Environmental Justice and Energy Production: Coal-Fired Power Plants in Illinois

1. Introduction

For the last two decades, questions of environmental justice and equity have been present in the environmental policy agenda, academic literature, and in communities all across America (Liu, 1997). In 1994, President Clinton issued an executive order that directed federal agencies to identify and address "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (Federal Register, 1994). Environmental injustices can be viewed as disproportionate exposures of toxic and hazardous waste on communities based upon prescribed biological characteristics (Bryant, 1995). This concept has been applied to such locally unwanted land uses as industrial stacks (Perlin et al, 1995), toxic release inventory sites (Bowen et al, 1995; Boer et al, 1997) hazardous waste incinerators (Oakes et al, 1996), landfills (Bullard, 1983), superfund sites (Hird, 1993; Stretesky and Hogan, 1998; Oakes and Egan, 1996), air pollution (Sadd et al, 1999, Jarrett et al, 2001) and transportation issues (Forkenbrock and Schweitzer, 1999). It has not been applied to the issue of energy production in the academic literature, although there are local grass roots organizations currently framing energy production as an environmental injustice.

Environmental injustices have often been identified by individual communities as they struggle to fight against them. These individual communities, when taken together along with regional and national organizations, academics, and policy-makers compose the environmental justice movement (Taylor, 2000). This movement like many other post-1960's movements can be better understood with social movement theory (Jenkins, 1983).

This study examines the environmental justice movement using common threads of social movement theory including the role of actors, resources, movement goals, framing, and grievances. I will examine the growth of the environmental justice movement to include the topic of climate change. This article argues that the traditional environmental movement topic of energy production is not only an environmental justice issue but is the missing link between the past and future of the environmental justice movement. I investigate the claims of one local grass roots organization that environmental injustice is present in energy production using a combination of geographic information system analysis and regression analysis in a case study fashion to encourage incorporation of this issue into the environmental justice master frame.

2. Literature Review

2.1 Social Movement Theory

Social movement theory has always been focused on answering the question: Why do movements form? (Jenkins, 1983). Traditional explanations have emphasized sudden increases in short-term grievances created by the "structural strains" of rapid social change (Gusfield, 1968). The resurgence of social movement theory to explain the social movements in the 1960's and 1970's tended to view grievances as secondary to factors such as the availability of resources (McCarthy and Zald, 1977) and an increase in importance with movement framing (Taylor, 2000). The post-1960's social movement theories of resource mobilization, political process approach, and new social movements have developed on the basis of the rational actor theory (Miller, 2000, Crossley, 2002).

Jenkins notes that movement actions are rational, adaptive responses to the costs and rewards of different lines of action (1983). Human beings possess rationality, are motivated by desires, and react to constraints and opportunities in the external environment which seek to raise and lower the costs and profits of taking action (Crossley, 2002).

Resource mobilization, which has been the most prevalent framework in social movement theory since the late 1970's (Buechler, 1993) emphasizes resources, organizations, and political opportunities. It was derived from the McCarthy and Zald (1973) theory of entrepreneurial mobilization, Gamson's (1975) theory of strategy and Tilly's (1978) polity theory. Jenkins (1983 p.528) describes the basic foundations of resource mobilization:

> (a) movement actions are rational, adaptive responses to the costs and rewards of different lines of action; (b) the basic goals of movements are defined by conflicts of interest built into institutionalized power relations; (c) the grievances generated by such conflicts are sufficiently ubiquitous that the formation and mobilization of movements depend on changes in resources, group organization, and opportunities for collective action; (d) centralized, formally structured movement organizations are more typical of modern social movements and more effective at mobilizing resources and mounting sustained challenges than decentralized, informal movement structures; and (e) the success of movements is largely determined by strategic factors and the political process in which they become enmeshed.

These are however, only the basic foundations and are not the homogenous views of social movement theorists (Buechler, 1993). For instance Korpi (1974) argues that while grievances remain a necessary part of movement formation, it can further be explained by either a change in power relationships or by structural conflicts of interest. Walsh et al (1993) distinguish between "equity" and "technology" movements whereby equity movements involve the gradual mobilization of long-standing grievances but technology movements involve a threat which precipitates rapid mobilization of local residents and outside supporters.

The assumptions of the rational actor theory allowed resource mobilization to help overcome the traditionally central problem of individual participation in social movements. It rests primarily on Olson's (1968) theory of collective action whereby the "free rider" problem, generally lowering participation by rational self-interested individuals to achieve collective goods, is overcome by offering selective benefits to participants. The selective benefits could be money, status, privileges, or anything sufficient to reduce the marginal cost of securing collective goods below the individual benefit of participation (Jenkins, 1993). For example, Friedman and McAdam (1992) argue that one reason the civil rights movement grew so rapidly was because the movement was able to redefine an already highly prized role in society: the good Christian as the good movement participant. As a result, for community members to identify and retain their status as a Christian (i.e. selective benefit), they also had to be active in the civil rights movement.

Resources available to social movements can come in many forms. Gamson et al (1982) argue that there exists a threshold level of resources below which mobilization will not occur and above which additional resources make little difference. These resources could be financial, political, mass media, universities, government agencies, charismatic leadership, or willing members (Jenkins, 1993) and can even shift over time to accommodate changes in the movement (Crossley, 2002). One of the most important resources for movement formation and growth is pre-existing group organizations (e.g. churches, neighborhood associations) (Tilly, 1978). Oberschall's (1973) bloc recruitment tactic can be used to encourage pre-existing groups to join together which can develop movements more efficiently than individuals joining the movement one by one.

The role of framing is one additional contribution of social movement theory. Movement formation can be brought about through a change in argument framing. For example, Wood (1982) traced the emergence of the environmental movement to a handful of natural scientists and policy researchers who redefined traditional conservationist concerns in ecological terms. Likewise, McCarthy and Zald's (1973) entrepreneurial model proposes that successful movements often contain an entrepreneur able to seize on a major interest cleavage and redefine long-standing grievances in new terms.

Lastly, as noted above, Jenkins describes centralized, formally structured movements as the type generally described by resource mobilization theory. Gamson (1975) and McCarthy and Zald (1973) argue that a formalized structure with a clear division of labor maximizes mobilization by transforming diffuse commitments into clearly defined roles, and a centralized decision-making structure increases combat readiness. However, Gerlach and Hine (1970) argue that decentralized movements with a minimum division of labor and integrated by informal networks and an overarching ideology are more effective. For example, student movements adopted a leaderless model of democratic structure to maximize the values of direct participation (Breines, 1980) and black lung victims were able to develop a successful formula in geographically dispersed leadership and decentralized organization akin to a federation of chapters. A decentralized form is also used in the environmental justice movement.

2.2 The Environmental Justice Movement

The environmental justice movement (EJM) is composed primarily of minority and low income communities, labor organizations, church leaders and members, policy makers and analysts, academics, and local, regional, and national environmental and mixed purpose organizations (Taylor, 2000). However, the movement has grown and changed over time. Taylor (2000) describes the formation of the environmental justice movement as arising in part from social justice struggles of people of color continuing out of the civil rights movement and in part a natural extension of the new environmental paradigm (NEP), which assumes an interconnectedness between humans and the natural world (Catton and Dunlap, 1980). The environmental justice movement supports the NEP with some radically extended ideas (Kuhn, 1970). The social justice concerns included are self-determination, sovereignty, human rights, social inequity, access to natural resources, and disproportionate impacts of environmental hazards. These concerns were not initially included in the environmental movement (Bullard, 1990) because the mostly middle-class, white male participants maintained a vastly different social location and therefore a different perspective (Taylor, 2000; Mueller, 1992). The success of the EJM has transformed the environmental discourse, even in mainstream environmental organizations initially resistant or even hostile to their views (Taylor, 2000).

Dorcetta Taylor (2000) has written on the ideological foundations of the environmental justice movement. She posits the EJM a transformative movement that seeks broad and sweeping changes in the social structure and its ideological foundations. It gained early success because its framing was salient to a large sector of the population. Initially the mainstream environmental movement believed that people of color and the working class were not interested in environmental issues. The EJM recognized that they were interested, and that recruiting them required only the proper message framing and appropriate recruiting techniques. A framework was developed that linked the social justice issues listed above with environmental issues. It uses an inclusive and open injustice frame that is not limited to one sector of the population but possesses a high level of identity salience focusing on peoples' direct and daily experiences. Community groups fighting injustices early in the movement were very adept at linking racism, injustice and environmentalism into one cohesive frame. They used idioms such as "*cancer alley*" to invoke fear and action both in their own communities and around the country (Taylor, 2000).

By the early 1990's, numerous grassroots community organizations joined together with national organizations at the First National People of Color Environmental Leadership Summit (Principles of Environmental Justice, 1991). Here they drafted the Principles of Environmental Justice. The formation of a document with such clearly articulated goals marked a turning point in the growth of the movement (Taylor, 2000). It was the first environmentally related movement to examine the human-human and human-nature relations through the lens of race, class, and gender. This simultaneity of oppression resonated with communities all over the U.S. (Brewer, 1999). The movement now had a clear objective of both distributive justice (who should get what) and corrective/commutative justice (how individuals are treated during transactions) (Bullard, 1992).

The EJM was able to capitalize on a few key resources to rapidly grow. It relied heavily on the tactic of bloc recruitment in two ways. Taylor (2000) describes how environmental justice groups often temporarily affiliated with multipurpose environmental organizations by sharing office space early in their development. This gave way to the sharing of ideas, and later, members. Secondly, environmental justice organizations often arose when existing community organizations expanded their focus to include environmental issues. Friedman and McAdam (1992) describe how the EJM was especially good at targeting efficacious people with dense and extensive community networks as well as strong institutional ties to be its foundational members. It did not try to build a movement from scratch, but took advantage of preexisting networks and organizations likely to support the new movement by sharing resources that would aid in movement growth.

In addition, the EJM was able to take advantage of political opportunities. EJM participants heavily supported the Clinton-Gore administration in the 1992 presidential election which resulted in a win for Bill Clinton and executive order 12898 for the EJM (Taylor, 2000).

Furthermore, the EJM was able to mobilize the academic community on its behalf. In partnership with environmental organizations, academics have published countless studies questioning injustices (Taylor, 2000). It is this tie between the local documentation and the national movement that has not been adequately addressed in the social movement framework of the environmental justice movement. Academic papers have begun to mischaracterize the environmental justice movement due to its lack of national studies (see Bowen, 2002) as piecemeal and not influential. However, as Taylor points out it is the case study approach that used people's experiences to show the necessity for the movement at all and the need to act immediately. The case study, like the grass roots organization is a building block of the movement. The community perspective inspires and encourages action at the local, regional, and national levels and is still the central way in which the EJM evolves.

2.3 Environmental Justice and New Issues

The Intergovernmental Panel on Climate Change (IPCC) reported in 2007 that the world's poorest citizens are at the highest risk of suffering negative impacts as a result of global climate change. The EJM has responded by incorporating climate change into its repertoire of relevant issues. Environmental justice organizations such as the National Black Environmental Justice Network and the Environmental Justice Resource Center have begun to introduce campaigns about climate change (NBEJN, 2008; EJRC, 2008). What is missing to date in the movement is a response to one of the critical issues related to climate change: energy production. Due to the acceptance of justice issues in the traditional environmental movement, where energy production is a central theme, the environmental justice organizations may be able to effectively partner with participants in the traditional environmental movement on mitigation and adoption to climate change, including how and where energy is produced.

Social movement theory suggests that framing and the presence of grievances is important in movement development. Incorporating energy production into the environmental justice movement requires a proper recognition that energy production may disproportionately affect poor and minority communities and recognition that the appropriate grievances are present to encourage action. One local grass roots group in Chicago, IL has begun to mobilize its community against local coal-fired power plants using the environmental justice frame.

The Pilsen Environmental Rights and Reform Organization (PERRO) was formed after a 2004 ballot initiative required the state to restrict pollution coming from a local industrial plant affecting the Pilsen neighborhood in South Chicago. After success against the plant, PERRO diversified its goals to include the Fisk power plant and the coal based energy industry in Chicago (PERRO, 2008). PERRO may serve as a model for how the national EJM can reframe energy production using a justice perspective on the path to mitigating climate change.

2.4 Grievances

Two grievances are particularly relevant today to encourage viewing energy production through the justice perspective: the stagnation in U.S. national energy policy and the negative health affects associated with coal-fired power plants. Resource mobilization theory suggests that with these grievances properly framed, taken with an upcoming window in national politics, it may be a propitious time to evolve the movement's agenda.

The stagnation in U.S. energy policy in reference to coal-fired power plants is related to the Clean Air Act and its enforcement. The Environmental Protection Agency (2008a) describes how the act was originally passed by Congress in 1970. The Clean Air Act applied to, among other sources of air pollution, coal-fired power plants built after 1970. It also included a "grandfather clause" that exempted existing coal-fired power plants from being regulated under the act. The goal of Congress was to allow plants with cleaner technology to replace old plants thereby cleaning up the air without an undo burden on the energy industry or customers having to pay suddenly higher energy prices.

As new plants opened to replace old plants, more and more plants would be regulated by and subject to the restrictions of the Clean Air Act (Hawkins, 2000).

However, a large number of the coal-fired power plants built before 1970 are still in operation. Instead of not being regulated at all, they are regulated under the Clean Air Act's New Source Review program (NSR) (Rogers, 1990). When a grandfathered plant is "modified," it becomes subject to the Clean Air Act. "Modification" is defined broadly to include "any physical change or change in method of operation" that increases emissions. The EPA rules, however, provide an exclusion for "routine maintenance, repair, and replacement" (Hawkins, 2000). It is this exclusion that has allowed many old coal-fired power plants to stay in operation emitting higher levels of pollution. It has become the strategy of the power industry to use capital investments to upgrade existing plants to run longer rather than having them retire and be replaced by newer more efficient and cleaner plants (Hawkins, 2000). This problem may have been exacerbated by the mid 1990's push for electricity deregulation. Long (1997) and Coequyt and Stanfield (1999) indicate that with individuals able to choose their own energy supplier, many are choosing the least expensive. This moves an even greater demand for electricity back to the oldest and dirtiest coal-fired power plants that are able to deliver a cheap product at the expense of environmental concerns.

The second grievance is the possible negative health effects of living near a coal-fired power plant. Keating and Davis (2002) and Keating (2004) have studied the connection between coal-fired power plants and African American and Latino communities. They describe the most troublesome pollutants as ozone, sulfur dioxides, particulate matter, nitrogen oxides, mercury, and carbon dioxide. Particulate matter comes in two forms: particulate matter 10 micrometers or less in diameter (PM_{10}) and particulate matter 2.5 micrometers or less in diameter ($PM_{2.5}$, also known as fine particulate matter). Mercury has only recently been limited and only for those plants subject to the full Clean Air Act, and carbon dioxide is not currently regulated (EPA, 2008b). The other pollutants listed above have been regulated as part of the Clean Air Act for the past few decades. Keating and Davis (2002) describe that asthma attacks send African Americans to the emergency room at three times the rate (174.3 visits per 10,000 persons) of whites (59.4 visits per 10,000 persons). African Americans are hospitalized for asthma at more than three times the rate of whites (35.6 admissions per 10,000 population vs. 10.6 admissions per 10,000 population). More than fifty percent of Latinos live in areas that violate the federal air pollution standards for ozone (Keating, 2004). The health effects from dirty air may be exacerbated in poor and minority communities where health coverage rates are low (Keating and Davis, 2002, Keating, 2004).

Given these grievances, the resources currently available to the environmental justice movement and its new agenda of global climate change, PERRO may be leading the way for the movement to begin addressing energy production from a justice perspective. This paper examines the claim of disproportionate siting of coal-fired power plants in poor and minority communities in the state of Illinois by employing geographic and regression analysis techniques.

2.5 Previous Empirical Research

Some of the previous empirical research using the environmental justice frame has examined Toxic Release Inventory (TRI) sites (Bowen et al, 1995, Ringquist, 1997, Morello-Frosch et al, 2002), hazardous waste treatment, storage, and disposal facilities (TSDF) (Oakes et al, 1996; Boer et al, 1997; Pastor et al, 2001), air pollution (Sadd et al, 1999; Jarrett et al, 2001) and superfund sites (Stretesky and Hogan, 1998). The early literature focused on the incidence of a locally unwanted land use (LULU) in a geographic area such as a zip code or county, and addressed the issue of disproportionate exposure in poor and minority areas.

Bowen et al (1995) examined the incidence of toxic release at the county level in Ohio using cross-sectional data and found high correlations between racial variables and toxic release levels. However, these results did not hold when a smaller unit of analysis (census tract) was examined for Cuyahoga County in Ohio. Bowen et al attributed these findings to the fact that industry, minority populations, and toxic releases are concentrated in urban areas so the correlations found with a coarser scale merely reflect their coincident existence. Oakes et al (1996) examined similar demographic variables in relation to TSDFs for the nation in a longitudinal study and found that changes in the populations around TSDFs are explained by general population trends and not environmental inequity or disparate impacts. Liu (1997) also found no evidence that supported the theory that the presence of LULUs made neighborhoods more likely to be home to African Americans and poor people. Boer et al (1997) found that in relation to TSDFs, industrial land and manufacturing employment are significantly related to the presence of TSDFs and that community wealth has a positive and then a negative relationship with TSDF location. At very low incomes, a community is not attractive to a TSDF and at high incomes a community can resist TSDF siting. They also found that after controlling for land values, both Latino and African American populations were significantly associated with TSDFs. Ringquist (1997) investigated TRI facilities in zip codes and found that racial factors, more than class characteristics, best accounted for spatial distribution patterns, although not more than manufacturing employment. Been and Gupta (1997) investigate the different effects for race and ethnicity and found Latinos were more likely than African Americans to attract TSDFs. Furthermore, she found that very poor neighborhoods were less attractive to TSDFs and that lower middle class neighborhoods were more likely to be targets. Stretesky and Hogan (1998) examined the relationship between superfund sites and racial, ethnic, and economic characteristics at the census tract level in Florida. They found that while African Americans and Latinos were more likely to live near superfund sites, income and poverty were not significantly related to site location. Sadd et al (1999) examined the relationship between toxic air emissions and minority populations to find that even after controlling for land values and the extent of manufacturing, minority residents were disproportionately located in neighborhoods with high toxic air emissions. Jerrett et al (2001) examined total suspended particulate air pollution and its relationship to socioeconomic status in Hamilton, Canada and found that dwelling values were negatively related to pollution exposure. Low income and unemployment were also significant predictors of exposure but were subject to variability depending on whether autocorrelation was included in the model. Pastor et al (2001) studied the changes in neighborhood composition in response to LULUs in Los Angeles and found that multi-racial communities were more likely than racially homogenous communities to see an increase in minority move-in after facility siting. Therefore, they found that minorities attract TSDFs, and not that a new TSDF encourages additional minority move-in.

Morello-Frosch et al (2002) examined the longitudinal relationship between TRI sites and minority community composition in California. They also found that minority population instead of market-based minority move-in was the best predictor of TRI sites.

Environmental justice empirical research has progressed significantly over the last few decades to address issues such as disproportionate exposures, land use and land values, minority move-in, and longitudinal changes in population in response to LULUs. To summarize the findings, African Americans, Latinos, and the poor have all been linked to disproportionate exposure to some LULUs, but these findings are not universal and depend on research methods and the site chosen. Most environmental justice literature does not prove historical racism but does present findings of disproportionate outcomes. Furthermore, several studies have confirmed that the minorities are usually present before the LULU and not that the LULU encourages minority move in. My research attempts to add to the existing literature by taking into account many problems addressed in previous studies such as unit of analysis (Bowen et al, 1995) and proximity methods for determining disproportionality (Mohai and Saha, 2006).

This study examines the relationship between coal-fired power plants and the socioeconomic characteristics of their host communities. I hypothesize that race, ethnicity and class will all be influential factors in predicting the location of coal-fired power plants but that race, more than ethnicity or class, will have a stronger influence based on historic patterns of isolation of African Americans in Illinois (Massey and Denton, 1993.)

3. Data Sources and Variables

Cross-sectional data are used to study the relationship among block groups, their socioeconomic characteristics, and the distance to coal-fired power plants. The socioeconomic characteristic information came from the Census 2000 Summary File 3, which presents detailed population and housing data collected from a 1-in-6 sample and weighted to represent the total population (U.S. Census Bureau American Fact Finder, 2007).

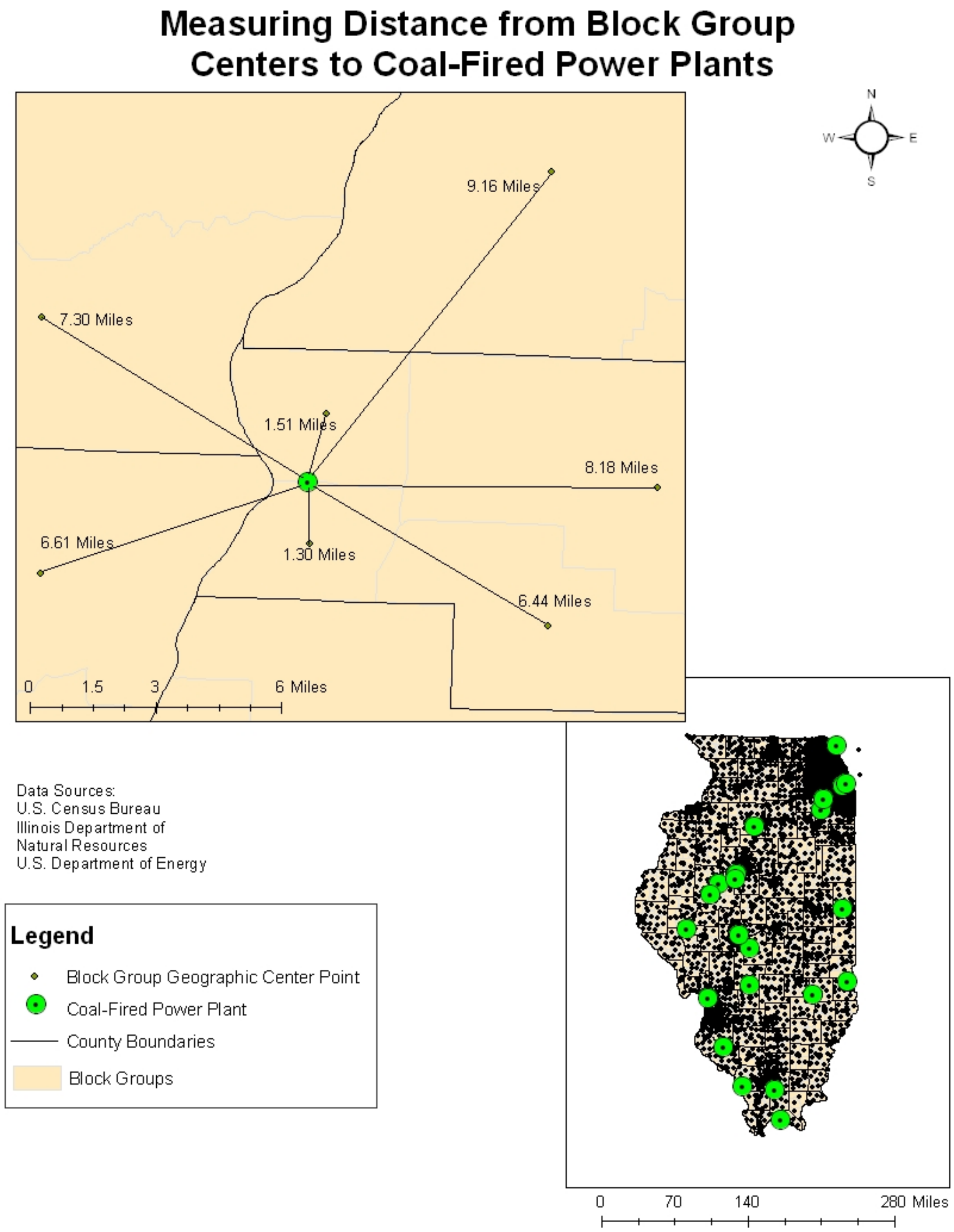
Block groups were chosen as the unit of analysis. There are 9843 block groups in the state of Illinois. Block groups help to combat oversimplification of data and allow for more modest assumptions about the statistical variations of local phenomena (Maantay, 2002; Sheppard et al, 1999; McMaster et al, 1997; Bowen et al, 1995). That is, the block group provides the smallest area over which to average variable data that is available from the U.S. Census Bureau in the geographically aggregated form necessary for such geographic analysis. Block groups generally contain between 600 and 3,000 people and never cross the boundaries of states or counties whereas census tracts consist of one or more block groups. Census tracts, which typically have between 1,500 and 8,000 people, with an average size of about 4,000 people, are defined with local input, and are intended to represent neighborhoods (i.e., they are designed to be relatively homogeneous with respect to population characteristics, economic status, and living conditions). However, as might be expected, smaller units of analysis (block groups) tend to be modestly more homogeneous than larger ones (Iceland and Steinmetz, 2003).

3.1 The Variables

3.1.1 Distance, the Dependent Variable

The most common method of analyzing environmental justice in a geographic manner is the unit-hazard coincidence method (also known as the spatial coincidence method) (Mohai and Saha, 2006; McMaster et al, 1997). Many studies over the last few decades have used this method (Oakes et al. 1996; Ringquist, 1997). It involves assigning a binary value to each unit as either containing the LULU being studied or not containing it, often referred to as host units or non-host units. This assumes that people living in host units are closer to the LULU than people living in non-host units (Mohai and Saha, 2006). This study takes a new approach. The dependent variable comes from a measure (in miles) of the distance from the center of each block group to the nearest coal-fired power plant (as seen below in Figure 1). The actual variable used in the analyses is the natural log of the distance, which represents a percent change in distance (instead of a change in miles). The unit of analysis for this study is the block group which is smaller than the census track often used. The method of analysis in this study allows for the relationship between each block group and the closest power plant to be examined and not just a host unit, as in previous analyses. The smaller unit of analysis requires a smaller margin of error in the assumptions. The block group unit still assumes a homogenous distribution of the population throughout the block group and only the geographic center of the block group is measured with relation to the power plant, but a block group is much smaller than a census track so these assumptions are more realistic than with a census track.

Figure 1:



3.1.2 Independent Variables

African American – For the 2000 census, race could be defined as White alone, Black or African American alone, American Indian and Alaska Native alone, Asian alone, Native

Hawaiian and Other Pacific Islander alone, some other race alone, and two or more races. The African American population for Illinois is 15% of its total population. This variable is the percent of the total population in each block group that identified themselves as Black or African American alone. It is expected that *African American* will have a negative relationship to *distance*. That is, the higher the African American population per block group, the closer that block group will be to a coal-fired power plant. (This variable has been used in previous environmental justice studies including Oakes et al, 1996; Boer et al, 1997; Ringquist, 1997; Been and Gupta, 1997; Stretesky and Hogan, 1998; Pastor et al, 2001; and Morello-Frosch et al, 2002.)

Latino – The Census Bureau defines ethnicity or origin as the heritage, nationality group, lineage, or country of birth of the person or the person's parents or ancestors before their arrival in the United States. People who identify their origin as Spanish, Hispanic, or Latino may be of any race (U.S. Census Bureau, 2001). This variable is the percent of the total population in each block group that identified themselves as having an ethnicity of Hispanic or Latino regardless of race. It is expected that *Latino* will have a negative relationship to *distance*. That is, the higher the Latino population per block group, the closer that block group will be to a

coal-fired power plant. (This variable has been used in previous environmental justice studies including Oakes et al, 1996; Boer et al, 1997; Ringquist, 1997; Been and Gupta, 1997; Stretesky and Hogan, 1998; Sadd, 1999; Pastor et al, 2001; and Morello-Frosch et al, 2002.)

Urban – This variable is the percent of the total population in each block group that lives in a place with a population of 1,000 persons per square mile or more and surrounding blocks of 500 persons per square mile or more (U.S. Census Bureau, 2002). Illinois' average population was 223 persons per square mile in 2000, which indicates much of the state is not urban. It is expected that *Urban* will have a negative relationship to *distance*. (This variable has been used in previous environmental justice studies including Ringquist, 1997; and Stretesky and Hogan, 1998.)

Female Only Headed Household - This variable is the percent of the total population in each block group whose household is headed by a female only. The Census Bureau defines a household as including at least two related persons. A female only headed household would consist of an unmarried female with dependent children or other related dependents. It is expected that *Female Only Headed Household* will have a negative relationship to *distance*. (This variable is similar to the 'percent single family households' used by Pastor et al, 2001.)

SSI – This variable is the percent of the total population in each block group whose household reported receiving Supplemental Security Income (SSI) in 1999. SSI is a federal income supplement program funded by U.S Treasury general funds designed to provide cash assistance to aging, blind, or disabled people primarily (Supplemental Security Income, 2007). It is expected that *SSI* will have a negative relationship to *distance*. (This variable is another way of measuring income like that used in Bowen et al, 1995; Oakes et al, 1996; Ringquist, 1997; and Jarrett et al, 2001.)

PAI – This variable is the percent of the total population in each block group whose household reported receiving Public Assistance Income (PAI) in 1999. PAI includes money received from the Temporary Assistance to Needy Families (TANF) and other cash welfare. It is expected that *PAI* will have a negative relationship to *distance*. (This variable was used previously by Oakes et al, 1996.)

Below 1999 Poverty Level – This variable is the percent of the total population in each block group whose household incomes were below the 1999 Federal Poverty Level. The 1999 Federal Poverty Level equates to an income below $16,700 for a four person household. It is expected that *Below 1999 Poverty Level* will have a negative relationship to *distance*. (This variable has been used in previous environmental justice studies including Bowen et al, 1995; Oakes et al, 1996; Ringquist, 1997; and Been and Gupta, 1997.)

Cook County – This variable is a binary variable that controls for Cook County. Cook County is the most populous county in the state of Illinois and contains the City of Chicago as well as large percentages of both African American and Latino populations. The variable is coded such that a value of 1 indicates the block group is located in Cook Co. and a value of 0 indicates the block group is not located in Cook Co. This variable helps to determine if disproportionality with respect to race or ethnicity is present outside of the Chicago area by holding Cook County constant. It is expected that *Cook County* will have a negative relationship to *distance*.

Median Housing Value – This variable is the median value of all owner occupied housing units in each block group measured in dollars. It is expected that *Median Housing Value* will have a positive relationship to *distance*. That is, the higher the median housing value for the block group, the farther from a coal-fired power plant it is expected to be. (This variable has been used in previous environmental justice studies including Bowen et al, 1995; Ringquist, 1997; Been and Gupta, 1997; Stretesky and Hogan, 1998; Jarrett et al, 2001; and Morello-Frosch et al, 2002.)

Median Household Income – This variable is the median household income for each block group in dollars for 1999. It is expected that *Median Household Income* will have a positive relationship to *distance*. (This variable has been used in previous environmental justice studies including Bowen et al, 1995; Boer et al, 1997; Been and Gupta, 1997; Pastor et al, 2001; and Morello-Frosch et al, 2002.)

Unemployment – This variable is the percent of the total population in each block group that is unemployed. It is expected that *Unemployment* will have a negative relationship to *distance*. (This variable has been used in previous environmental justice studies including Oakes et al, 1996; Been and Gupta, 1997; Stretesky and Hogan, 1998; and Jarrett et al, 2001.)

High School Graduates – This variable is the percent of the total population aged 25 years or older in each block group with a high school diploma or equivalent. It is expected that *High School Graduates* will have a positive relationship to *distance*. (This variable is similar to variables used in Been and Gupta, 1997 and Ringquist, 1997.)

4-Year College Graduates – This variable is the percent of the total population aged 25 years or older in each block group with a 4-year college degree. It is expected that *4-Year College Graduates* will have a positive relationship to *distance*. (This variable is similar to variables used in Been and Gupta, 1997 and Ringquist, 1997.)

Population Density – This variable represents the number of persons per square mile of each block group calculated from the block group area and total population reported by the 2000 Census. It is expected that *Population Density* will have a negative relationship to *distance*. (This variable has been used in previous environmental justice studies including Bowen et al, 1995; Pastor et al, 2001; Morello-Frosch et al, 2002.)

Distance to Major River – Previous studies evaluating the distribution of TSDFs, TRI sites, and superfund sites included a measure of the percent of the work force involved in manufacturing (Boer et al, 1997, Ringquist, 1997, Stredesky, 1998). This provided a very specific control variable for LULUs related to manufacturing. Similarly, in studies of air pollution, manufacturing and transportation variables were added to control for factors specifically related to the air pollution source (Sadd et al, 1999, Jarrett et al, 2001, Morello-Frosch et al, 2002). Since this study examines the distribution of coal-fired power plants, the specifically related variable added was the distance from the center of each block group to a large river because availability of water is a key factor in choosing the location for a plant (Eskom, 2006). Therefore, this variable is included to control for the availability of water that is necessary for a coal plant but may also relate to specific community location. Controlling for water availability allows the results to indicate the relationship of coal plants to people above and beyond the physical necessities of operating a plant. In this study, the major river designation indicates the river has a mean annual flow of at least 600 cubic feet per second. This level was chosen to accommodate existing power plants in Illinois. It is expected that *Distance to Major River* will have a positive relationship to *distance*.

Table 1 below provides an overview of each variable.

Table 1: Study Dependent and Control Variables

Variable	Description
African American	Black or African American Only Race
Latino	Hispanic or Latino (All Races)
Urban	Census defined Urban
Female Only Headed Household	Female householder; no husband present
SSI	Supplemental Security Income for Households
PAI	Public Assistance Income for Households
Below 1999 Poverty Level	Income in 1999 below poverty level by Household
Cook County	1=in Cook County, 0=not in Cook County
Median Housing Value	Median Value for Owner Occupied Housing Units (dollars)
Median Household Income	Median Household Income (dollars)
Unemployment	Employment Status for the Population 16 years and older
High School Graduates	Educational Attainment for the Population 25 years and older
4-Year College Graduates	Educational Attainment for the Population 25 years and older
Population Density	Total Population per block group/block group area (persons per square mile)
Distance to Major River	Distance from center of block group to nearest river of 600cfs
Distance	Distance from center of block group to nearest coal-fired power plant

In addition to the direct census information from the 2000 Census (U.S. Census Bureau, 2007), shapefiles for all 2000 Census blockgroups in Illinois were obtained (ESRI ArcData Download Census 2000 TIGER/Line Data, 2005). Block group files were added to additional data for the state of Illinois including county boundaries, state boundaries, rivers, and roads (Illinois Natural Resources Geospatial Data Clearinghouse, 2003) to create a usable map of the state for analysis purposes.

Currently active and recently inactive coal-fired power plants were also located (Scorecard: The Pollution Information Site, 2005; Energy Information Administration: Official Energy Statistics from the U.S. Government, 2007; P.E.R.R.O, 2006; CWLP, 2008; Power Plant Jobs, 2008, Ameren Corporate Facts, 2008) and visually validated using remotely sensed imagery (Google Maps, 2007). The coal fired power plants used in this analysis are described in Table 2 below, including their name, location, parent company, and first operational date.

4. Methods

A two pronged analysis was undertaken. The first was a comparison of means test to determine if populations near coal-fired power plants differed from those further away (Oakes et al, 1996; Pastor et al, 2001). This was accomplished by employing a buffer analysis in ArcGIS 9.2 (ESRI, 2005). Buffers of 10, 20, and 30 miles were used because environmental health literature suggests that the majority of the negative health effects associated with coal-fired power plants occur within 30 miles (Levy et al, 2001). Each block group was identified as being inside or outside each buffer. The means of each characteristic were then compared for inside and outside each buffer group.

Table 2: Coal-Fired Power Plants in Illinois

Plant Name	Address	City	State	Zip	County	Operational	Parent Company
Baldwin	SR 154	Baldwin	IL	62217	Randolph	1970	Dynergy
Coffeen	132 Cips Ln	Coffeen	IL	62739	Montgomery	1965	Ameren
Crawford	3501 S. Pulaski	Chicago	IL	60623	Cook	1959	Midwest Generations EME LLC
Dallman	3100 Stevenson Dr	Springfield	IL	62707	Sagamon	1968	City of Springfield
Duck Creek	17751 N. Cilco Rd	Canton	IL	61520	Fulton	1976	Ameren
E D Edwards	7800 S. Cilco Ln	Bartonville	IL	61607	Peoria	1960	Ameren
Fisk	1111 W. Cermak	Chicago	IL	60608	Cook	1958	Midwest Generations EME LLC
Grand Tower	1820 Power Plant Rd	Grand Tower	IL	62942	Jackson	1951	Ameren
Havana	SR 78	Havana	IL	62644	Mason	1940	Dynergy
Hennepin	RR #1	Hennepin	IL	61327	Putnam	1953	Dynergy
Hutsonville	15142 E. 1900 Ave	Hutsonville	IL	62433	Crawford	1953	Ameren
Joliet 29	1800 Channahon Rd	Joliet	IL	60436	Will	1965	Midwest Generations EME LLC
Joliet 9	1801 Channahon Rd	Joliet	IL	60436	Will	1959	Midwest Generations EME LLC
Joppa Steam	2100 Portland Rd	Joppa	IL	62953	Massac	1953	Ameren
Kincaid	West Route 104	Kincaid	IL	62540	Christian	1967	Dominion
Lakeside	3100 Stevenson Dr	Springfield	IL	62707	Sagamon	1935	City of Springfield
Marion	11543 Lake of Egypt Rd	Marion	IL	62959	Williamson	1986	Industrial Energy Applications
Meredosia	800 West Washington	Meredosia	IL	62665	Morgan	1948	Ameren
Newton	6725 North 500th St	Newton	IL	62448	Jasper	1977	Ameren
Powerton	13082 East Manito Rd	Pekin	IL	61554	Tazewell	1972	Midwest Generations EME LLC
Vermilion	Power plant rd	Oakwood	IL	61858	Vermilion	1955	Dynergy
Waukegan	401 East Greenwood Ave	Waukegan	IL	60087	Lake	1952	Midwest Generations EME LLC
Will County	529 East Romeo Rd	Romeoville	IL	60441	Will	1955	Midwest Generations EME LLC
Wood River	1 Chessen Ln	Alton	IL	60242	Madison	1949	Dynergy

A null hypothesis suggests that the means of the characteristics inside and outside the buffers do not differ.

$$Ho : \mu 1 = \mu 2$$

Where Ho is the null hypothesis, μ1 is the mean of population 1 and μ2 is the mean of population 2.

$$H_A : \mu 1 \neq \mu 2$$

Where H_A is the alternative hypothesis, μ1 is the mean of population 1 and μ2 is the mean of population 2.

The second method of analysis was a regression analysis employing ordinary least squares multiple regression. All previously mentioned variables were tested to determine which were best able to predict the distance of each block group from the nearest coal-fired power plant. Three models were used. They include:

Model 1: Distance = β1 + β2 (African American) + β3 (Latino) + β4 (Urban) + β5 (Female Only Headed Household) + β6 (SSI) + β7 (PAI) + β8 (Below 1999 Poverty Level) + ε

Model 2: Distance = β1 + β2 (African American) + β3 (Latino) + β4 (Urban) + β5 (Female Only Headed Household) + β6 (SSI) + β7 (PAI) + β8 (Below 1999 Poverty Level) + β9 (Cook County) + ε

Model 3: Distance = β1 + β2 (African American) + β3 (Latino) + β4 (Urban) + β5 (Female Only Headed Household) + β6 (SSI) + β7 (PAI) + β8 (Below 1999 Poverty Level) + β9 (Cook County) + β10 (Median Housing Value) + β11 (Median Household Income) + β12 (Unemployment) + β13 (High School Graduates) + β14 (4-Year College Graduates) + β15 (Population Density) + β16 (Distance to Major River) + ε

The first model includes simple variables important to the hypothesis. The second model includes the addition of only the Cook County variable to investigate specifically what effect, if any, this variable will have on the model in response to the claims of PERRO. The third model includes other place, social, and economic variables to further refine the effects each have on the location of coal-fired power plants.

Base SAS was used to analyze the regression models. ArcGIS was used to map the residuals from the best fit regression model to identify geographically where the model is strongest and where it is weakest in its prediction capabilities.

While high correlation between cross-sectional variables is common in regression analysis, it was not problematic for this data set. The models met all assumptions of the Gauss-Markov Theorem except independent distribution of errors. To compensate for this heteroskedasticity, the White estimator was used to produce a heteroskedastic-constant variance matrix in conjunction with the Ordinary Least Squares (OLS) parameter estimator. The results presented use White's constant variance matrix to produce reliable standard errors and t-ratios. The parameter estimates remain unbiased in OLS regression.

5. Results

The population of both African Americans and Latinos is distributed throughout the state; however their highest population percentages per block group are in the Chicago area. This can be seen below in Figures 1 and 2. Figure 3 below shows the location of each block group in relation to the 10-, 20- and 30- mile buffers around the coal-fired power plants. This represents the basis for the comparison of means analysis. Tables 3, 4, and 5 show the results from the difference in means test.

Figure 2:

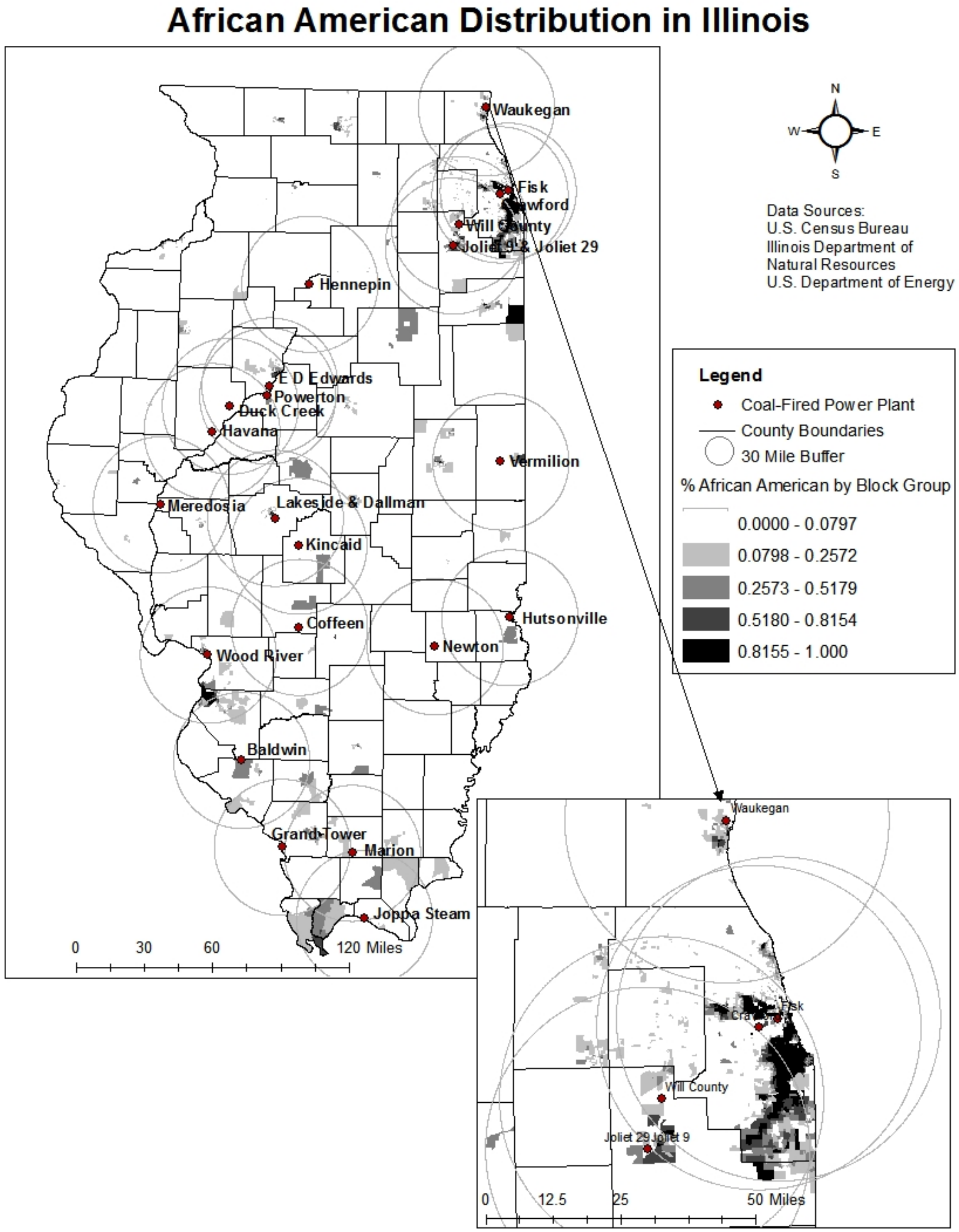

African American Distribution in Illinois
Waukegan
Fisk
Crawford
Will County
Joliet 9 & Joliet 29
Hennepin
E D Edwards
Powerton
Duck Creek
Havana
Vermilion
Meredosia
Lakeside & Dallman
Kincaid
Coffeen
Hutsonville
Newton
Wood River
Baldwin
Grand Tower
Marion
Joppa Steam
0 30 60 120 Miles
N
W
E
S
Data Sources:
U.S. Census Bureau
Illinois Department of Natural Resources
U.S. Department of Energy
Legend
Coal-Fired Power Plant
County Boundaries
30 Mile Buffer
% African American by Block Group
0.0000 - 0.0797
0.0798 - 0.2572
0.2573 - 0.5179
0.5180 - 0.8154
0.8155 - 1.000
Waukegan
Fisk
Will County
Joliet 29
Joliet 9
0 12.5 25 50 Miles

Figure 3:

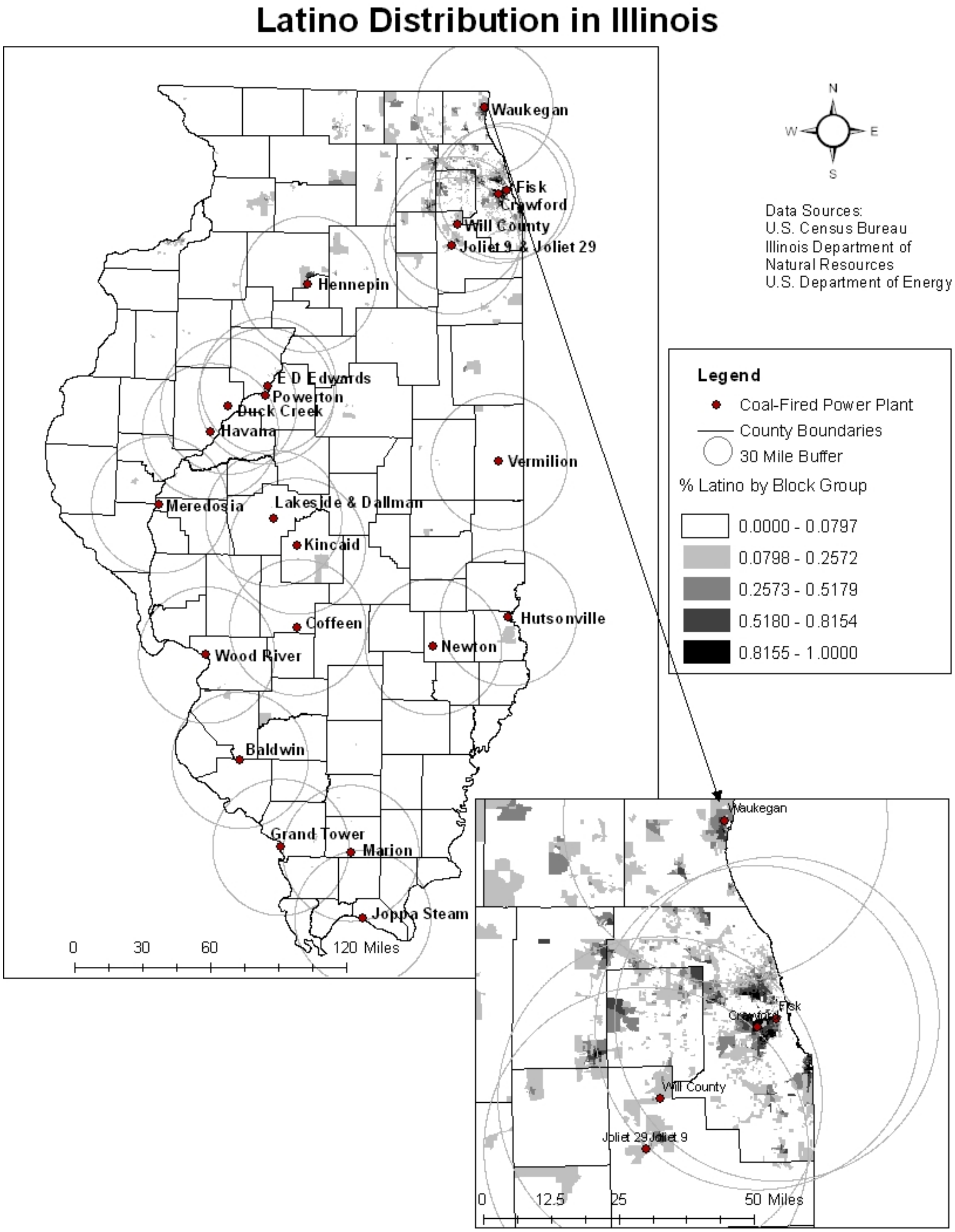
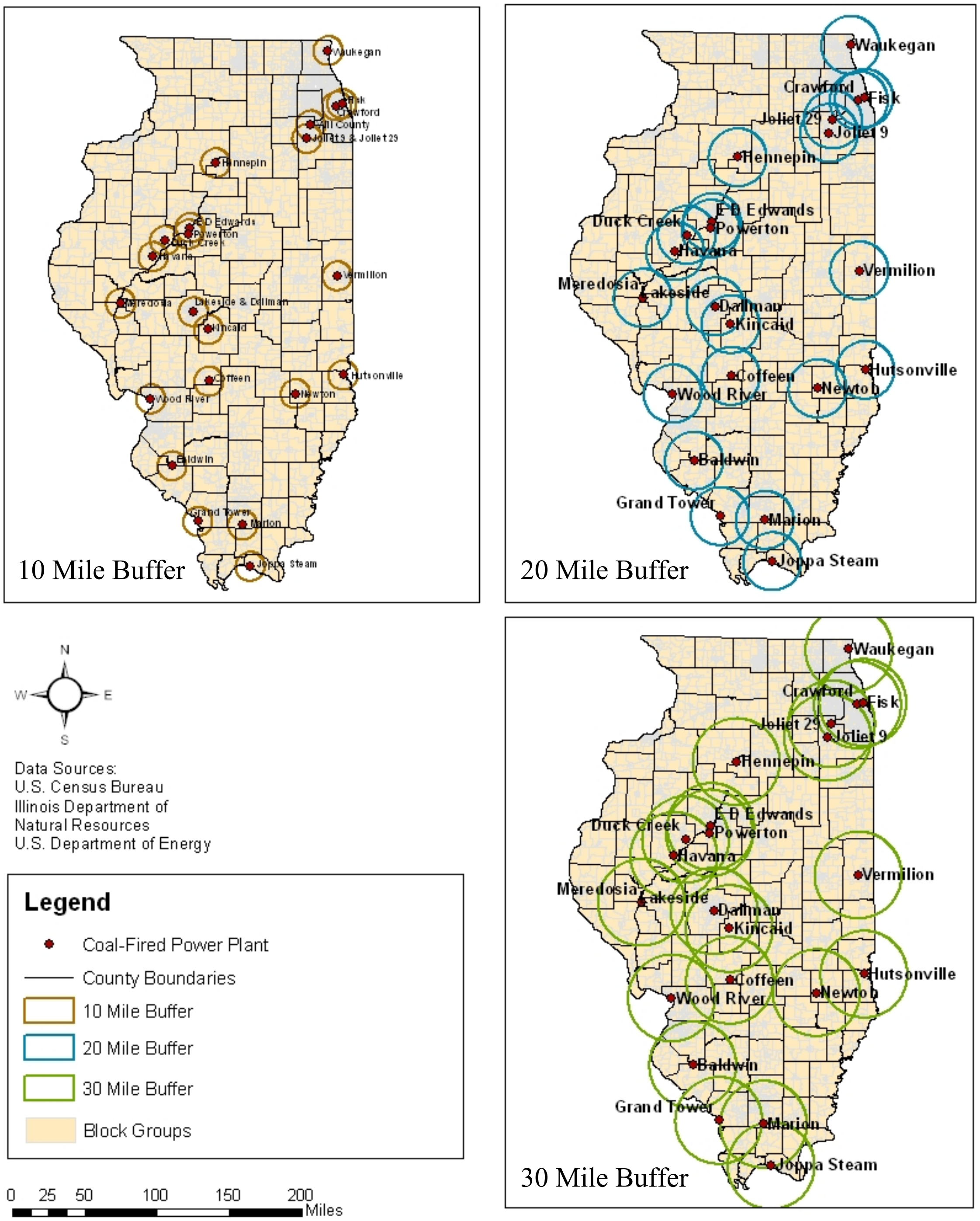

Latino Distribution in Illinois
Waukegan
Fisk
Crawford
Will County
Joliet 9 & Joliet 29
Hennepin
E D Edwards
Powerton
Duck Creek
Havana
Vermilion
Meredosia
Lakeside & Dallman
Kincaid
Hutsonville
Coffeen
Newton
Wood River
Baldwin
Grand Tower
Marion
Joppa Steam
0 30 60 120 Miles
N
W
E
S
Data Sources:
U.S. Census Bureau
Illinois Department of
Natural Resources
U.S. Department of Energy
Legend
Coal-Fired Power Plant
County Boundaries
30 Mile Buffer
% Latino by Block Group
0.0000 - 0.0797
0.0798 - 0.2572
0.2573 - 0.5179
0.5180 - 0.8154
0.8155 - 1.0000
Waukegan
Fisk
Crawford
Will County
Joliet 29
Joliet 9
0 12.5 25 50 Miles

Figure 4:

Coal-Fired Power Plant Buffer Areas in Illinois



In the 10-mile buffer difference in means test (Table 3), all results were significant at the 99% confidence level except the *population density* variable. All difference in means computations except *population density* revealed a non-zero result indicating at that significance level that the null hypothesis of no difference is rejected and it provides an indication that there is a difference in the populations within 10 miles of the coal-fired power plant and outside of the 10 mile buffer for all significant results. The high confidence level indicates there is only a 1% chance of rejecting a true null hypothesis.

In the 20-mile buffer difference in means test (Table 4), all results were also significant at the 99% confidence level except for *median household income*. All difference in means computations except *median household income* revealed a non-zero result indicating at that significance level that the null hypothesis of no difference is rejected and it provides an indication that there is a difference in the populations within 20 miles of the coal-fired power plant and outside of the 20 mile buffer for all significant results.

In the 30-mile buffer difference in means test (Table 5), all results were also significant at the 99% confidence level except for *median household income*. All difference in means computations except *median household income* revealed a non-zero result indicating at that significance level that the null hypothesis of no difference is rejected and it provides an indication that there is a difference in the populations within 30 miles of the coal-fired power plant and outside of the 30 mile buffer for all significant results.

Table 3: 10 Mile Buffer Difference in Means Test

Variable	Mean Outside 10 Mile Buffer	Mean Inside 10 Mile Buffer	Difference in Means	t-Value	Pr > |t|
African American***	0.0917849	0.2848144	-0.1930295	-26.05	<.0001
Urban***	0.8006741	0.8969195	-0.0962454	-10.56	<.0001
Latino***	0.0657628	0.1721652	-0.1064024	-22.47	<.0001
Female Only Headed Household***	0.1672672	0.2663482	-0.0990810	-15.77	<.0001
SSI***	0.2659883	0.2484583	0.0175300	10.08	<.0001
PAI***	0.0253496	0.0611146	-0.0357650	-21.48	<.0001
Below 1999 Poverty Level***	0.0899229	0.1558310	-0.0659081	-23.37	<.0001
Median Housing Value***	127656.05	140655.41	-12999.36	3.76	0.0002
Median Household Income***	50369.36	43819.24	6550.12	19.07	<.0001
Unemployment***	0.0345736	0.0541807	-0.0196071	-21.61	<.0001
High School Graduates***	0.3067017	0.2710043	0.0356974	6.37	<.0001
4-Year College Graduates***	0.1518665	0.1358090	0.0160575	13.28	<.0001
Population Density	6728.79	12659.63	-5930.84	-1.12	0.2636

***Indicates significance at the 99% confidence level. **Indicates significance at the 95% confidence level. *Indicates significance at the 90% confidence level.

Table 4: 20 Mile Buffer Difference in Means Test

Variable	Mean Outside 20 Mile Buffer	Mean Inside 20 Mile Buffer	Difference in Means	t-Value	Pr > |t|
African American***	0.0883843	0.2087215	-0.1203372	-29.07	<.0001
Urban***	0.7932604	0.8615908	-0.0683304	-20.89	<.0001
Latino***	0.0516094	0.1358290	-0.0842196	-25.76	<.0001
Female Only Headed Household***	0.1745091	0.2231855	-0.0486764	-18.21	<.0001
SSI***	0.2557492	0.2601861	-0.0044369	3.77	0.0002
PAI***	0.0250067	0.0468847	-0.0218780	-23.71	<.0001
Below 1999 Poverty Level***	0.0931015	0.1278678	-0.0347663	-20.12	<.0001
Median Housing Value***	98233.02	148864.26	-50631.24	-28.87	<.0001
Median Household Income	45124.19	48849.55	-3725.36	0.72	0.4688
Unemployment***	0.0348856	0.0461152	-0.0112296	-19.82	<.0001
High School Graduates***	0.3362732	0.2718287	0.0644445	34.25	<.0001
4-Year College Graduates***	0.1303417	0.1521974	-0.0218557	-7.39	<.0001
Population Density***	3149.05	11908.86	-8759.81	-46.16	<.0001

***Indicates significance at the 99% confidence level. **Indicates significance at the 95% confidence level. *Indicates significance at the 90% confidence level.

Table 5: 30 Mile Buffer Difference in Means Test

Variable	Mean Outside 30 Mile Buffer	Mean Inside 30 Mile Buffer	Difference in Means	t-Value	Pr > |t|
African American***	0.0775007	0.1893847	-0.1118840	-14.13	<.0001
Urban***	0.7703768	0.8538968	-0.0835200	-10.16	<.0001
Latino***	0.0433961	0.1224131	-0.0790170	-24.71	<.0001
Female Only Headed Household***	0.1762681	0.2141517	-0.0378836	-8.84	<.0001
SSI***	0.2661931	0.2573397	0.0088534	12.51	<.0001
PAI***	0.0251127	0.0429591	-0.0178464	-23.71	<.0001
Below 1999 Poverty Level***	0.0913142	0.1220143	-0.0307001	-16.65	<.0001
Median Housing Value***	82792.21	142865.06	-60072.85	-29.88	<.0001
Median Household Income	41149.54	48966.53	-7816.99	-0.73	0.4657
Unemployment***	0.0366961	0.0437398	-0.0070437	-9.72	<.0001
High School Graduates***	0.3552217	0.2796516	0.0755701	30.24	<.0001
4-Year College Graduates***	0.1147441	0.1513584	-0.0366143	-11.72	<.0001
Population Density***	2648.67	10443.84	-7795.17	-38.33	<.0001

***Indicates significance at the 99% confidence level. **Indicates significance at the 95% confidence level. *Indicates significance at the 90% confidence level.

Given the suggested difference in populations near coal plants compared to populations further away, the secondary method, regression analysis was employed to determine which characteristics, if any, were predictors of the distance of each block group from a coal-fired power plant. Tables 6 and 7 below shows the estimated parameters for each of the three ordinary least squares regression models. The parameter estimates and t-ratios have been adjusted to reflect White's heteroskedastic constant estimates. T-ratios are given in the parentheses. Table 6 provides coefficients that have been standardized to allow comparison of variables that originally had different units. Table 7 provides the unstandardized coefficient results for reference. The following results description refers to the standardized coefficients (see footnote on page 36 for an interpretation of the unstandardized coefficients).

Table 6: OLS Regression Results

Standardized Coefficients

Variable	Model 1	Model 2	Model 3
African American	-0.27951*** (-21.37)	-0.12432*** (-9.53)	-0.11974*** (-8.68)
Latino	-0.36414*** (-36.53)	-0.24126*** (-23.50)	-0.20695*** (-17.42)
Urban	-0.03407*** (-3.46)	0.05107*** (5.23)	0.03144*** (3.29)
Female Only Headed Household	0.07557*** (5.15)	0.02278* (1.74)	0.02796** (2.15)
SSI	0.02997*** (2.98)	0.02406*** (2.71)	-0.01958** (-2.16)
PAI	-0.06838*** (-4.95)	-0.04397*** (-3.68)	-0.04513*** (-4.04)
Below 1999 Poverty Level	-0.07323*** (-5.14)	-0.11254*** (-8.80)	-0.08542*** (-6.45)
Cook County		-0.37231*** (-36.86)	-0.24054*** (-20.25)
Median Housing Value			-0.08258*** (-6.17)
Median Household Income			0.02616* (1.80)
Unemployment			-0.03955*** (-3.61)
High School Graduates			0.08176*** (6.18)
4-Year College Graduates			0.04037*** (2.63)
Population Density			-1.69345*** (-9.77)
Distance to Major River			-0.03443*** (-2.67)
N	9843	9843	9843
R-Squared	0.2347	0.3341	0.3575

***Indicates significance at the 99% confidence level. **Indicates significance at the 95% confidence level. *Indicates significance at the 90% confidence level. T-ratios are given in parentheses.

Table 7: OLS Regression Results
Unstandardized Coefficients

Variable	Model 1	Model 2	Model 3
Intercept	2.91045*** (77.33)	2.96057*** (89.16)	2.92800*** (42.85)
African American % of Block Group	-0.84901*** (-21.37)	-0.37761*** (-9.53)	-0.36372*** (-8.68)
Latino % of Block Group	-1.76316*** (-36.53)	-1.16820*** (-23.50)	-1.00207*** (-17.42)
Urban % of Block Group	-0.09338*** (-3.46)	0.13999*** (5.23)	0.08618*** (3.29)
Female Only Headed Household % of Block Group	0.34164*** (5.15)	0.10300* (1.74)	0.12641** (2.15)
SSI % of Block Group	0.24543*** (2.98)	0.19699*** (2.71)	-0.16029** (-2.16)
PAI % of Block Group	-0.97987*** (-4.95)	-0.63016*** (-3.68)	-0.64669*** (-4.04)
Below 1999 Poverty Level % of Block Group	-0.53201*** (-5.14)	-0.81759*** (-8.80)	-0.62060*** (-6.45)
Cook County 1=in Cook Co 0=not in Cook Co		-0.72010*** (-36.86)	-0.46525*** (-20.25)
Median Housing Value Dollars			-7.913E-7*** (-6.17)
Median Household Income Dollars			0.00000105* (1.80)
Unemployment % of Block Group			-0.87678*** (-3.61)
High School Graduates % of Block Group			0.67375*** (6.18)
4-Year College Graduates % of Block Group			0.34829*** (2.63)
Population Density Persons/square mile			-0.0000107*** (-9.77)
Distance to Major River Miles			-0.00332*** (-2.67)
N	9843	9843	9843
R-Squared	0.2347	0.3341	0.3575

***Indicates significance at the 99% confidence level. **Indicates significance at the 95% confidence level. *Indicates significance at the 90% confidence level. T-ratios are given in parentheses.

Model 1: Distance = – 0.27951 (African American) – 0.36414 (Latino) – 0.03407 (Urban) + 0.07557 (Female Only Headed Household) + 0.02997 (SSI) – 0.6838 (PAI) – 0.07323 (Below 1999 Poverty Level)

The first model indicates that, for instance, a 1 standard deviation increase in Latino population for a block group would be related to a 0.36414 standard deviation decrease in the distance the block group is to a coal-fired power plant. That is, for each 1 standard deviation increase in Latinos in the block group, the model predicts that the block group will be 0.36414 standard deviations closer to a coal-fired power plant than would be expected if the block group was composed of 1 standard deviation more non-hispanics. Model 1 displayed directional results as expected except for *Female Only Headed Household* and *SSI* variables. They are both positively related to *distance* where a negative relationship was predicted. The variable with the largest coefficient was the *Latino* variable. This does not support the hypothesis that the variable *African American* would have the strongest prediction ability, but does support the hypothesis that a minority variable would have a strong predictive ability. The *African American* variable was the second strongest predictor. All of the parameter estimates in model 1 were significant at the 99% confidence level. Model 1 explains 23.47% of the variation in the distance between each block group and a coal-fired power plant. Additional variables may increase the explanatory power of the model.

*The unstandardized coefficients can be interpreted as a 1 unit (percent) increase in the Latino population corresponds to a 1.76% decrease the block group is to a coal-fired power plant, as seen in Model 1 of Table 7.

Model 2: Distance = – 0.12432 (African American) – 0.24126 (Latino) + 0.05107 (Urban) + 0.02278 (Female Only Headed Household) + 0.02406 (SSI) – 0.04397 (PAI) – 0.11254 (Below 1999 Poverty Level) – 0.37231 (Cook County)

The second model shows that all variables have the same direction as in model 1 except *Urban*. With *Cook County* in model 2, the sign of the *Urban* coefficient has switched and the coefficient has become stronger. This is likely due to competing influences of urban areas in the state. Chicago is negatively associated with *distance* but other urban areas are positively associated with *distance*. When *Cook County* is controlled for, only the other urban areas are influencing this coefficient and the positive association is displayed.

Also in model 2, *Female Only Headed Household* is less significant than in model 1. In model 2, it is only significant at the 90% confidence level. All other variables are significant at the 99% confidence level. The new variable *Cook County* shows the negative directional effect predicted. Cook County is now the best predictor, followed by L*atino* and *African American*. Model 2 explains 33.73% of the variation in the distance each block group is from a coal plant. Additional variables were added to the model to create model 3, which may increase the explanatory power of the new model.

Model 3: Distance = – 0.11974 (African American) – 0.20695 (Latino) + 0.03144 (Urban) + 0.02796 (Female Only Headed Household) – 0.01958 (SSI) – 0.04513 (PAI) – 0.08542 (Below 1999 Poverty Level) – 0.24054 (Cook County) – 0.08258 (Median Housing Value) + 0.02616 (Median Household Income) – 0.03955 (Unemployment) + 0.08176 (High School Graduates) + 0.04037 (4-Year College Graduates) – 0.1.69345 (Population Density) – 0.03443 (Distance to Major River)

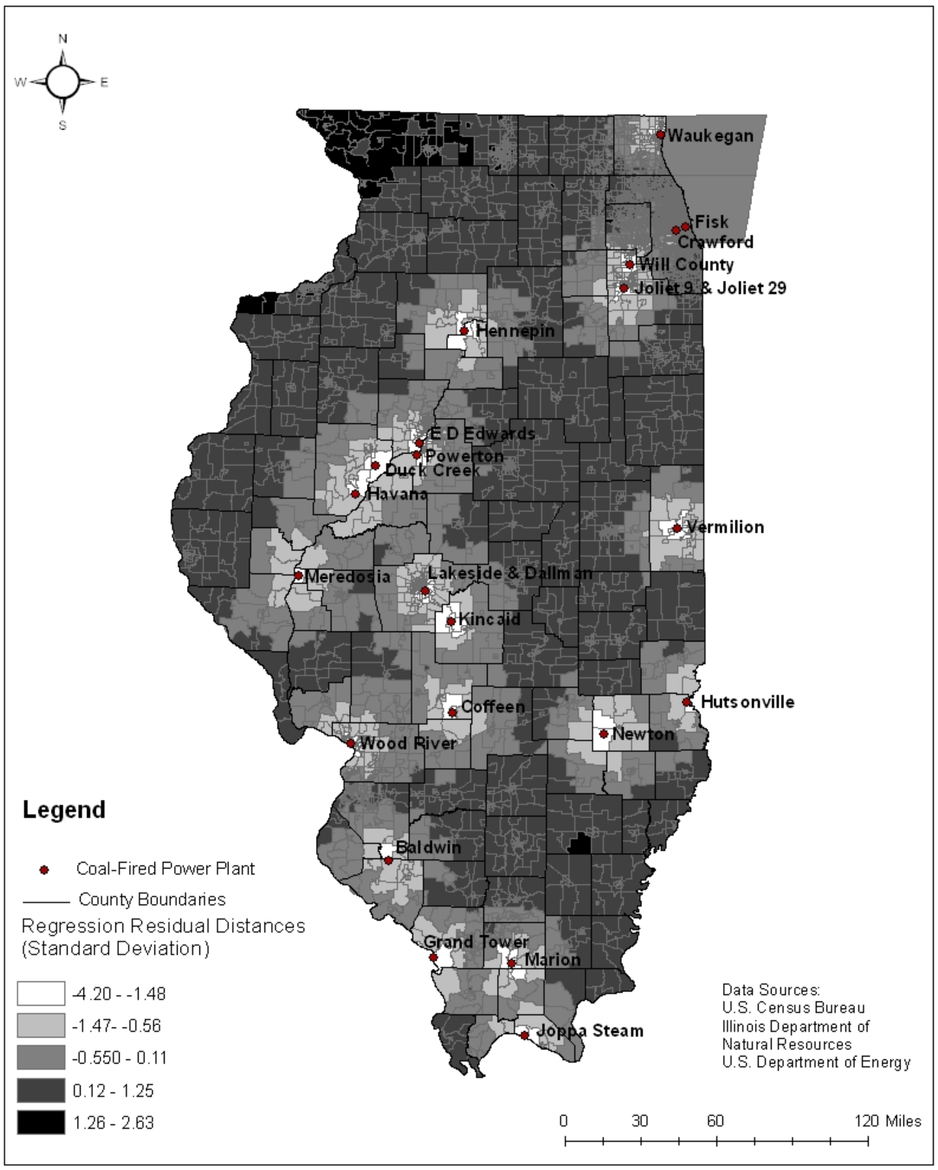
The third model adds *Median Housing Value*, *Median Household Income*, *Unemployment*, *High School Graduates*, *4-Year College Graduates*, *Population Density*, and *Distance to Major River* to model 2. After controlling for these variables, *SSI* changed signs in model 3 to display a negative relationship to *distance*. This is likely the result of a complicated relationship between *SSI* participation and Supplemental Security Income being a source of income included in *Median Household Income*. The results, therefore, should be used with caution. The same effect is not seen with *PAI* likely because much of the public assistance included in *PAI* is in the form of non-cash payments and therefore would not be included as part of *Median Household Income*. All of the other variables from model 2 maintained their directional effect. Each of the new variables in model 3 show their predicted relationship with *distance*. All variables in model 3 are statistically significant. *Median Household Income* is only significant at the 90% confidence level and *Female Only Headed Household* and *SSI* are significant at the 95% confidence level.

In model 3, *Population Density* is the strongest predictor of *distance*, followed by *Cook County*, *Latino,* and *African American*. Adding the new variables raised the explanatory power of model 3 to 35.75%. This indicates that 64.25% of the variation in the location of coal plants is not explained by the model. While not shown in table 6 or table 7, adjusted R-squared values for each model were different from the R-squared value by less than 0.1%.

Figure 5 shows geographically where model 3 was able to correctly predict distances and where it was less accurate. The white portions of the map indicate that the error was below the predicted value. In other words, the model under-predicted the presence of a coal plant for both the Duck Creek and Newton plants. Furthermore, the model over-predicted a plant in the north-western most corner of the state. The model would have indicated this spot likely for a plant to exist, but one does not. Further investigation would be needed to determine if a plant exists nearby but in a bordering state. The model was correct in predicting power plant locations with a +/- 4% margin of error. The Duck Creek and Newton plants are likely under-predicted for different reasons considering there are already many other plants surrounding the Duck Creek location. The model most correctly predicts the locations of power plants in the Chicago area. This is to be expected since the model included *Cook County* as a variable and therefore controlled for the Chicago area.

Figure 5:

Residual Distances from Regression Analysis



6. Discussion

6.1 Answering the Main Questions

This investigation centers around two main questions. Is there something unique or different about the population that lives near a coal plant compared to the population that lives further away? The difference in means tests indicated that for each distance, 10-, 20-, and 30- miles surrounding the coal-fired power plants, there is a difference between populations inside and outside with the exception of the variables *Population Density* (in the 10-mile analysis) and *Median Household Income* (in the 20 and 30-mile analyses). Population density is likely not different inside and outside of the 10-mile buffer because much of the urban, densely populated area is larger than 10 miles wide and therefore exists both inside and outside of the buffer. The similar populations of Median Household Income inside and outside the 20 and 30-mile buffers is more difficult to explain, however, it is important to note as income was often previously cited as an explanatory variable in environmental injustice (Boer et al, 1997, Been and Gupta, 1997).

The next question posed was which population characteristics would predict the distance of each block group to the nearest coal plant. The regression analysis indicated that the Population Density variable was the best predictor of coal-fired power plants. The *Cook County, Latino, and African American* were also consistent predictors of plant location. These findings do not support my original hypothesis that the *African American* variable would be a better predictor of power plant location than the *Latino* variable. An examination of the distribution of Latinos and African Americans in Illinois seems to suggest that African Americans will be a better predictor because of their larger and more spatially diverse population. Upon closer examination, however, it is clear that some of the largest populations of African Americans outside of Chicago are in rural areas. Furthermore, the large population of Latinos next to the Hennepin plant may have a strong influence on the results. Further investigation will be necessary to be certain of these hypotheses. The effects of the African American variable, however, may still be more influential than the results indicate. The largest population of African Americans in Illinois is in Cook County. Using the *Cook County* variable in models 2 and 3 may be masking the true relationship between this population and *distance*.

Other possible contributing factors to the lack of *African American* influence could be found in the choice of variable definitions. Beginning in 2000, the U.S. Census Bureau allowed for the first time, an individual to choose more than one race. The variable used in this analysis captured only the percent of the population that views themselves as African American alone. With no prior analysis to determine the effects of such a choice on distribution, caution should be applied to this variable. Further contributing to this problem is the fact that 15% of all Latinos in Illinois are also African American (Census, 2007).

The definition for the *Urban* variable and the *Cook County* variable share similar problems. The Urban variable is defined as a population density of 1000 persons per square mile. While this has been a Census Bureau convention for some time, the cut-off is somewhat arbitrary. The average population density of Illinois is only 233 persons per square mile indicating that the urban areas are highly populated, but the rural areas of the state outweigh their influence. Population Density was used specifically to provide a more precise measure of ‘urban’ and to help uncover the confounding results associated with the *Urban* variable. Its more precise definition makes it a more reliable variable.

Similarly, the block groups residing in Cook County to make up the *Cook County* variable are also somewhat arbitrary. *Cook County* was included in the model to control for the effects of the Chicago area to see if the same disproportionate impacts were present throughout the state. The population distribution of Cook County indicates that while the highest percentages of minorities occur here, all block groups of the county are not the same. There are many block groups in this county that have very low minority populations. Choosing to control for the highest percent minority block groups in the county might have made for a better analysis, and should be pursued in future research.

One of the most surprising results of this study was the directional effect shown by Median Housing Value. Previous studies indicate that once population density or urban areas are controlled for, higher housing values should be further from power plants and industrialized areas. A micro-investigation of power plant neighborhoods would be necessary to fully explain this phenomenon, however, the early construction of places in the Midwest might have left a legacy of larger, nicer houses in neighborhoods that are now more industrialized but previously had higher land values.

Since the *Population Density* variable was the best predictor of power plants, the relationship between populations and coal plants is likely the result of centralized energy production in the largest energy consuming areas. However, even after controlling for place, economic, and social factors, race and ethnicity are still important predictors of power plant locations. The limitation of cross-sectional data is that it does preclude the possibility of assessing the causal sequences of facility siting (Morello-Frosch et al, 2002).

Previous environmental justice literature suggested that when studying hazardous waste transfer, storage and disposal facilities and toxic release inventory sites, a useful variable in predicting their locations was a measure of the percent of the population employed by manufacturing (Boer et al, 1997; Ringquist, 1997; Been and Gupta, 1997). While this study attempted to find a corresponding explanatory variable for coal-fired power plants, it was unsuccessful. The low explanatory power of the *distance to major river* variable indicated while this may have been an initial factor in siting coal-fired power plants, it can not wholly account for their current distribution. Factors such as coal availability, electricity demand, competing electrical production and distance to a major interstate highway or railroad should be examined in the future to find the best variables to explain the distribution of coal-fired power plants. Including some of these variables in future research may create a better model with lower and less geographically based errors.

6.2 Study Limitations

There are specific limitations to my study. One is that the findings are not generalizable to the larger population of states, the region, or the nation. The findings are only applicable to the state of Illinois due to the specific distances between block groups and the location of power plants in the state. While other states may possess similar patterns in the distribution of power plants, further research would be needed to determine this. The case study approach presented here follows the majority of research in the environmental justice movement, which addresses one case at a time. Each case of possible injustice needs to be viewed individually to determine what injustices have occurred, if any. Further research is necessary to determine if systematic injustices are present throughout the energy industry. Spatial autocorrelation was not investigated or removed from this investigation. If present, it would provide higher statistical significance than reality. Caution should be used when interpreting these results. Furthermore, with a highest R-squared value of 35.75%, the regression models appear to account for only about 1/3 of the potential factors in the relationship between block group populations and coal-fired power plants. Determining the causes of any disproportionality in the populations near coal-fired power plants will require a more rigorous historical investigation and a deep familiarity with the local politics and social context in Illinois. Future research is urged to tackle these important questions.

My research does attempt to address the issue of scale by using block groups as the unit of analysis. Geographic plotting of the residual from regression analysis was also done to address issues of quantitative rigor (Bowen, 2002). This unique pairing of sociological research and geographic analysis is not new and will certainly be repeated as more social researchers become familiar with the tools and training of geographic approaches. Studying geographically based problems such as environmental justice can only benefit from an interdisciplinary approach.

The major findings of this study indicate that while my hypothesis was only partially correct, the claims of P.E.R.R.O. are valid and indicate that Latinos may be disproportionately close to coal-fired power plants. P.E.R.R.O. is concerned about the justice issues presented in these findings and possible negative health affects associated with being close to power plants. My results can not address the health concerns or the causes for the possible justice issues but they do provide some evidence to suggest that P.E.R.R.O'.s claims should be taken seriously. My results were similar to Been and

Gupta's 1997 study of TSDFs in California. They concluded that the siting process of TSDFs since the 1970's has disproportionately affected Hispanics.

Since 1980, Latino immigration has been a large source of population growth in the Midwest. Nowhere was that more so than in Illinois, and especially Chicago (Aponte and Siles, 1994). Seventy percent of the Latino immigration in the Midwest was of Mexican origin. The movement has largely been driven by a few key industries such as agriculture and meat-packing (Aponte and Siles, 1994). Hernandez (2004) notes barrios that determined original Latino settlement patterns were located outside heavily industrialized areas in the rust belt. Therefore, an additional variable that might further explain the coincident distribution of Latinos and power plants would be a measure of employment by industry.

Some Latino groups (particularly of Cuban and Mexican decent) fair better than African Americans but not better than Whites in indicators of well being such as employment rates, household earnings, and educational attainment. Latinos of Puerto Rican decent often fair slightly worse than African Americans on these same well being indicators (Aponte and Siles, 1994). However, these measures do not directly correlate with social movement participation and may help explain the difference in participation in the Environmental Justice Movement between African Americans and Latinos.

6.3 Latinos and the Environmental Justice Movement

While the Environmental Justice Movement has included both African American groups and Latino groups, the African American groups tend to be more predominant both historically and currently. This is likely because of the growth of the EJM out of the civil rights movement as and the ease of bloc recruitment through church groups for

African Americans. Churches also play an important part in the recruitment of Latinos, but not in the same bloc recruitment pattern as for African Americans. African Americans are more likely than Latinos to participate in movements due to their culture of opposition and disenfranchisement with the dominant white culture (Massey and Denton, 1993). Latinos on the other hand are less likely to participate in movements because they possess fewer resources, have higher employment rates, often have language barriers, and see participation as having a high cost (i.e. risk of deportation for illegals) (Martinez, 2005). There have been examples of Latinos successfully participating in the EJM, such as in Kettleman City, CA. However, the farm workers in Kettleman City were able to successfully partner with the farm owners to protest against a new chemical plant. This partnership lowered the risk or cost of being involved for the farm workers because their uprising did not put their jobs in jeopardy (Invisible 5, 2008). The PERRO group took advantage of a political opportunity which helped lower their cost of participation as well. This gives the PERRO group a higher chance of success in the movement than for other Latino groups.

The results of this study contribute to a line of studies showing possible environmental justice issue affecting the Latino community (Boer et al, 1997; Been and Gupta, 1997; Pastor et al, 2001). However, given the results that coal-fired power plants have the largest coincidence with Latinos and Latinos are less likely to participate in protest activities, it is unlikely that the Environmental Justice Movement will strongly embrace energy production as a focal topic. Two factors provide hope, however. Pro-immigration rallies encouraged hundreds of thousands of Latinos to begin participating in protests in 2008 (Williams, 2006). These rallies were organized primarily through informal communication and the Latino media in the U.S. The energy crisis of 2008 also provides a window for discussing energy production. Many environmental groups not previously aligned with the energy production issue have taken it up. Groups participating in the Environmental Justice Movement are no different and may be likely to jump on the band wagon.

6.4 Policy Recommendations

The results of my study indicate there may be a larger problem than a simple economic explanation of low cost housing or even a racism explanation of lack of power that explains coal plants and the populations living near them. While social, economic, and historical factors all played a role in developing the current situation, it is the role of policy to recognize and provide solutions for how to overcome it. Many simple steps can be taken to minimize negative effects that may arise from a group of people with less political power and less health coverage than the average American living so close to coal plants. Primarily, removing the grandfather clause from the Clean Air Act and requiring all existing plants to meet the same standards may lessen air pollution, and therefore risk. Previous studies note Latinos may also be disproportionately exposed to places that consistently fall below attainment of air pollution goals listed in the Clean Air Act (Keating, 2004). This suggests the need for more stringent enforcement of existing clean air policies to avoid creating “hot spots” of pollution often populated by minority groups. Lastly, with Latinos being less likely to participate in political action than their white or African American counterparts, policies and organizations designed to lessen the cost or risk for such participation would strengthen their ability to do so.

7. Conclusion

In this paper, I have argued for the new method for evaluating the relationship of communities to LULUs, the distance measurement, to replace the spatial coincidence method for environmental justice examinations. I have also provided an alternative motivation for moving away from the historical U.S. policy of centralized, dirty energy production.

This study finds that there is something different about the populations living very near coal-fired power plants (within 10-, 20-, and 30- miles) from those living further away. Population density, Cook County, Latinos, and African American populations are the best predictors of the location of a coal-fired power plant in Illinois, even after controlling for income and housing values. While these findings may seem to simply reiterate the legacy problems of poor air quality in the cities, there is more to be concluded. The problems of the urban area, the problems of energy, and the problems of pollution are problems for everyone. Environmental justice is just another in the long list of reasons to promote cleaner energy production for every American.

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