

# Environmental Equity and Electric Power Generation: Disparate Community Outcomes within Texas?

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(Received July 2004; revised February 2005)

**ABSTRACT** *The examinations conducted in this study focus at the community level to test for disparate outcomes involving utility-based electric power generation within the crucial state of Texas. Potential policy implications are discussed as relevant to the general thesis of environmental racism postulated by justice advocates and the civil rights strategies advanced by justice advocates. Cross-sectional and longitudinal perspectives are used in testing for distributive inequities involving locations of fossil fuel power plants and emissions and output rates of emissions originating from such power plants. These tests provide empirical basis for assessing outcomes of the siting and emissions regulatory processes. While the civil rights strategies that would use Title VI of the Civil Rights Act of 1964 and the disparate impact standard are inapplicable, some limited findings indicate disparate outcomes involving other disadvantaged populations that are difficult to justify in context of legitimate market dynamics. Issues raised in this study have relevance to national energy policy proposals that promote many more power plants across the USA and encourage emissions trading.*

## Introduction

A grassroots environmental justice movement has emerged in recent decades through a diverse network of concerned communities across the USA (Foreman, 1998; Schlosberg, 1999). Although environmental justice does include issues other than race (Bullard, 1996), this movement has been directed primarily toward opposing what justice advocates have generally termed ‘environmental racism’ (Lee, 1992; Mohai & Bryant, 1992; Bullard, 1994; Grossman, 1994; Getches & Pellow, 2002). Bullard (1996, p. 497) defines environmental racism as “any policy, practice, or directive that differentially affects or disadvantages (whether intended or unintended) individuals, groups, or communities based on race or color”. Accordingly, widespread racism throughout societal institutions defends, protects and enhances

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quality-of-life choices for affluent whites while producing environmental disparities that disproportionately burden minority populations (Bullard, 1993, 1994; Bryant, 1995; Bullard & Johnson, 1997; Romm, 2002). Early landmark studies by the US General Accounting Office (1983) and the Commission for Racial Justice (1987) examined geographic distributions of hazardous facilities. These and other studies indicate distributive inequities involving locations of hazardous facilities and risks originating from hazardous facilities disproportionately burden minority communities. As investigating processes and decisions that produce such disparities to prove discriminatory intent can be very difficult (Been, 1993; Bryner, 2002; Cole, 2002), justice advocates have advanced civil rights strategies using Title VI of the Civil Rights Act of 1964 and the disparate impact standard that concentrate attention on disparate outcomes of processes and decisions rather than on the processes and decisions themselves (Lee, 1997; Bryner, 2002; Cole, 2002).

While environmental justice has expanded dramatically in scope (Bullard & Johnson, 1997; Bullard *et al.*, 2000; Mutz *et al.*, 2002), relatively few environmental justice studies have focused closely on electric power generation. Touché (2004) thematically catalogued an assortment of relevant literature for general purposes of integrating energy use within frameworks of environmental justice and ecological sustainability, and a nation-wide report by the Black Leadership Forum (2002) expressed serious concerns about electric power generation in a loosely-measured and broad-brush sense. Case studies focused more closely on particular locations and facilities involving energy use and stages of fuel life cycles (Creech & Brown, 2000; Hall, 1994; Robinson, 1992), but no environmental justice study closely observed the compositions of specific communities that host electric generating power plants across an entire state or broader region. Furthermore, cross-sectional studies that examined geographic distributions of other types of hazardous facilities have been criticized on methodological grounds. Anderton *et al.* (1994) argue the landmark studies by the US General Accounting Office (1983) and the Commission for Racial Justice (1987) used a geographic unit of analysis that is too large in measuring the compositions of the hosting communities. Accordingly, a geographic unit of analysis that is too large invites aggregation errors and ecological fallacies (Anderton *et al.*, 1994). The widely-sited landmark studies, together with many other cross-sectional studies, also lack longitudinal perspective. The compositions of the hosting communities were not observed before the hazardous facilities were initially established, and not knowing whether the minorities or the facilities came first dampens assessments of causation (Been, 1993, 1994). In order to argue the disparities were direct outcomes of the siting process, it would be useful to demonstrate that minority populations preceded the facilities (Rogers, 1995).

This study spans the geography of Texas, observing the compositions of the actual communities within which coal or natural gas utility power plants were established between 1970 and 1990. A sufficient number of such power plants were established in these two decades to allow for cross-sectional community examinations, while providing necessary temporal duration for longitudinal perspective. Beyond these analytical considerations, the time period 1970 to 1990 best corresponds to two of the most significant waves of relevant environmental and social policy making over the second half of the 20th century. Power plants established in these two decades are most closely bracketed in time by the series of amendments to the Clean Air Act of

1963 that led to the Clean Air Act of 1970 and the substantial amendments embodied 20 years later in the Clean Air Act of 1990, as well as the deregulation of electric power generation that occurred in the 1990s. Power plants established in these two decades are also most closely bracketed in time by the passage of early civil rights legislation throughout the 1960s and the formal institutionalized recognition of environmental equity and justice as contemporary issues of concern during the 1990s under the administrations of President George Herbert Walker Bush and President William Jefferson Clinton. Power plants established in these two decades are simply subject to various requirements and considerations that differ from power plants established in other decades, with relevance back when they were initially established as well as relevance to the regulation of their emissions that continues today.

Table 1 specifies the coal or natural gas utility power plants that began operating within Texas between 1970 and 1990 (Public Utility Commission of Texas, 1994; US Energy Information Administration, 2000; US Environmental Protection Agency, 2001a). Figure 1 displays the 28 map locations: 15 where coal is the primary fuel source and 13 where natural gas is the primary fuel source. The compositions of the hosting communities are examined both before and after establishment of the power plants in comparison to paired communities from the same areas. The compositions of the communities that host the coal power plants are then compared as a group to the communities that host the natural gas power plants. Finally, the compositions of the hosting communities are examined in relation to emissions and output rates of emissions originating from the power plants. These community examinations are conducted for purposes of identifying distributive inequities and indicating disparate outcomes of the siting and emissions regulatory processes. Testing for disparate outcomes is in accord with the civil rights strategies advanced by justice advocates. This study does not investigate various procedures and decisions or evaluate different local histories and cultures. That would be best accomplished on a case-by-case basis where each power plant could be observed as a distinct phenomenon in and of itself. In accord with the general thesis of environmental racism, minorities receive primary attention in the community examinations conducted in this study. Yet, several other community composition variables are included to encourage a broader conceptualization of environmental equity.

## **Rationale**

### *Electric Power Generation, Ambient Air Pollution and Texas*

Electric power generation is a very significant source of ambient air pollution throughout the USA (Creech & Brown, 2000). Nationally, power plants are responsible for 33 to 40 per cent of the carbon dioxide (CO<sub>2</sub>), 66 to 70 per cent of the sulfur dioxide (SO<sub>2</sub>), and 30 to 33 per cent of the nitrogen oxides (NO<sub>x</sub>) emitted into the ambient air each year (Creech & Brown, 2000; Fox-Penner, 1997). Power plants are also sources of other air pollutants including air-borne heavy metals such as Mercury (Hg).

Texas is a critical energy production and energy consumption state that is ideal for closer observation of electric power generation. Texas generates and uses more electricity than any other state (Texas Energy Planning Council, 2004). Texas is also

**Table 1.** Coal or natural gas utility power plants that began operating within Texas between 1970 and 1990

<b>Power Plant</b>	<b>Map #</b>	<b>Primary fuel</b>	<b>Began commercial operation</b>	<b>County</b>	<b>Utility owner and operator</b>
Big Brown	1C	Coal	1971	Freestone	TXU Electric and Gas
O. W. Sommers and J. T. Deely <sup>1</sup>	2C	Coal	1972, 1977	Bexar	San Antonio Public Service Bd.
Monticello	3C	Coal	1974	Titus	TXU Electric and Gas
Harrington Electric Station	4C	Coal	1976	Potter	Southwestern Public Service Co.
Welsh	5C	Coal	1977	Titus	Southwestern Electric Power Co.
Martin Lake	6C	Coal	1977	Rusk	TXU Electric and Gas
Sam Seymour Fayette Power Project	7C	Coal	1979	Fayette	Lower Colorado River Authority <sup>3</sup>
Coletto Creek	8C	Coal	1980	Goliad	Central Power and Light Co.
Sandow 4 Electric Utility Plant <sup>2</sup>	9C	Coal	1981	Milam	TXU Electric and Gas
San Miguel	10C	Coal	1982	Atascosa	San Miguel Electric Coop. <sup>3</sup>
Tolk Electric Station	11C	Coal	1982	Lamb	Southwestern Public Service Co.
Gibbons Creek	12C	Coal	1983	Grimes	Texas Municipal Power Agency
Henry W. Pirkey	13C	Coal	1985	Harrison	Southwestern Electric Power Co. <sup>3</sup>
Limestone	14C	Coal	1985	Limestone	Reliant Energy HL and P
Oklaunion	15C	Coal	1986	Wilbarger	West Texas Utilities Co. <sup>3</sup>
Tradinghouse Creek	1NG	Gas	1970	McLennan	TXU Electric and Gas
Lake Hubbard	2NG	Gas	1970	Dallas	TXU Electric and Gas
Cedar Bayou	3NG	Gas	1970	Chambers	Reliant Energy HL and P
Lewis Creek	4NG	Gas	1970	Montgomery	Entergy Gulf States
E. S. Joslin	5NG	Gas	1971	Calhoun	Central Power and Light Co.
Decker Creek	6NG	Gas	1971	Travis	Austin Energy
Jones Electric Station	7NG	Gas	1971	Lubbock	Southwestern Public Service Co.
Barney M. Davis	8NG	Gas	1974	Nueces	Central Power and Light Co.

*(continued)*

Table 1. (Continued)

Power Plant	Map #	Primary fuel	Began commercial operation	County	Utility owner and operator
Fort Phantom	9NG	Gas	1974	Jones	West Texas Utilities Co.
Thomas C. Ferguson	10NG	Gas	1974	Llano	Lower Colorado River Authority
DeCordova	11NG	Gas	1975	Hood	TXU Electric and Gas
Roland C. Dansby	12NG	Gas	1977	Brazos	City of Bryan
Copper	13NG	Gas	1980	El Paso	El Paso Electric Co.

<sup>1</sup>Multiple power plant complex of San Antonio Public Service Board. O. W. Sommers is a natural gas power plant that began operating in 1972. J. T. Deely is a coal power plant that began operating in 1977. Another coal power plant, J. K. Spruce, began operating at the complex later in 1992. Coal is considered the primary fuel for the complex as a whole.

<sup>2</sup>Sandow 4 is specified by Sources as separate from Sandow 1, 2, and 3. Sandow 4 is utility based, and it is owned and operated by TXU Electric and Gas. Sandow units 1, 2, and 3 are non-utility based, and they are owned and operated by Alcoa.

<sup>3</sup>Identified utility operates the specified power plant while sharing ownership with other utilities.

Sources: Public Utility Commission of Texas (1994); US Energy Information Administration (2000); US Environmental Protection Agency (2001a).

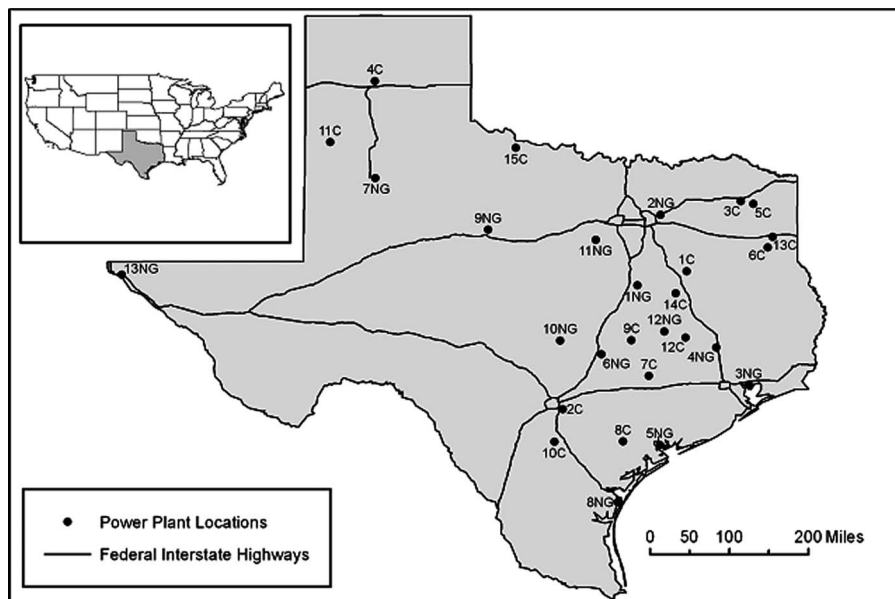


Figure 1. Mapped locations of coal or natural gas utility power plants that began operating within Texas between 1970 and 1990 (corresponds to Map # field in Table 1).

the home of President George W. Bush, whose national energy policy (National Energy Policy Development Group, 2001) is largely based on Texas. Much ambient air pollution originates from electric power generation within Texas. Relative to all other states, Texas ranks first for total emissions of CO<sub>2</sub>, sixth for total emissions of SO<sub>2</sub>, second for total emissions of NO<sub>x</sub>, first for total emissions of NO<sub>x</sub> (ozone season), and second for total emissions of Hg originating from electric power generation statewide (US Environmental Protection Agency, 2001a). Table 2 shows Texas ranks first for total power plant emissions in general, as measured by factor scores on a general emissions component extracted with principal component factor analysis from total emissions of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, NO<sub>x</sub> (ozone season), and Hg originating from electric power generation statewide.

Table 2 also shows Texas has a very high ranking in percent minority. Including white Hispanics with non-white Hispanics and all racial minorities, Texas has the fourth greatest percent minority of all states (US Census Bureau, 1992). Given these rankings and the extensive and well-documented history of various environmental justice concerns throughout the state, dating back to 1979 when resident homeowners of a middle-class African American community in suburban Houston filed the first-ever environmental lawsuit charging racial discrimination in the siting of a hazardous facility (Bullard, 1994; Tyson *et al.*, 1998), Texas clearly warrants closer observation in this environmental justice study. Of states with very high ranking in total emissions originating from electric power generation statewide, Texas has by far the highest ranking in percent minority statewide. This study is observing more closely what appears to be the worst of all domestic situations.

These power plant emissions are responsible for negative health effects and harmful environmental impacts (Miller, 1992; Fox-Penner, 1997; Koenig, 2000; Lee, 2002; Levy *et al.*, 2002). CO<sub>2</sub> is not recognized by National Ambient Air Quality Standards (NAAQS), but it adds to greenhouse gasses that may intensify climate change and produce physical disasters (Miller, 1992; Fox-Penner, 1997; Lee, 2002). SO<sub>2</sub> and NO<sub>x</sub> enter the ambient air directly and then react with other air pollutants and natural air components to form acid deposition and smog (Miller, 1992; Fox-Penner, 1997; Lee, 2002). Acid deposition aggravates human respiratory tracts and can cause respiratory diseases (Koenig, 2000; Lee, 2002), and it irritates the skin and eyes (Miller, 1992). It also harms natural and built environments as it damages vegetation, erodes soils, impairs crops, kills aquatic life and corrodes structures and materials (Lee, 2002; Miller, 1992). Photochemical smog with troposphere ozone (O<sub>3</sub>) is a ground-level chemical hazard that negatively affects human respiratory systems and pulmonary functions (Miller, 1992; Koenig, 2000; Lee, 2002). It also threatens woodlands, reduces crop production and diminishes visibility and aesthetic value (Miller, 1992; Lee, 2002). Both SO<sub>2</sub> and NO<sub>x</sub> contribute to the formation of secondary fine particulate matter (Lee, 2002) that can cause serious respiratory, pulmonary and cardiac problems (Levy *et al.*, 2002). Hg is a hazardous air toxin that can cause severe health effects and ecological damage (Koenig, 2000). It enters aquatic ecosystems by air deposition and then accumulates in its most toxic form, methyl mercury, through the food chain (Miller, 1992). Health effects range from mild to moderate loss of sensory or cognitive abilities, with worst potential consequences including severe nervous system damage and death.

**Table 2.** State rankings for total power plant emissions and percent minority

State	General emissions component	CO <sub>2</sub>	SO <sub>2</sub>	NO <sub>x</sub>	NO <sub>x</sub> (O <sub>3</sub> season)	Hg	Percent minority
Texas	1	1	6	2	1	2	4
Ohio	2	4	1	1	2	3	29
Pennsylvania	3	5	2	8	9	1	30
Indiana	4	3	3	3	4	5	34
Florida	5	2	4	4	3	15	12
Illinois	6	7	5	7	6	4	16
West Virginia	7	8	7	6	8	7	46
Kentucky	8	6	9	5	5	8	40
North Carolina	9	12	11	9	7	9	17
Alabama	10	10	10	13	13	6	13
Georgia	11	11	8	14	11	11	10
Michigan	12	9	13	11	12	10	24
Tennessee	13	15	12	10	10	14	25
Missouri	14	13	15	12	14	12	28
New York	15	14	14	20	21	25	8
Wisconsin	16	18	18	17	18	16	39
Maryland	17	28	16	15	16	18	9
Virginia	18	22	17	16	15	23	18
North Dakota	19	27	20	23	23	13	45
Oklahoma	20	19	26	18	17	19	22
Louisiana	21	17	21	21	19	29	6
Iowa	22	23	22	26	27	17	47
Wyoming	23	16	28	22	24	22	36
South Carolina	24	30	19	24	20	27	7
Minnesota	25	25	27	19	22	24	44
Arizona	26	20	29	25	26	26	11
Kansas	27	29	25	27	25	21	32
New Mexico	28	31	31	28	28	20	2
Colorado	29	24	30	29	29	34	21
Utah	30	26	40	30	31	35	37
Mississippi	31	34	24	31	30	32	5
Arkansas	32	33	32	34	32	30	23
Massachusetts	33	32	23	35	35	37	31
Nebraska	34	36	34	33	34	31	43
Nevada	35	35	37	32	33	36	19
California	36	21	41	38	38	47	3
Montana	37	37	43	36	36	28	41
New Jersey	38	38	38	37	37	39	15
Washington	39	40	33	40	41	33	27
Connecticut	40	39	36	42	42	42	26
Hawaii	41	41	42	39	39	45	1
Delaware	42	42	39	44	43	38	20
South Dakota	43	47	44	41	40	41	38
New Hampshire	44	44	35	45	45	43	48
Oregon	45	43	46	46	46	40	35
Alaska	46	46	47	43	44	46	14
Maine	47	45	45	47	47	44	49
Rhode Island	—	48	50	48	48	—	33

(continued)

Table 2. (Continued)

State	General emissions component	CO <sub>2</sub>	SO <sub>2</sub>	NO <sub>x</sub>	NO <sub>x</sub> (O <sub>3</sub> season)	Hg	Percent minority
Idaho	–	49	48	50	50	–	42
Vermont	–	50	49	49	49	–	50

General emissions component extracted from actual total emissions of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, NO<sub>x</sub> (O<sub>3</sub> season), and Hg; not from tabulated rankings for total emissions of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, NO<sub>x</sub> (O<sub>3</sub> season), and Hg.

– Hg not available from source.

Sources: US Environmental Protection Agency (2001a); US Census Bureau (1992).

### *Ambient Air Pollution and Minority Populations*

Justice advocates argue minority populations are disproportionately vulnerable to health risks from ambient air pollution because of disproportionate exposure (Bullard, 1994; Ferris, 1994). For example, the asthma rate is greater among African American children than white children, and asthma hospitalization and mortality rates are greater among minorities than whites (Creech & Brown, 2000). Wernette & Nieves (1992) conducted a nation-wide study for Argonne National Laboratory focusing on counties and independent cities designated as NAAQS non-attainment areas across the USA. Compared to non-Hispanic whites, they found greater percentages of African American and Hispanic populations living in the non-attainment areas. Furthermore, the percentages of African American and Hispanic populations were consistently greater regardless of the number of pollutants exceeding NAAQS. Wernette & Nieves (1992) then compared these same minority percentages to the percentage of the entire population, from all population groups, with income below the poverty level living in the non-attainment areas. The percentages of African American and Hispanic populations were again consistently greater regardless of the number of pollutants exceeding NAAQS. The more recent report *Air of Injustice* by the Black Leadership Forum (2002) reaffirms these nation-wide findings, while going one step further. The report emphasizes electric power generation is a primary source of ambient air pollution and indicates a greater percentage of African Americans, as compared to the white population, live within 30 miles of a power plant—the distance within which the maximum effects of the plume are expected to occur (Black Leadership Forum, 2002). The report also expresses concern that future power plants will likely be sited in minority communities.

However, such findings do not demonstrate racial injustice. Few will dispute that exposure to emissions originating from power plants can be experienced within 30 miles. In fact, exposure to the different emissions and their negative effects can be experienced at much closer distances as well as at distances far beyond 30-mile radii (Fox-Penner, 1997; Lee, 2002; Levy *et al.*, 2002). However, generalizations drawn from such large geographic units of analysis as entire counties and independent cities, or whole areas up to 60 miles in diameter, are obviously subject to similar criticisms as those emphasized by Anderton *et al.* (1994). Beyond aggregation errors

and ecological fallacies, antecedent and intervening variables are more difficult to identify and spurious relationships are more difficult to ascertain. This is particularly so with respect to cross-sectional examinations. For appropriate methods of assessing environmental inequities, the Institute of Medicine (1999) suggests examining specific communities that host specific hazardous facilities and characterizing the nature and severity of risk exposure by direct measurement or estimation. Accordingly, assertions of disparities are often well founded and warrant careful assessment (Institute of Medicine, 1999). This study focuses within a specific state that clearly warrants closer observation and examines the actual communities within which specific power plants have been established, instead of larger areas within speculative distances of possible exposure to the different emissions. Although consequent health effects are not observed in this study, the compositions of the hosting communities are examined in relation to emissions and output rates of emissions originating from the specified power plants.

### *Potential Policy Implications*

Potential policy implications entail constitutional, legal and economic dimensions. Following the creation of an Office of Environmental Equity in the US Environmental Protection Agency (EPA) under the administration of President George Herbert Walker Bush, President Clinton signed Executive Order 12898 (1994). This executive order instructed federal agencies to develop strategies for identifying and addressing adverse health effects and environmental impacts of programs, policies and activities that disproportionately affect minority and low-income populations. President Clinton also released an accompanying memorandum (Clinton, 1994) to the heads of all departments and agencies. This memorandum accentuated use of Title VI of the Civil Rights Act of 1964 and its provision that federally funded programs or activities affecting human health or the environment do not discriminate on basis of race, color or national origin. These actions enhanced the potency of strategies advanced by justice advocates and led to significant changes in environmental risk assessment procedures throughout government.

As use of Title VI has become a primary environmental justice strategy, the distinction between discriminatory intent and discriminatory effects is absolutely crucial (Lee, 1997; Bryner, 2002; Cole, 2002). The Fourteenth Amendment to the Constitution of the United States prohibits intentional discrimination, but proving it can be very difficult (Been, 1993; Bryner, 2002; Cole, 2002). The Civil Rights Act of 1964 prohibits intentional discrimination and provides potential remedy for unjustified disparate impact. For the disparate impact standard, a plaintiff must demonstrate an adverse disparate impact resulting from a policy or process, and the burden shifts to the defendant to justify the decision that led to the disparate outcome (Lee, 1997; Cole, 2002). If the defendant meets this burden, the plaintiff can still prevail if it is demonstrated that the defendant could have decided upon a less discriminatory alternative (Lee, 1997). The disparate impact standard can be applicable where specific hazardous facilities are sited in minority communities rather than in alternative white communities and for inequitable regulation or mitigation of risks originating from such facilities (Lee, 1997).

Federal agencies have implemented Title VI through regulations barring discriminatory effects (Cole, 2002), and the disparate impact standard applies to Title VI administrative proceedings and cases brought to enforce Title VI implementing regulations (Lee, 1997). Throughout all strata of government, umbrella agencies can lose federal funding if a program or activity fails to comply. The matter can also be referred to the Department of Justice for litigation and possible injunction. The EPA Office of Civil Rights revised its policies and procedures to accommodate complaints filed under Title VI alleging discriminatory effects resulting from the issuance of permits by state and local agencies that receive federal funds (US Environmental Protection Agency, 1998). Because permitting agencies directly influence the siting process and regulatory agencies directly influence the emissions regulatory process, disparate outcomes of these processes involving locations of power plants or emissions originating from power plants can result in legal problems and lost funds for state and local governments.

Given all of the difficult how and why questions entailed in proving discriminatory intent, potential applicability of Title VI and the disparate impact standard to outcomes of the siting and emissions regulatory processes really is of great strategic value to justice advocates. This is especially true when applied to cross-sectional distributions, as in this study, where investigating the various procedures and decisions for every power plant and evaluating the different local histories and cultures for every hosting community to prove discriminatory intent on a distributive cross-sectional basis would be very difficult indeed. These considerations are now extraordinarily relevant. Within Texas, the Texas Electric Choice education campaign of the Public Utility Commission of Texas is aggressively advertising proposals for additional increases in electric generating capacity in response to the insatiable energy consumption of the very large and rapidly growing state population. In terms of the broader United States, President George W. Bush is promoting many more coal and natural gas power plants and encouraging emissions trading (National Energy Policy Development Group, 2001).

## **Hypotheses**

Three specific hypotheses are tested in this study. The first two hypotheses are designed to test for distributive inequities involving locations of power plants and provide empirical basis for indicating disparate outcomes of the siting process. The third hypothesis is designed to test for distributive inequities involving emissions and output rates of emissions originating from power plants and provide empirical basis for indicating disparate outcomes of the emissions regulatory process.

Each hypothesis is assessed in terms of four pre-specified equity factors: minority, poverty, property value and education. These factors reflect the theories of equity and justice that are most strongly emphasized in the literature. Minority is the primary factor of concern. Minority is at the heart of the general thesis of environmental racism, and it provides constitutional and legal basis for the environmental justice movement. Low-income populations are included in Executive Order 12898 (Bullard, 1996), and such populations are afforded equal protection against discrimination under the Fourteenth Amendment. Yet, poverty is overshadowed by race in terms of environmental justice. The civil rights strategies

that use Title VI and the disparate impact standard are directed toward categorizing disparities on basis of race, color, and national origin (Clinton, 1994; Lee, 1997; Cole, 2002), and race is identified as a suspect classification under the law while economic class is not (Bryner, 2002). Property value is the major economic factor in this study, and it offers opposing explanations for the locations of hazardous facilities (Been, 1993, 1994; Liu, 2001). Land values may be a siting determinant, with low-income minorities and hazardous facilities being attracted to low-cost locations (Rogers, 1995). Land values may also decline when hazardous facilities are sited, and low-income minorities may be attracted thereafter (Rogers, 1995). Education is included as a principal component of socio-economic status. Furthermore, substandard education may reflect unawareness or incomprehension of environmental hazards, along with insufficient organizational capacity to take appropriate collective action in opposing such hazards. A multiple-unit case study conducted through Harvard School of Public Health (Levy *et al.*, 2002) selected five older fossil fuel power plants near Washington DC for examination. Under-educated adults were found susceptible to premature mortality from the emissions and likely to benefit in terms of health if the emissions are reduced (Levy *et al.*, 2002).

Justice advocates often point to the study by the Commission for Racial Justice (1987) that concluded race is the most significant factor in determining where hazardous waste facilities are located (Lee, 1992; Mohai & Bryant, 1992; Bullard, 1994; Grossman, 1994; Getches & Pellow, 2002). Beyond waste facilities, justice advocates argue minority populations are adversely affected by a wide spectrum of disparities that involves many different types of environmental hazards (Mohai & Bryant, 1992; Ferris, 1994; Grossman, 1994; Bullard, 1996). The first hypothesis evaluates this general thesis of environmental racism in regard to electric power generation.

H1. Communities with power plants tend to be composed of greater concentrations of disadvantaged populations than communities without power plants.

The compositions of communities which host coal or natural gas utility power plants that began operating within Texas between 1970 and 1990 are examined both before and after establishment of the power plants in comparison to paired communities that do not host such power plants. The second hypothesis then focuses only on the hosting communities. Since coal is often considered more hazardous than natural gas, disparities in the distribution of coal power plants relative to the distribution of natural gas power plants could be an environmental justice concern.

H2. Communities with coal-fired power plants tend to be composed of greater concentrations of disadvantaged populations as a group than communities with natural gas-fired power plants.

Hence, the compositions of the communities that host the coal power plants are compared as a group to the communities that host the natural gas power plants.

Justice advocates also point to a study by Lavelle & Coyle (1992) that focused on toxic waste sites as they argue environmental racism influences more than the locations of hazardous facilities (Bullard, 1994; Getches & Pellow, 2002). Lavelle & Coyle (1992) found racial disparities involving regulation and mitigation of environmental risks that indicate environmental racism continues long after hazardous facilities are initially established. Lavelle & Coyle (1992) indicate this racially imbalanced environmental protection often occurs irrespective of whether the hosting communities are wealthy or poor. With regard to electric power generation, there may be a tendency for owners and operators of power plants located in minority communities to be remiss in controlling emissions. Moreover, there may be a tendency for government regulatory agencies to be remiss in regulating emissions where power plants are located in such communities. The third hypothesis examines the compositions of communities which host coal or natural gas utility power plants that began operating within Texas between 1970 and 1990 in relation to emissions and output rates of emissions originating from the power plants.

H3. The greater the concentrations of disadvantaged populations in communities with power plants, the greater the emissions and output rates of emissions originating from the power plants.

## **Methods and Data**

### *Measurement*

Percent minority, percent families in poverty, median home value and percent high school graduates are used as operational measures of the equity factors minority, poverty, property value and education. Percent minority includes white Hispanics with non-white Hispanics and all racial minorities, percent families in poverty includes families that are living in poverty, median home value includes specified owner occupied units, and percent high school graduates includes persons 25 years of age and older that are high school graduates. The 1970 Census and the 1980 Census are used in measuring these community composition variables before the power plants began operating. The 1990 Census is used for all other community examinations. Other operational measures of these and other equity factors were considered. For example, Hockman & Morris (1998) indicate many operational measures with predictive possibilities are available at different units of analysis from different data sources. However, the operational measures of the equity factors employed in this study are not intended to be exhaustive. They were pre-specified on basis of theories of equity and justice emphasized in the literature and clear and consistent enumeration at the community level in the 1970, 1980 and 1990 Censuses. Tons of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and NO<sub>x</sub> (O<sub>3</sub> season) emitted during 1998 and pounds of Hg emitted during 1998 are used as operational measures of power plant emissions. Tons of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and NO<sub>x</sub> (O<sub>3</sub> season) emitted per megawatt hour during 1998 and pounds of Hg emitted per gigawatt hour during 1998 are used as operational measures of power plant emissions output rates.

For each power plant, the census tract within which it is located is considered the hosting community. Census tracts are used as such to measure the community

composition variables instead of postal zip codes, census blocks or census block groups. Census tracts are ordinarily smaller, more clearly defined, more permanent in nature and more stable over time than postal zip codes (Anderton *et al.*, 1994; Liu, 2001). Beyond aggregation errors and ecological fallacies (Anderton *et al.*, 1994), postal zip codes are virtually impossible to use when community examinations span several previous decades (Liu, 2001). Census tracts are also delineated by local people to “reflect the structure of the metropolis as viewed by those most familiar with it” (Bogue, 1985, p. 137), and they are more likely to reflect homogenous local neighborhoods (Anderton *et al.*, 1994). Census blocks are smaller than census tracts, but less detailed data are available for reasons of protecting confidentiality (Been, 1994; Liu, 2001). Sufficiently detailed data are generally available for census block groups, but the arguments against using either census blocks or census block groups are substantial (Been, 1994). Most relevant to this study, neither census blocks nor census block groups are as permanent or stable over time as census tracts (Been, 1994; Liu, 2001). The relative permanency and stability of census tracts make them the most reliable of the small geographic units of analysis, particularly for studies that include longitudinal examinations (Been, 1994; Liu, 2001).

A complication arose where power plants are located in rural areas that are not census tract demarcated, but block numbering areas (BNAs) are demarcated for such areas. The criteria used in defining census tracts and BNAs have converged in recent decades so that, as of the 1990 Census, BNAs are now categorized with census tracts for sharing the same basic attributes (Liu, 2001). Hence, a BNA is used to measure the community composition variables where a power plant is located in an area that is not census tract demarcated. Unfortunately, as BNAs were not categorized with census tracts in the 1970 Census and the 1980 Census, community compositions can be observed before the power plants began operating for only the 14 power plant locations that were census tract demarcated for these earlier census periods. Another complication arose where power plants are located in direct proximity to census tract or BNA boundaries, suggesting the hosting communities may stretch into immediately adjacent census tracts or BNAs. For any such observation, the immediately adjacent census tract or BNA was amalgamated to ensure capturing the hosting community.

Following from the logic of experimental design (Campbell & Stanley, 1963; Shadish *et al.*, 2002), each comparison community census tract or BNA was selected randomly, after matching by the following criteria: (1) same metropolitan area; (2) same urban, urban periphery, or rural distinction; and (3) same county. Matching by these criteria prior to random selection of each comparison community census tract or BNA provides notable control for regional variation in socio-political situation, utility market structure, natural geology, topography, land use and infrastructure access. This is important given the extent to which local history and culture, the natural and built environment and utility ownership and operation vary across Texas and have changed throughout Texas since the power plants were initially established. In matching by the specified criteria, there were instances where a comparison community census tract or BNA had to be selected from an immediately adjoining county to prevent violating the higher priority criterion of same urban, urban periphery, or rural distinction. Another complication arose where census tracts were split into parts from one census period to the next. For each of the

14 power plant locations that were census tract demarcated in the census periods before the power plants began operating, the 1990 census tract boundary for the hosting community and the 1990 census tract boundary for its paired comparison community were traced back in time. When a census tract split into parts in a later census period, the split parts were amalgamated to cover the same geographic area as the whole census tract from the preceding census period. Thus, the same geographic areas are used in measuring community composition variables before establishment of the power plants as are used in measuring community composition variables afterwards.

### *Testing the Hypotheses*

For the first hypothesis, paired *t* tests are conducted to test for compositional differences between the hosting communities and their paired comparison communities both before and after establishment of the power plants. For the second hypothesis, independent *t* tests are conducted to test for compositional differences between the communities that host the coal power plants as a group and the communities that host the natural gas power plants. For the third hypothesis, principal component factor analyses and stepwise regressions are conducted. A factor analysis is conducted to extract one general emissions component from the power plant emissions, and a separate factor analysis is conducted to extract one general emissions output rate component from the power plant emissions output rates. The factor scores for these components are separately regressed on the community composition variables to identify relationships between each of the community composition variables and power plant emissions in general and power plant emissions output rates in general. Each of the specific emissions and each of the specific emissions output rates are then separately regressed on the community composition variables to further discern specific relationships.

As all hypotheses are directional, one-tailed directional *t* test statistics are used to test each hypothesis. Calculations are performed so that any mean of paired differences that is positive and significant confirms the first hypothesis, and any difference between means that is positive and significant confirms the second hypothesis. Relationships with emissions or emissions output rates that are positive and significant confirm the third hypothesis for percent minority and percent families in poverty, while relationships with emissions or emissions output rates that are negative and significant confirm the third hypothesis for median home value and percent high school graduates.

In extracting the general emissions component from the power plant emissions and the general emissions output rate component from the power plant emissions output rates, components with eigenvalues less than one are eliminated from consideration. The stepwise procedure, instead of forward selection or backward elimination, is used in selecting the community composition variables for inclusion in the regression models. As it both enters and removes inappropriate variables at each step, the stepwise procedure is considered more stringent and better for protecting against multicollinearity. Further multicollinearity diagnostics are checked as suggested by SPSS (1999) and Neter *et al.* (1996). SPSS (1999) cautions against a final model with one or more condition indices greater than 15. Neter *et al.*

(1996) cautions against a final model with one or more variance inflation factors greater than 10 and a final model with a mean variance inflation factor 'considerably' greater than one. In as much as all hypotheses are directional and SPSS reports two-tailed tests for regression, any remaining model component that is not in the predicted direction is also excluded.

### *Data*

The utility owners and operators of the power plants, the Public Utility Commission of Texas (1994), the Texas Natural Resource Conservation Commission, the US Energy Information Administration (2000), and the EPA were all contacted in specifying the power plants and identifying their locations. These sources provided the years the power plants began operating, the primary fuel source, and the simple latitude and longitude co-ordinates. A geographic information system power plant file from the EPA Air Markets Division (US Environmental Protection Agency, 2001b) and a state map of electric facilities from Texas Utilities (Texas Utilities, 1999) provided further clarification and confirmation. The 1970 Census of Population and Housing: Census Tracts (US Census Bureau, 1972), the 1980 Census of Population and Housing: Census Tracts (US Census Bureau, 1983), and the 1990 Census of Population and Housing: Population and Housing Characteristics for Census Tracts and Block Numbering Areas (US Census Bureau, 1993) were used in identifying census tracts and BNAs and measuring the community composition variables. The Emissions and Generation Resource Integrated Database (EGRID) (US Environmental Protection Agency, 2001a) provided all emissions and output rates of emissions originating from the power plants during 1998. EGRID is a comprehensive database that is compiled from several federal sources including the EPA, the Federal Energy Regulatory Commission, and the Energy Information Administration.

### **Results and Findings**

Table 3 shows paired *t* tests with paired statistics derived from the 1990 census tract and BNA measures of the compositional variables for the hosting communities and their comparison communities. Table 4 shows paired *t* tests with paired statistics derived from the census tract measures of the compositional variables for these communities before the power plants began operating. Hispanics are less clearly enumerated in the 1970 Census than in the 1980 Census and the 1990 Census, but the 1970 Census does provide persons of Spanish surname, persons of Spanish language, and persons of Spanish mother tongue as three estimates. In testing for a difference in percent minority before the power plants began operating, three separate tests were conducted with three distinct measures of percent minority derived from these three estimates of Hispanics.

Table 3 exhibits no significant compositional difference between the hosting communities and their paired comparison communities. These results indicate communities with power plants do not tend to have a larger proportion of minorities, a larger proportion of families in poverty, a lower median home value or a smaller proportion of high school graduates. Table 4 exhibits a significant

**Table 3.** Paired *t* tests (1990) for community composition variables

	Pairs	Mean of differences	df	SE	<i>t</i>
Minority	Hosting communities	Mean = 0.234	<i>n</i> = 28	0.037	
	Comparison communities	Mean = 0.248	<i>n</i> = 28	0.032	
	Hosting communities minus Comparison communities	-0.014	27	0.030	-0.453
Families in poverty	Hosting communities	Mean = 0.129	<i>n</i> = 28	0.011	
	Comparison communities	Mean = 0.124	<i>n</i> = 28	0.012	
	Hosting communities minus Comparison communities	0.005	27	0.012	0.442
Median home value	Hosting communities	Mean = 54 364	<i>n</i> = 28	3306	
	Comparison communities	Mean = 56 527	<i>n</i> = 28	6178	
	Comparison communities minus Hosting communities	2163	27	5643	0.385
High school graduates	Hosting communities	Mean = 0.700	<i>n</i> = 28	0.017	
	Comparison communities	Mean = 0.689	<i>n</i> = 28	0.021	
	Comparison communities minus Hosting communities	-0.011	27	0.022	-0.510

difference in the predicted direction for percent families in poverty before the power plants began operating. This finding indicates communities with power plants tended to have a larger proportion of families in poverty when the power plants were initially established. Table 4 exhibits no other significant compositional difference before the power plants began operating. These results indicate communities with power plants did not tend to have a larger proportion of minorities, a lower median home value, or a smaller proportion of high school graduates when the power plants were initially established.

Table 5 shows independent *t* tests with group statistics derived from the 1990 census tract and BNA measures of the compositional variables for the communities that host the coal power plants and the communities that host the natural gas power plants. Table 5 also shows *p* values derived from Levene's equality of variances test. When a Levene *p* value is significant, the separate-variance independent *t* test is appropriate in testing for a difference between means. When a Levene *p* value is not significant, the pooled-variance independent *t* test is appropriate in testing for a difference between means.

Table 5 exhibits a significant difference in the predicted direction for median home value. This finding indicates communities with coal power plants tend to have a lower median home value as a group than communities with natural gas power plants. Table 5 exhibits no other significant compositional difference. These results indicate communities with coal power plants do not tend to have a larger proportion of minorities, a larger proportion of families in poverty or a smaller

**Table 4.** Paired *t* tests (before plant) for community composition variables

	<b>Pairs</b>	<b>Mean of differences</b>	<b>df</b>	<b>SE</b>	<b><i>t</i></b>
Minority 1 <sup>2</sup>	Hosting communities	Mean = 0.272	<i>n</i> = 14	0.060	
	Comparison communities	Mean = 0.229	<i>n</i> = 14	0.055	
	Hosting communities minus Comparison communities	0.043	13	0.042	1.025
Minority 2	Hosting communities	Mean = 0.264	<i>n</i> = 14	0.060	
	Comparison communities	Mean = 0.225	<i>n</i> = 14	0.056	
	Hosting communities minus Comparison communities	0.040	13	0.042	0.952
Minority 3	Hosting communities	Mean = 0.256	<i>n</i> = 14	0.060	
	Comparison communities	Mean = 0.213	<i>n</i> = 14	0.055	
	Hosting communities minus Comparison communities	0.043	13	0.041	1.052
Families in poverty	Hosting communities	Mean = 0.157	<i>n</i> = 14	0.018	
	Comparison communities	Mean = 0.127	<i>n</i> = 14	0.017	
	Hosting communities minus Comparison communities	0.030	13	0.016	1.941 <sup>1</sup>
Median home value	Hosting communities	Mean = 16 206	<i>n</i> = 14	3070	
	Comparison communities	Mean = 17 892	<i>n</i> = 14	2879	
	Comparison communities minus Hosting communities	1686	13	2699	.625
High school graduates	Hosting communities	Mean = 0.446	<i>n</i> = 14	0.038	
	Comparison communities	Mean = 0.508	<i>n</i> = 14	0.041	
	Comparison communities minus Hosting communities	0.062	13	0.055	1.133

<sup>1</sup>Significant at 0.05 level.

<sup>2</sup>Hispanics included by surname in Minority 1, language in Minority 2, and mother tongue in Minority 3.

proportion of high school graduates as a group than communities with natural gas power plants.

Table 6 shows Pearson correlation coefficients measuring the 1990 community composition variables in relation to each other, the factor scores for the general emissions component, the factor scores for the general emissions output rate component, each of the specific emissions, and each of the specific emissions output rates. Table 7 shows findings derived from separately regressing the factor scores for the general emissions component, the factor scores for the general emissions output rate component, each of the specific emissions, and each of the specific emissions output rates on the 1990 community composition variables. In total, 48 potential coefficients were examined from these regressions (12 emission variables by four

**Table 5.** Independent *t* tests (coal plant and gas plant) for community composition variables

	Groups	Levene Test	Difference between means	df	SE	<i>t</i>
Minority	Coal plant communities	F = 4.797	Mean = 0.197	<i>n</i> = 15	0.031	
	Gas plant communities	<i>p</i> = 0.038	Mean = 0.277	<i>n</i> = 13	0.071	
	Coal community mean minus Gas community mean	Separate Variance Test	-.079	16	0.078	-1.016
Families in poverty	Coal plant communities	F = 0.134	Mean = 0.137	<i>n</i> = 15	0.013	
	Gas plant communities	<i>p</i> = 0.717	Mean = 0.120	<i>n</i> = 13	0.018	
	Coal community mean minus Gas community mean	Pooled Variance Test	0.018	26	0.022	0.813
Median home value	Coal plant communities	F = 1.048	Mean = 46 912	<i>n</i> = 15	3781	
	Gas plant communities	<i>p</i> = 0.315	Mean = 62 963	<i>n</i> = 13	4714	
	Gas community mean minus Coal community mean	Pooled Variance Test	16 051	26	5977	2.686 <sup>1</sup>
High school graduates	Coal plant communities	F = 1.505	Mean = 0.680	<i>n</i> = 15	0.017	
	Gas plant communities	<i>p</i> = 0.231	Mean = 0.722	<i>n</i> = 13	0.029	
	Gas community mean minus Coal community mean	Pooled Variance Test	0.042	26	0.033	1.267

<sup>1</sup>Significant at 0.01 level.

community variables). For brevity, Table 7 shows only final models that have at least one community composition variable significant in the predicted direction. Due to data limitations, Hg was not included in deriving the factor scores for the general emissions component or the general emissions output rate component. Hg is included in examining the community composition variables in relation to the specific emissions and specific emissions output rates.

Table 7 exhibits a significant relationship in the predicted direction between median home value and the factor scores for the general emissions output rate component. This finding indicates output rates of emissions tend to be greater from power plants located in communities with a lower median home value. Table 7 also exhibits significant relationships in the predicted direction between median home value and tons of CO<sub>2</sub> per megawatt hour, tons of NO<sub>x</sub> per megawatt hour, and tons of NO<sub>x</sub> (O<sub>3</sub> season) per megawatt hour. These findings indicate CO<sub>2</sub> emissions

**Table 6.** Correlation matrix for emissions and community composition variables

	Minority	Families in poverty	Median home value	High school graduates	Descriptive summary
General emissions component	-0.315	-0.019	-0.210	-0.008	Eigenvalue = 3.630 % of variance = 90.76 n = 28 all emissions
General output rate component	-0.162	0.238	-0.496 <sup>2</sup>	-0.261	Eigenvalue = 3.097 % of variance = 77.43 n = 28 all output rates
CO <sub>2</sub> tons	-0.304	-0.021	-0.182	-0.004	Mean = 5 606 801.26 SD = 5 195 494.13
Tons per MW hour	-0.157	0.237	-0.460 <sup>2</sup>	-0.265	Mean = 1832.70 SD = 598.99
SO <sub>2</sub> tons	-0.193	0.010	-0.192	-0.026	Mean = 21 349.68 SD = 29 588.38
Tons per MW hour	-0.141	0.056	-0.309	-0.101	Mean = 5.62 SD = 6.73
NO <sub>x</sub> tons	-0.334	-0.005	-0.226	-0.014	Mean = 9 650.11 SD = 8 312.07
Tons per MW hour	-0.026	0.338 <sup>1</sup>	-0.479 <sup>2</sup>	-0.330 <sup>1</sup>	Mean = 3.32 SD = 1.12
NO <sub>x</sub> (O <sub>3</sub> season) Tons	-0.361	-0.057	-0.198	0.013	Mean = 4599.32 SD = 3689.34
Tons per MW hour	-0.244	0.187	-0.484 <sup>2</sup>	-0.207	Mean = 3.25 SD = 1.07
Hg <sup>3</sup> pounds	-0.391	-0.332	0.325	0.388	Mean = 576.62 SD = 496.36
Pounds per GW hour	-0.400	-0.450	0.297	0.411	Mean = 0.0733 SD = 0.0502
Minority	1.000	0.715 <sup>2</sup>	-0.198	-0.578 <sup>2</sup>	Mean = 0.234 SD = 0.197
Families in poverty		1.000	-0.657 <sup>2</sup>	-0.834 <sup>2</sup>	Mean = 0.129 SD = 0.058
Median home value			1.000	0.693 <sup>2</sup>	Mean = 54 364 SD = 17 494
High school graduates				1.000	Mean = 0.700 SD = 0.088

<sup>1</sup>Significant at 0.05 level, <sup>2</sup>Significant at 0.01 level.

<sup>3</sup>All correlations based on 28 power plant locations, except Hg where 15 were available. Emissions component extracted from tons of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and NO<sub>x</sub> (O<sub>3</sub> season).

Emissions output rate component extracted from pounds of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and NO<sub>x</sub> (O<sub>3</sub> season) per MW hour.

As all hypotheses are directional, any coefficient with high absolute value that is not in the predicted direction is not significant.

output rates, NO<sub>x</sub> emissions output rates, and NO<sub>x</sub> (O<sub>3</sub> season) emissions output rates tend to be greater from power plants located in communities with a lower median home value. No other regression produced any relationship significant in the predicted direction. These results indicate emissions and output rates of emissions do not tend to be greater from power plants located in communities with a larger

**Table 7.** Regression models of emissions dependent variables with at least one community composition variable significant in the predicted direction

Dependent Variable	Minority	Families in poverty	Median home value	High school graduates	Model summary	
General emissions output rate component	ns	ns	-0.496	ns	R <sup>2</sup> = 0.246 F = 8.503 p = 0.004	Adj. R <sup>2</sup> = 0.217 df = 26
CO <sub>2</sub> Tons per MW hour	ns	ns	-0.460	ns	R <sup>2</sup> = 0.212 F = 6.983 p = 0.007	Adj. R <sup>2</sup> = 0.181 df = 26
NO <sub>x</sub> Tons per MW hour	ns	ns	-0.479	ns	R <sup>2</sup> = 0.229 F = 7.735 p = 0.005	Adj. R <sup>2</sup> = 0.200 df = 26
NO <sub>x</sub> (O <sub>3</sub> season) Tons per MW hour	ns	ns	-0.484	ns	R <sup>2</sup> = 0.234 F = 7.962 p = 0.005	Adj. R <sup>2</sup> = 0.205 df = 26

ns = not significant at 0.05 level.

Emissions output rate component extracted from pounds of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and NO<sub>x</sub> (O<sub>3</sub> season) per MW hour.

As all hypotheses are directional, 1-tail *p* values are reported for model summaries.

proportion of minorities, a larger proportion of families in poverty, or a smaller proportion of high school graduates.

## Discussion

### *Percent Minority*

The results and findings of the hypothesis testing conducted in this study do not provide empirical support for the general thesis of environmental racism. This study concludes minority communities are not adversely affected on a distributive cross-sectional basis by disparate outcomes of the siting process or the emissions regulatory process. Other environmental justice studies focusing on different types of hazardous facilities examined more specific populations of concern. For example, a study conducted through Harvard Center for Risk Analysis (Graham *et al.*, 1999) that concentrated on distributions of coke production plants and oil refineries looked at percent Hispanic. This study of electric power generation tested percent Hispanic, as well as percent African American. Although analysis is not shown for brevity, percent Hispanic and percent African American were separately substituted for percent minority in testing each of the three hypotheses. These substitutions produced no findings that indicate either Hispanic communities or African American communities are adversely affected on a distributive cross-sectional basis by disparate outcomes of the siting process or the emissions regulatory process.

*Air of Injustice* by the Black Leadership Forum (2002) expressed nation-wide concerns about electric power generation, while providing some loosely-measured

and broad-brush observations. This study observed more closely what appeared from statewide comparisons to be the worst of all domestic situations. The rankings shown in Table 2 for total emissions originating from electric power generation statewide and percent minority statewide clearly identified Texas, above all other states, as the crucial state for examination. However, disparate outcomes involving percent minority are not apparent upon closer observation. It is important to remember that this study tested only for disparate outcomes on a distributive cross-sectional basis. Investigations focusing on individual power plants on a case-by-case basis might produce different results and findings. It is also important to keep in mind this study tested only for disparate outcomes involving coal or natural gas utility power plants that were established between 1970 and 1990. The results and findings cannot be generalized with confidence to other types of power plants, or to other coal or natural gas utility power plants that were established in other decades.

#### *Other Community Composition Variables*

Percent families in poverty is the only compositional variable for which the paired *t* tests found a significant difference between the hosting communities and their comparison communities either before or after establishment of the power plants. This finding indicates disparate outcomes of the siting process, but the potential implications are minimal. Although Executive Order 12898 includes low-income populations, the civil rights strategies that would use Title VI and the disparate impact standard are inapplicable. In evaluating economic theory, which would predict property value as a siting determinant, the results of the paired *t* tests for median home value do not provide supporting evidence. However, median home value is the only compositional variable for which the independent *t* tests found a significant difference between the communities that host the coal power plants as a group and the communities that host the natural gas power plants. This finding suggests there may be a tendency for power plants that combust what is often considered the more hazardous fossil fuel to be sited in communities where homes are of lower monetary value.

The relationships found between median home value and the general emissions output rate component, CO<sub>2</sub> emissions output rates, NO<sub>x</sub> emissions output rates, and NO<sub>x</sub> (O<sub>3</sub> season) emissions output rates indicate disparate outcomes of the emissions regulatory process. While Title VI and the disparate impact standard are again inapplicable, such disparate outcomes are difficult to justify in context of legitimate market dynamics. Property value could be construed as a legitimately rational land cost consideration by decision makers in the siting process, but owners and operators of established power plants that are located in communities where homes are of lower monetary value should not feel less obligated to control emissions. Emissions regulations are not designed for purposes of discriminating against such homeowners or any other disadvantaged population.

Beyond present-day institutional practices, these equity considerations bear relevance upon future institutional practices that will be influenced by ongoing debates over emissions trading. Control of emissions should not be remiss where power plants are located in communities concentrated with disadvantaged populations. *Air of Injustice* (Black Leadership Forum, 2002) suggested future

power plants will probably be sited in minority communities. The results and findings of the community examinations conducted in this study suggest concerns about the siting of future power plants will more likely be substantiated on a case by case basis than on a distributive cross-sectional basis. However, the trading of emissions credits among owners and operators of established power plants could turn out to have widespread viability as an environmental justice application in coming years, with consequences for minority populations and other disadvantaged populations.

### *Further Remarks*

Although this study did not produce empirical findings that support the general thesis of environmental racism, justice advocates have conducted many studies that indicate minorities are burdened by a variety of adverse environmental disparities throughout Texas and the broader USA. There have been methodological criticisms, but it is reasonable to assume some environmental disparities have resulted from institutional racism. With the horrors of slavery and other forms of racial injustice throughout the history of Texas and the broader USA, this is not an unreasonable assumption. Such injustices are so immoral that instituting civil rights protections to deter policies, practices and directives that differentially affect or disadvantage (whether intended or unintended) individuals, groups or communities based on race or color is essential to assuring freedom and equality for all. The environmental justice movement has enhanced pluralism in environmental decision making. This equitable representation can function to prevent pollution in the future, while counterbalancing the pressure that decision makers often feel from affluent whites who have organized around such themes as NIMBY (not-in-my-backyard) in recent decades. Justice advocates, on the other hand, would be wise to expand their primary environmental focus beyond the theme of racial injustice. Given the policy rationale and the political situation that currently defines decision making, it is in the interest of minority populations to realize common ground with other disadvantaged populations. Many disadvantaged populations can be adversely affected by environmental inequities, and such injustices should not be a lesser moral concern where Title VI and the disparate impact standard are inapplicable. Moreover, issues of ecological distribution engender consequences for all populations of future generations. A broader conceptualization of environmental equity, as discussed by Hockman & Morris (1998), Pezzoli (1997) and Touché (2004), would be in agreement with the promotion of long-term ecological sustainability for all humanity.

### **Acknowledgements**

This article is from the dissertation of George E. Touché (Touché, 2002). Professor George O. Rogers chaired the doctoral committee, and Professors Dennis E. Wenger, Michael K. Lindell, and Steven H. Murdock served as committee members. The Spatial Sciences Laboratory, State Demographer Steven H. Murdock and the Texas State Data Center at Texas A&M University provided assistance in confirming power plant locations, identifying census tracts and BNAs, and operationally measuring community composition variables.

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