabling federal agencies to properly direct energies away from the courtroom to the delivery of public goods. The cost savings to tax payers could offset non-selection fees.

Seventh, this hazardous waste allocation program meets the demands of environmental justice advocates. It is procedurally just, color-blind, and optimizes equity and fairness in distribution of environmental health risks. The coercive toxic assault on poor communities of color can be managed more effectively.

This hazardous waste allocation proposal is an example of win-win for all stakeholders. The existing EPA permit process is difficult. Applications range from 500 to 2000 pages of text. TSDF operators must meet strict administrative and technical requirements. Administrative requirements involve record keeping and reporting, preparedness and prevention strategies, and emergency procedures should something go wrong. Technical requirements include standards for groundwater monitoring, facility closure and post-closure procedures, and specific engineering standards for design and operation of the installation. Our program maintains these important technical and administrative safeguards, while simplifying the post permit burden on TSDF operators.

TSDF operators receive of a cost reduction with the negotiated compensation procedure shifted to generators and the public, are protected against accusations of discrimination and racial animus, and extricated from the time-consuming and expensive process of hiring lobbyists and consultants to navigate the political thicket of site selection. These savings enable TSDF operators to concentrate energies on technological improvements, and decrease barriers to commercial involvement in hazardous waste management.

Poor communities of color are given a procedurally fair system of hazardous waste allocation. The environmental justice movement has struggled valiantly for fairness in the application of environmental laws and policies, and for equity in the distribution of environmental hazards. This proposal can reduce the toxic burden on disadvantaged communities, without denying them the economic opportunity to host a TSD installation should they desire one for job growth and community improvement. More important, implementation of this proposal allows poor communities of color to concentrate energies on other social problems.

Governments benefit from the proposal in numerous ways. Because the program is transparent and fair, government actors are perceived as legitimate and neutral actors. Less energy is spent defending decisions, and more energy and tax dollars are spent on technical and scientific management of the country's environmental resources. Above all, our program brings federal agencies into compliance with President Clinton's Executive Order 12898.

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APPENDIX

TABLE A.1: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR ALABAMA

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	1062	-4918	348630494	2351542.60	16310707.25
Social Capital Rate	1062	-1.51	132641.29	832.8576	6725.6425
Environmental Capital Assets	1062	.00	5290749.00	11709.3550	191609.1468
Environmental Capital Rate	1062	.00	1350.37	4.4397	59.6462
Population Density	1062	.00	4683.66	443.2410	629.6144
Young Dependency Ratio	1062	.00	1.08	.3709	.1029
Old Dependency Ratio	1062	.00	1.06	.2223	.1065
BUSINESS RATIONALITY					
Large Quantity Generators	1062	.00	5.00	.1695	.5487
% Industrial Labor	1062	.00	69.11	35.2460	14.5449
% Managerial Technical Labor	1062	.00	100.00	48.9416	17.5295
Mean Value of Household	1062	18100.00	350000.00	59104.1046	30948.3791
Median Gross Rent	1062	.0	1001.0	307.315	115.930
% Units Built Before 1960	1062	.00	100.00	35.0601	20.5739
% Units Built before 1970	1062	.00	100.00	53.7864	21.1585
SCIENTIFIC RATIONALITY					
Land Area Sq Km	1062	.00	1309.03	123.7694	168.4575
Water Area Sq Km	1062	.00	453.32	4.0793	23.0554
Peak Ground Acceleration	1062	1.3589930	7.4735560	3.508874875	1.367009663
% Hydrologic Code in Tract	1062	.0000010	1.3475630	5.04072159E-02	.101552409
RACE, CLASS, GENDER					
% White Persons	1062	.00	100.00	70.7764	29.9132
% Black Persons	1062	.00	100.00	28.1529	30.1808
% Hispanic Persons	1062	.00	7.47	.5737	.8004
% Non-Hispanic White Persons	1062	.00	100.00	70.4082	29.7971
% Non-Hispanic Black Persons	1062	.00	100.00	28.0710	30.1016
% American Indian	1062	.00	23.97	.4380	1.2383
% Families 50% Below Poverty	1062	.00	69.27	9.4412	8.8113
% Families at or Below Poverty	1062	.00	100.00	21.8701	14.3263
% Public Assistance in 1989	1062	.00	60.00	9.7655	7.6110
% Female Households w/ Kids	1062	.00	100.00	8.3090	6.8289
% Black Female Households	1062	.00	100.00	27.2312	15.5875
% Renter Occupied Units	1062	.00	100.00	29.7016	19.3253
% 18+ Without High School	1062	.00	91.91	34.2650	14.4529
% 18+ With 1 year of College	1062	.00	97.50	36.3080	17.9548
Total Persons	1062	.00	13164.00	3804.6959	1863.7176
Valid N	1062				

TABLE A.2: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR FLORIDA

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	2448	-131231	538450545	4683983.48	24421491.36
Social Capital Rate	2448	-15.44	498268.36	1735.1117	14797.3322
Environmental Capital Assets	2448	.00	45572208.00	68540.5016	1398553.0011
Environmental Capital Rate	2448	.00	7604.42	18.6101	293.5926
Population Density	2448	.00	12120.18	1122.4301	1237.5404
Young Dependency Ratio	2448	.00	1.05	.3103	.1243
Old Dependency Ratio	2448	.00	12.73	.3753	.5638
BUSINESS RATIONALITY					
Large Quantity Generators	2448	.00	7.00	.1017	.4409
% Industrial Labor	2448	.00	100.00	23.9909	10.0513
% Managerial Technical Labor	2448	.00	93.85	56.9410	15.1310
Mean Value of Household	2448	22282.05	600000.00	98371.5432	67478.8776
Median Gross Rent	2448	.0	1001.0	474.872	169.731
% Units Built Before 1960	2448	.00	100.00	24.2879	22.5371
% Units Built before 1970	2448	.00	100.00	41.6234	27.0626
SCIENTIFIC RATIONALITY					
Land Area Sq Km	2448	.00	2857.04	57.1295	192.0032
Water Area Sq Km	2448	.00	2794.48	12.4418	76.6528
Peak Ground Acceleration	2448	.5000000	2.2354490	.992392804	.412992275
% Hydrologic Code in Tract	2448	.0000000	1.2003000	2.07841989E-02	7.808485E-02
RACE, CLASS, GENDER					
% White Persons	2448	.00	100.00	81.8547	24.5166
% Black Persons	2448	.00	100.00	15.1957	24.4627
% Hispanic Persons	2448	.00	100.00	9.4251	17.1022
% Non-Hispanic White Persons	2448	.00	100.00	74.3783	28.2209
% Non-Hispanic Black Persons	2448	.00	100.00	14.8211	24.1381
% American Indian	2448	.00	15.17	.3556	.6291
% Families 50% Below Poverty	2448	.00	56.20	5.9734	6.2610
% Families at or Below Poverty	2448	.00	80.77	15.2445	11.9039
% Public Assistance in 1989	2448	.00	100.00	6.5585	6.4465
% Female Households w/ Kids	2448	.00	36.84	6.1991	4.5974
% Black Female Households	2448	.00	100.00	24.0857	18.5744
% Renter Occupied Units	2448	.00	100.00	33.1177	20.6298
% 18+ Without High School	2448	.00	100.00	26.9433	14.5407
% 18+ With 1 year of College	2448	.00	100.00	42.8610	16.6697
Total Persons	2448	.00	71872.00	5285.1005	3695.2867
Valid N	2448				

TABLE A.3: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR GEORGIA

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	1470	-4919	1736539201	5050005.83	53610043.43
Social Capital Rate	1470	-2.49	986744.69	2490.5959	33369.9577
Environmental Capital Assets	1470	.00	4979188.00	10056.1224	167971.3866
Environmental Capital Rate	1470	.00	1553.57	2.2053	43.2622
Population Density	1470	.00	11261.26	517.2966	831.7013
Young Dependency Ratio	1470	.00	1.46	.3691	.1168
Old Dependency Ratio	1470	.00	2.20	.1867	.1167
BUSINESS RATIONALITY					
Large Quantity Generators	1470	.00	8.00	.1830	.6050
% Industrial Labor	1470	.00	100.00	32.7288	13.3384
% Managerial Technical Labor	1470	.00	100.00	50.2258	17.1429
Mean Value of Household	1470	12500.00	461719.59	73136.4276	46663.2304
Median Gross Rent	1470	.0	1001.0	372.650	176.848
% Units Built Before 1960	1470	.00	100.00	31.6651	21.7258
% Units Built before 1970	1470	.00	100.00	48.7462	23.2571
SCIENTIFIC RATIONALITY					
Land Area Sq Km	1470	.00	1237.20	102.0473	138.0371
Water Area Sq Km	1470	.00	265.76	2.6820	14.9766
Peak Ground Acceleration	1470	1.6819550	9.3133160	4.351705194	1.641680008
% Hydrologic Code in Tract	1470	.0000000	1.0474930	3.24282143E-02	6.335491E-02
RACE, CLASS, GENDER					
% White Persons	1470	.00	100.00	68.2399	28.7916
% Black Persons	1470	.00	100.00	30.0628	29.0809
% Hispanic Persons	1470	.00	33.64	1.4504	2.4342
% Non-Hispanic White Persons	1470	.00	100.00	67.4693	28.6124
% Non-Hispanic Black Persons	1470	.00	100.00	29.9461	28.9943
% American Indian	1470	.00	18.95	.2543	.6676
% Families 50% Below Poverty	1470	.00	82.88	8.6811	9.4159
% Families at or Below Poverty	1470	.00	100.00	19.5284	14.9742
% Public Assistance in 1989	1470	.00	70.51	10.3792	9.0232
% Female Households w/ Kids	1470	.00	41.67	8.2056	6.0220
% Black Female Households	1470	.00	100.00	27.0338	15.5349
% Renter Occupied Units	1470	.00	100.00	34.8027	21.4813
% 18+ Without High School	1470	.00	86.78	33.2425	15.6895
% 18+ With 1 year of College	1470	.00	100.00	35.9467	19.7385
Total Persons	1470	.00	17724.00	4406.9497	2862.8109
Valid N	1470				

TABLE A.4: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR KENTUCKY

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	997	-3113	284323071	3111415.66	16895670.73
Social Capital Rate	997	-.89	51776.64	886.1389	4335.4692
Environmental Capital Assets	997	.00	48101437.00	86384.0411	1753260.5735
Environmental Capital Rate	997	.00	3006339.81	3023.2600	95211.6494
Population Density	997	.00	5716.02	601.1783	974.2304
Young Dependency Ratio	997	.00	1.04	.3609	8.609E-02
Old Dependency Ratio	997	.00	1.13	.2092	9.795E-02
BUSINESS RATIONALITY					
Large Quantity Generators	997	.00	13.00	.2708	.8601
% Industrial Labor	997	.00	82.08	35.2716	12.8054
% Managerial Technical Labor	997	5.00	100.00	46.5199	15.6643
Mean Value of Household	997	13686.13	222041.83	53885.2327	27978.9099
Median Gross Rent	997	.0	923.0	300.267	98.325
% Units Built Before 1960	997	.00	100.00	40.2964	22.3153
% Units Built before 1970	997	.27	100.00	56.6515	20.6590
SCIENTIFIC RATIONALITY					
Land Area Sq Km	997	.00	562.75	103.2164	110.1469
Water Area Sq Km	997	.00	82.98	1.7638	6.4906
Peak Ground Acceleration	997	3.1207610	23.1314500	5.466219268	3.924497690
% Hydrologic Code in Tract	997	.0000000	1.4148080	4.621289E-02	9.330920E-02
RACE, CLASS, GENDER					
% White Persons	997	.32	100.00	91.9389	16.5424
% Black Persons	997	.00	99.56	7.3311	16.3635
% Hispanic Persons	997	.00	13.63	.4756	.8941
% Non-Hispanic White Persons	997	.32	100.00	91.6143	16.5805
% Non-Hispanic Black Persons	997	.00	99.52	7.3016	16.3148
% American Indian	997	.00	3.78	.1945	.3744
% Families 50% Below Poverty	997	.00	66.38	10.4017	8.3313
% Families at or Below Poverty	997	.00	88.13	23.7040	14.3086
% Public Assistance in 1989	997	.00	51.89	10.3228	7.2073
% Female Households w/ Kids	997	.00	26.58	6.2293	4.0544
% Black Female Households	997	.00	100.00	24.1157	19.3689
% Renter Occupied Units	997	2.28	100.00	29.4973	17.3134
% 18+ Without High School	997	.00	77.95	36.4730	14.8940
% 18+ With 1 year of College	997	.00	100.00	31.2406	17.4097
Total Persons	997	.00	18861.00	3696.3852	1847.8911
Valid N	997				

TABLE A.5: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR MISSISSIPPI

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	581	0	168845195	2053637.75	12259599.80
Social Capital Rate	581	.00	52403.85	664.4051	4221.9191
Environmental Capital Assets	581	.00	17854767.00	35179.4888	743243.5559
Environmental Capital Rate	581	.00	3702.77	7.5176	154.6816
Population Density	581	.00	5667.48	360.5258	580.2970
Young Dependency Ratio	581	.00	.79	.4214	.1153
Old Dependency Ratio	581	.00	.80	.2203	9.669E-02
BUSINESS RATIONALITY					
Large Quantity Generators	581	.00	4.00	.1274	.4406
% Industrial Labor	581	.00	100.00	35.4567	12.9602
% Managerial Technical Labor	581	.00	93.24	47.2435	14.7942
Mean Value of Household	581	23851.48	191484.53	50631.0114	18788.8072
Median Gross Rent	581	.0	786.0	287.145	97.345
% Units Built Before 1960	581	.32	100.00	32.1750	16.8961
% Units Built before 1970	581	.46	100.00	51.0843	18.1666
SCIENTIFIC RATIONALITY					
Land Area Sq Km	581	.00	1338.47	209.1332	261.6565
Water Area Sq Km	581	.00	480.31	6.1933	30.3185
Peak Ground Acceleration	581	1.5894980	12.3408300	3.195629165	1.853414429
% Hydrologic Code in Tract	581	.0000000	1.5041710	9.37823029E-02	.180675607
RACE, CLASS, GENDER					
% White Persons	581	.00	100.00	61.7152	27.7883
% Black Persons	581	.00	100.00	37.2106	27.9884
% Hispanic Persons	581	.00	100.00	.7805	4.2469
% Non-Hispanic White Persons	581	.00	100.00	61.1831	27.6872
% Non-Hispanic Black Persons	581	.00	100.00	37.1102	27.9426
% American Indian	581	.00	88.93	.4151	3.8300
% Families 50% Below Poverty	581	.00	100.00	12.3469	8.7404
% Families at or Below Poverty	581	.00	100.00	27.7543	13.8279
% Public Assistance in 1989	581	.00	54.48	13.8597	8.5463
% Female Households w/ Kids	581	.00	35.97	9.2132	5.5749
% Black Female Households	581	.00	100.00	30.4538	13.6000
% Renter Occupied Units	581	.00	100.00	30.2989	18.4373
% 18+ Without High School	581	.00	100.00	36.2470	13.7647
% 18+ With 1 year of College	581	.00	100.00	35.8355	15.3389
Total Persons	581	.00	13523.00	4428.9432	2017.1312
Valid N	581				

Table A.6: Descriptive Statistics on Independent Variables for North Carolina

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	1482	-996	233306476	3339742.47	15579119.65
Social Capital Rate	1482	-.35	132178.32	1126.1000	6894.2511
Environmental Capital Assets	1482	.00	2454067.00	11253.2807	131430.7384
Environmental Capital Rate	1482	.00	2339.66	4.7133	75.1782
Population Density	1482	.00	3412.72	402.9497	518.1840
Young Dependency Ratio	1482	.00	.78	.3249	8.620E-02
Old Dependency Ratio	1482	.00	1.05	.2047	.1046
BUSINESS RATIONALITY					
Large Quantity Generators	1482	.00	8.00	.2220	.6885
% Industrial Labor	1482	.00	100.00	35.3546	14.8423
% Managerial Technical Labor	1482	.00	100.00	49.4822	16.9427
Mean Value of Household	1482	9000.00	313191.16	74509.3838	35891.0936
Median Gross Rent	1482	.0	1001.0	361.949	117.797
% Units Built Before 1960	1482	.00	100.00	33.7719	19.8915
% Units Built before 1970	1482	.00	100.00	50.7764	20.3116
SCIENTIFIC RATIONALITY					
Land Area Sq Km	1482	.00	1587.22	85.1416	127.3236
Water Area Sq Km	1482	.00	1942.99	6.9566	72.4591
Peak Ground Acceleration	1482	1.2644370	9.5852360	4.388084789	1.663710274
% Hydrologic Code in Tract	1482	.0000000	1.2115060	3.836476E-02	9.960286E-02
RACE, CLASS, GENDER					
% White Persons	1482	.00	100.00	74.2149	25.6237
% Black Persons	1482	.00	100.00	23.5999	25.0867
% Hispanic Persons	1482	.00	18.97	.9717	1.3380
% Non-Hispanic White Persons	1482	.00	100.00	73.7092	25.5709
% Non-Hispanic Black Persons	1482	.00	100.00	23.5065	25.0105
% American Indian	1482	.00	86.39	1.0872	5.6977
% Families 50% Below Poverty	1482	.00	45.72	6.4039	5.8496
% Families at or Below Poverty	1482	.00	81.48	16.5150	11.2051
% Public Assistance in 1989	1482	.00	56.80	7.6129	6.3462
% Female Households w/ Kids	1482	.00	37.46	7.2513	4.8053
% Black Female Households	1482	.00	100.00	24.5406	14.8113
% Renter Occupied Units	1482	.00	100.00	33.5637	19.8443
% 18+ Without High School	1482	.00	100.00	30.4099	13.8543
% 18+ With 1 year of College	1482	.00	100.00	40.1034	18.2236
Total Persons	1482	.00	37612.00	4472.7645	2335.4077
Valid N	1482				

TABLE A.7: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR SOUTH CAROLINA

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	805	-1239	298957194	2977894.75	17230819.85
Social Capital Rate	805	-.49	132923.16	1082.4076	7040.7619
Environmental Capital Assets	805	.00	12039298.00	21922.2646	434703.0426
Environmental Capital Rate	805	.00	1744.07	4.1566	70.2637
Population Density	805	.00	7798.76	437.5066	722.6778
Young Dependency Ratio	805	.00	1.27	.3577	.1159
Old Dependency Ratio	805	.00	1.82	.1966	.1195
BUSINESS RATIONALITY					
Large Quantity Generators	805	.00	9.00	.3193	.8617
% Industrial Labor	805	.00	100.00	35.3627	14.6996
% Managerial Technical Labor	805	.00	93.15	48.4932	16.5193
Mean Value of Household	805	17500.00	427822.91	71391.7188	39163.0319
Median Gross Rent	805	.0	865.0	344.692	130.930
% Units Built Before 1960	805	.00	100.00	31.9375	20.5688
% Units Built before 1970	805	.00	100.00	48.6666	21.1806
SCIENTIFIC RATIONALITY					
Land Area Sq Km	805	.00	818.79	90.3433	125.4016
Water Area Sq Km	805	.00	473.61	6.0617	28.9819
Peak Ground Acceleration	805	4.8982940	18.9090300	9.417944009	3.819672523
% Hydrologic Code in Tract	805	.0000000	2.0483100	4.272712E-02	.112824929
RACE, CLASS, GENDER					
% White Persons	805	.00	100.00	67.3355	26.2825
% Black Persons	805	.00	100.00	31.5992	26.5280
% Hispanic Persons	805	.00	100.00	.9520	3.6897
% Non-Hispanic White Persons	805	.00	100.00	66.7869	26.2397
% Non-Hispanic Black Persons	805	.00	100.00	31.4588	26.4909
% American Indian	805	.00	8.81	.2479	.6012
% Families 50% Below Poverty	805	.00	48.28	7.5174	6.4795
% Families at or Below Poverty	805	.00	100.00	18.3633	12.5797
% Public Assistance in 1989	805	.00	48.52	8.5550	6.6604
% Female Households w/ Kids	805	.00	35.90	8.2700	5.6006
% Black Female Households	805	.00	100.00	27.3047	13.5484
% Renter Occupied Units	805	.00	100.00	31.5508	19.5859
% 18+ Without High School	805	.00	100.00	31.9804	14.8702
% 18+ With 1 year of College	805	.00	100.00	38.2116	18.4559
Total Persons	805	.00	18081.00	4087.0385	2284.0880
Valid N	805				

TABLE A.8: DESCRIPTIVE STATISTICS ON INDEPENDENT VARIABLES FOR TENNESSEE

	N	Minimum	Maximum	Mean	Std. Deviation
SOCIAL CAPITAL VARIABLES					
Social Capital Assets	1221	0	806594674	5063336.24	31860586.76
Social Capital Rate	1221	.00	2414954.11	3615.8727	69923.3431
Environmental Capital Assets	1221	.00	20338589.00	28696.8026	645250.8298
Environmental Capital Rate	1221	.00	4470.02	5.9068	134.4905
Population Density	1221	.00	5381.02	498.9524	738.1703
Young Dependency Ratio	1221	.00	1.26	.3400	.1081
Old Dependency Ratio	1221	.00	1.87	.2171	.1140
BUSINESS RATIONALITY					
Large Quantity Generators	1221	.00	9.00	.3415	.8486
% Industrial Labor	1221	.00	71.61	35.1422	14.2595
% Managerial Technical Labor	1221	.00	100.00	48.2700	16.8940
Mean Value of Household	1221	15612.90	288177.84	62938.9107	32359.8276
Median Gross Rent	1221	.0	1001.0	320.004	128.741
% Units Built Before 1960	1221	.00	100.00	36.0695	21.0498
% Units Built before 1970	1221	.00	100.00	54.1318	21.4704
SCIENTIFIC RATIONALITY					
Land Area Sq Km	1221	.00	779.77	87.4353	114.3801
Water Area Sq Km	1221	.00	93.01	1.9653	6.7207
Peak Ground Acceleration	1221	3.9337330	23.8058500	8.919528846	4.131269213
% Hydrologic Code in Tract	1221	.0000000	1.1563130	4.748120E-02	9.80713676E-02
RACE, CLASS, GENDER					
% White Persons	1221	.00	100.00	81.5006	27.4418
% Black Persons	1221	.00	100.00	17.4674	27.4906
% Hispanic Persons	1221	.00	34.74	.7058	1.3672
% Non-Hispanic White Persons	1221	.00	100.00	81.0226	27.4010
% Non-Hispanic Black Persons	1221	.00	100.00	17.4125	27.4268
% American Indian	1221	.00	3.67	.2609	.3976
% Families 50% Below Poverty	1221	.00	100.00	8.5257	8.5973
% Families at or Below Poverty	1221	.00	100.00	20.7881	14.2434
% Public Assistance in 1989	1221	.00	56.82	9.5717	7.8855
% Female Households w/ Kids	1221	.00	41.60	7.4486	5.8297
% Black Female Households	1221	.00	100.00	25.5454	18.9606
% Renter Occupied Units	1221	.00	100.00	32.5202	20.6018
% 18+ Without High School	1221	.00	87.23	34.7197	14.8028
% 18+ With 1 year of College	1221	.00	100.00	34.4792	18.2751
Total Persons	1221	.00	15314.00	3994.4185	2277.8001
Valid N	1221				

EXECUTIVE ORDER NO. 12898
FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1-1. Implementation

1-101. Agency Responsibilities.

To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

1-102. Creation of an Interagency Working Group on Environmental Justice.

(a) Within 3 months of the date of this order, the Administrator of the Environmental Protection Agency ("Administrator") or the Administrator's designee shall convene an interagency Federal Working Group on Environmental Justice ("Working Group"). The Working Group shall comprise the heads of the following executive agencies and offices or their designees:

Department of Defense; Department of Health and Human Services; Department of Housing and Urban Development; Department of Labor; Department of Agriculture; Department of Transportation; Department of Justice; Department of the Interior; Department of Commerce; Department of Energy; Environmental Protection Agency; Office of Management and Budget; Office of Science and Technology Policy; Office of the Deputy Assistant to the President for Environmental Policy; Office of the Assistant to the President for Domestic Policy; National Economic Council; Council of Economic Advisers; and such other Government officials as the President may designate. The Working Group shall report to the president through the Deputy Assistant to the President for Environmental Policy and the Assistant to the President for Domestic Policy.

(b) The Working Group shall:

1. provide guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority populations and low-income populations;
2. coordinate with, provide guidance to, and serve as a clearinghouse for, each Federal agency as it develops an environmental justice strategy as required by section 1-103 of this order, in order to ensure that the administration, interpretation and enforcement of programs, activities and policies are undertaken in a consistent manner;
3. assist in coordinating research by, and stimulating cooperation among, the Environmental Protection Agency, the Department of Health and Human Services, the Department of Housing and Urban Development, and other agencies conducting research or other activities in accordance with section 3-3 of this order;
4. assist in coordinating data collection, required by this order;
5. examine existing data and studies on environmental justice;
6. hold public meetings as required in section 5-502(d) of this order; and
7. develop interagency model projects on environmental justice that evidence cooperation among Federal agencies.

1-103. Development of Agency Strategies.

(a) Except as provided in section 6-605 of this order, each Federal agency shall develop an agency-wide environmental justice strategy, as set forth in subsections (b)-(e) of this section that identifies and addresses disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. The environmental justice strategy shall list programs, policies, planning and public participation processes, enforcement and/or rule makings related to human health or the environment that should be revised to, at a minimum:

1. promote enforcement of all health and environmental statutes in areas with minority populations and low-income populations;
2. ensure greater public participation;
3. improve research and data collection relating to the health of and environment of minority populations and low-income populations; and
4. identify differential patterns of consumption of natural resources among minority populations and low-income populations. In addition, the environmental justice strategy shall include, where appropriate, a timetable for undertaking identified revisions and consideration of economic and social implications of the revisions.

(b) Within 4 months of the date of this order, each Federal agency shall identify an internal administrative process for developing its environmental justice strategy, and shall inform the Working Group of the process.

(c) Within 6 months of the date of this order, each Federal agency shall provide the Working Group with an outline of its proposed environmental justice strategy.

(d) Within 10 months of the date of this order, each Federal agency shall provide the Working Group with its proposed environmental justice strategy.

(e) Within 12 months of the date of this order, each Federal agency shall finalize its environmental justice strategy and provide a copy and written description of its strategy to the Working Group. During the 12month period from the date of this order, each Federal agency, as part of its environmental justice strategy shall identify several specific projects that can be promptly undertaken to address particular concerns identified during the development of the proposed environmental justice strategy and a schedule for implementing those projects.

(f) Within 24 months of the date of this order, each Federal agency shall report to the Working Group on its progress in implementing its agency-wide environmental justice strategy.

(g) Federal agencies shall provide additional periodic reports to the Working Group as requested by the Working Group.

1-103. Reports to the President.

Within 14 months of the date of this order, the Working Group shall submit to the President, through the Office of the Deputy Assistant to the President for Environmental Policy and the Office of the Assistant to the President for Domestic Policy, a report that describes the implementation of this order, and includes the final environmental justice strategies described in section 1-103(e) of this order.

SECTION 2-2. FEDERAL AGENCY RESPONSIBILITIES FOR FEDERAL PROGRAMS

Each Federal agency shall conduct its programs, policies, and activities that substantially affect human health or the environment, in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under, such programs, policies, and activities, because of their race, color, or national origin.

SECTION 3-3. RESEARCH, DATA COLLECTION, AND ANALYSIS

3-301. Human Health and Environmental Research and Analysis.

(a) Environmental human health research, whenever practicable and appropriate, shall include diverse segments of the population in epidemiological and clinical studies, including segments at high risk from environmental hazards, such as minority populations, low-income populations and workers who may be exposed to substantial environmental hazards.

(b) Environmental human health analyses, whenever practicable and appropriate, shall identify multiple and cumulative exposures.

(c) Federal agencies shall provide minority populations and low-income populations the opportunity to comment on the development and design of research strategies undertaken pursuant to this order.

3-302. Human Health and Environmental Data Collection and Analysis.

To the extent permitted by existing law, including the Privacy Act, as amended (5 U.S.C. section 552a):

(a) each Federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information assessing and comparing environmental and human health risks borne by populations identified by race, national origin, or income. To the extent practical and appropriate, Federal agencies shall use this information to determine whether their programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations;

(b) In connection with the development and implementation of agency strategies in section 1-103 of this order, each Federal agency, whenever practicable and appropriate, shall collect, maintain and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have a substantial environmental, human health, or economic effect on the surrounding populations, when such facilities or sites become the subject of a substantial Federal environmental administrative or judicial action. Such information shall be made available to the public, unless prohibited by law; and

(c) Each Federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding Federal facilities that are: (1) subject to the reporting requirements under the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. section 11001-11050 as mandated in Executive Order No. 12856; and (2) expected to have a substantial environmental, human health, or economic effect on surrounding populations. Such information shall be made available to the public, unless prohibited by law.

(d) In carrying out the responsibilities in this section, each Federal agency, whenever practicable and appropriate, shall share information and eliminate unnecessary duplication of efforts through the use of existing data systems and cooperative agreements among Federal agencies and with State, local, and tribal governments.

SECTION 4-4. SUBSISTENCE CONSUMPTION OF FISH AND WILDLIFE

4-401. Consumption Patterns.

In order to assist in identifying the need for ensuring protection of populations with differential patterns of subsistence consumption of fish and wildlife, Federal agencies, whenever practicable and appropriate, shall collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence. Federal agencies shall communicate to the public the risks of those consumption patterns.

4-402. Guidance.

Federal agencies, whenever practicable and appropriate, shall work in a coordinated manner to publish guidance reflecting the latest scientific information available concerning methods for evaluating the human health risks associated with the consumption of pollutant-bearing fish or wildlife. Agencies shall consider such guidance in developing their policies and rules.

SECTION 5-5. PUBLIC PARTICIPATION AND ACCESS TO INFORMATION

(a) The public may submit recommendations to Federal agencies relating to the incorporation of environmental justice principles into Federal agency programs or policies. Each Federal agency shall convey such recommendations to the Working Group.

(b) Each Federal agency may, whenever practicable and appropriate, translate crucial public documents, notices, and hearings relating to human health or the environment for limited English speaking populations.

(c) Each Federal agency shall work to ensure that public documents, notices, and hearings relating to human health or the environment are concise, understandable, and readily accessible to the public.

(d) The Working Group shall hold public meetings, as appropriate, for the purpose of fact-finding, receiving public comments, and conducting inquiries concerning environmental justice. The Working Group shall prepare for public review a summary of the comments and recommendations discussed at the public meetings.

SECTION 6-6. GENERAL PROVISIONS

6-601. Responsibility for Agency Implementation.

The head of each Federal agency shall be responsible for ensuring compliance with this order. Each Federal agency shall conduct internal reviews and take such other steps as may be necessary to monitor compliance with this order.

6-602. Executive Order No. 12250.

This Executive order is intended to supplement but not supersede Executive Order No. 12250, which requires consistent and effective implementation of various laws prohibiting discriminatory practices in programs receiving Federal financial assistance. Nothing herein shall limit the effect or mandate of Executive Order No. 12250.

6-603. Executive Order No. 12875.

This Executive order is not intended to limit the effect or mandate of Executive Order No. 12875.

6-604. Scope.

For purposes of this order, Federal agency means any agency on the Working group, and such other agencies as may be designated by the President, that conducts any Federal program or activity that substantially affects human health or the environment. Independent agencies are requested to comply with the provisions of this order.

6-605. Petitions for Exemptions.

The head of a Federal agency may petition the President for an exemption from the requirements of this order on the grounds that all or some of the petitioning agency's programs or activities should not be subject to the requirements of this order.

6-606. Native American Programs.

Each Federal agency responsibility set forth under this order shall apply equally to Native American programs. In addition, the Department of the Interior, in coordination with the Working Group, and, after consultation with tribal leaders, shall coordinate steps to be taken pursuant to this order that address Federally-recognized Indian Tribes.

6-607. Costs.

Unless otherwise provided by law, Federal agencies shall assume the financial costs of complying with this order.

6-608. General.

Federal agencies shall implement this order consistent with, and to the extent permitted by, existing law.

6-609. Judicial Review.

This order is intended only to improve the internal management of the executive branch and is not intended to, nor does it create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies, its officers, or any person. This order shall not be construed to create any right to judicial review involving the compliance or non-compliance of the United States, its agencies, its officers, or any other person with this order.

William J. Clinton
The White House
11 February 1994

Vita

Sammy Joseph Zahran was born on September 18, 1971. Sammy Graduated from FJ Brennan Catholic Secondary in 1991. He received a Bachelor of Arts Degree in Political Science from the University of Windsor, Ontario in 1995. Sammy completed his Doctor of Philosophy degree in Sociology from the University of Tennessee in 2003. He is the first member of his immediate and extended family to earn an advanced university degree.