Environmental Justice:

Mapping Coal Power Plants in Illinois and Chicago

A project for the Little Village Environmental Justice Organization

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Project Summary

The Little Village Environmental Justice Organization (LVEJO) has been working since August of 1998 to address public health issues primarily in the southwest side of Chicago (Little Village, Pilsen, and North Lawndale), but is also is also involved in city, regional, and national networks and coalitions. Our project began with LVEJO due to the presence in Little Village of the Crawford power plant. The synchronicity of the largest coal-burning, electricity generating plants being located in an area with 45% of the population living 200% under the poverty level, along with Little Village being the largest Mexican American community in the United States (outside of Los Angeles), and with the youngest population of all Chicago's 77 community area raised questions about whether power plants are disproportionately located within areas of lower socio-economic status and/or minority population.

Our group's project expanded this initial question about whether communities with a lower economic status and/or minority population (specifically Latino) were more likely to have a power plant located in their area from Little Village to the State of Illinois. This not only provided us with more cases to study (which meant that our results were more likely to be representative of a trend as opposed to a singular phenomena within Little Village), but also broadened the relevance of our project to communities throughout Illinois.

The second question raised by the presence of the Crawford power plant was whether or not the location of a power plants in an area is significant, especially in relation to the health of the local population. The assumption of LVEJO was that the release into the air by power plants of chemicals such as Sulfur Dioxide (which causes coughing, wheezing, shortness or breath, nasal congestion, and inflammation and increases infant mortality rates) might have a negative affect on the health of the nearby population.

Instead of only comprehensively researching all the health affects which might arise from the release of chemicals such as Sulfur Dioxide, Nitrogen Oxide, Carbon Dioxide, and Mercury which are emitted from coal burning power plants, we decided to also focus on the incidence of asthma in areas near power plants. This allowed us to better assess the correlation between power plants and hazardous health affects in communities.

Both of our questions, about the placement of power plants and the health affects related to power plants, needed to be approached using GIS since they were fundamentally spatial in nature. Our group succeeded in not only spatially coding data on community and county areas and their median household income levels, the percent Latino population in these areas, the location of power plants along with each power plants' toxic output in tons, but we also managed to present this information in a format which is easily understood and aesthetically pleasing. By creating these maps, along with giving our organization the data sets we used to make them, a major outcome of our project is that we have results which are useful for a variety of applications both by laypeople and those who can use our data to expand or focus our research. A project initially conceived in Little Village has now gone one step further in expanding the scope (and hopefully the impact) of LJEVO's goal of environmental justice.

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I. Introduction

Little Village Environmental Justice Organization base is the Southwest side of Chicago: Little Village, Pilsen & North Lawndale. However, LVEJO works on city, regional and national networks & coalitions. LVEJO campaigns: Green Jobs/*Clean Power/Climate Justice, Clean-up Toxic Land/More Parks, Public Transit Equity, Youth Activists Organizing as Today's Leaders (YAOTL) and Urban Agriculture* unite them with sister organizations throughout the Chicago Region and the U.S. The roots of LVEJO began in 1994 when parents, grandparents, neighbors, students, teachers and priests organized to move a proposed elementary school to a safer environmental location and began the Gary Public School Environmental Justice Project (GSEJP). 30 students and 20 parents participated in the GSEJP leadership program for 3 years. GSEJP voted to establish a community based organization (CBO), LVEJO, in June, 1997. LVEJO became incorporated as a 501-c-3 Community Based Organization (CBO) in August, 1998. Currently, LVEJO has 11 paid staff and 12 board members.

South Lawndale, also known as Little Village is the largest Mexican American area in the U.S. outside of East Los Angeles, 45% of people live 200% beneath the poverty level and they are the youngest of all 77 Chicago community areas by age. Little Village has the least amount of open space per capita in Chicago but some of the most polluting industry, including the region's largest coal-burning electrical generating plant: Crawford.

When Marisol Becerra, a 2008 winner of the distinguished Earth Island Institute Brower Youth Award, was growing up in Chicago's Little Village neighborhood she thought the Crawford coal fired power plant she could see from her window was a cloud factory. During her freshman year in high school, Marisol joined the Little Village Environmental Justice Organization (LVEJO) to map and inventory the assets and toxic industry in her predominantly Mexican-American community. Marisol was enraged to discover that in Little Village and neighboring Pilsen the 60,000 youth who live within a two-mile radius of the Fisk and Crawford Coal Power Plants are forced to breathe air that violates EPA standards. Later she found out that the two coal power plants are Chicago's largest sources of carbon dioxide greenhouse gases. She was inspired to act, saying, "in order to shut down these coal power plants, build more parks, and clean up the toxics. We must organize more people to stand up and fight." Her first step was launching the youth branch of LVEJO — Youth Activists Organizing as Today's Leaders, YAOTL. Under Marisol's leadership, YAOTL created an interactive online map that includes 12 videos, descriptions of toxic sites, and gang territory delineations. With this map, Marisol is educating her community about local environmental injustice and organizing them to participate in the campaign to replace Chicago's two coal fired power plants with renewable energy & energy efficiency.

LVEJO & its partners have applied for a Google Grant to expand OurMap of Environmental Justice and create an interactive map of Illinois' existing & planned coal fired power plants & mines & existing & future renewable energy sources & projects. The maps will be multi-layered to include the adverse economic, environmental & health effects of coal fired plants throughout the state, along with organizations who are advocating for an end to coal and the companies who own the existing plants & who are pushing "clean coal" and other expansion projects. The maps will include where the coal for each plant comes from as well as existing coal mines in Illinois. LVEJO has partnered with the organizations of

iLoveMountains.org at the U.S. Social Forum in 2007 to begin to build a network that unites those directly affected by the mining of coal and the burning of it in power plants. Existing sources of renewable energy will be mapped along with completed projects & those under construction. Grass-roots, environmental and economic/job development organizations, governmental agencies, academic institutions, and companies involved in renewable energy & coal will be featured through videos, photos, text and links to websites as well as demographic, electricity, economic, environmental & health data. The economic data will emphasize new job creation and replacing coal related jobs with energy efficiency/renewable energy jobs. Energy efficiency & renewable energy training programs throughout the state will be mapped out with links to each program. Both existing and projected transmission lines from each renewable energy project will be mapped to show where & how it is replacing electricity

Goals and objectives

Our first goal is to map the toxic release from each coal power plant in Illinois Our objective is to find out how many power plants are in Illinois and provide a visual representation of the amount of toxic release per coal power plant. This information will serve as the foundation of LVEJO's google map project since one of their objectives is to map all existing coal power plants in order to propose the implementation of renewable energy such as wind turbines where power plants exist today.

Second goal is to map socio-economic status of the residents living near power plants. Mapping socio-economic status of residents in each county will allow us to reach the objective of analyzing the spatial distribution of hazardous air pollutants and find out if there are any patterns such as the higher air pollution present, the more likely it is that these coal power plants are situated in low-income areas.

Third, map Latino ethnicity of each county based on census 200 data. Our objective is to map the Latino ethnicity of each county to spatially compare the areas of highest Latino concentration in Illinois in relation to the spatial distribution of hazardous air pollutants. We choose to focus on the Latino population since LVEJO works closely with them. This will provide LVEJO the foundation for future projects and maps that will use other census data, such as race as the main focus.

Fourth, map total cases of pediatric asthma per county based on American Lung Association Data. Our objective is to map pediatric asthma per county to spatially compare counties with a great amount of pediatric asthma cases and those with fewer. Additionally, we want to compare this map to maps of socio-economic status and race. This will serve as the foundation for future LVEJO maps and projects that plan to examine the access to health care and cases of asthma.

Fifth, create a map with a smaller unit of analysis (community area) to further analyze any disparities. The objective is to provide LVEJO with a map of Chicago and spatially represent the percent of Latinos in each community area as well as to analyze the location of the two coal power plants in Chicago in relation to ethnicity.

The main goal and ongoing goal is to provide information of the location of coal power plants in Illinois, and if true, the disproportionate distribution of hazardous air pollutants in low-income and minority areas. The objective is to use this information to

educate residents and engage them in social action. Additionally, LVEJO hopes to use this information as a tool to influence environmental policy and a just transition from fossil

To meet our goals and objectives, we created four choropleth maps for goals one thru four. The first one analyzed income and toxic release of hazardous air pollution by county. The second, analyzed latino population and toxic release of hazardous air pollution by county. The third, focused on pediatric asthma cases in counties with a high risk for asthma determined by the American Lung Association. The fourth looked closely at Chicago's Latino population and the two coal power plants: Crawford and Fisk. These maps will give LVEJO the tools to continue expanding their mapping project.

II. Needs Assessment

The goal of our group project is to map existing coal power plants in Illinois and map the demographics of each county and each community area in Chicago to to see if there is any relationship the location of each coal power plant and the socio-economic status. In order to answers our need-to-know questions, we will collect U.S. Census data and EPA TRI Explorer, an online database that allows users to view the amount of toxic release of sulfur dioxide and nitrogen oxide. Through the use of ArcGIS tools, such as choropleth and graduated symbology, we will be able to provide our client a foundation to move this GIS project forward for future updates. Additionally, this basic foundation will help LVEJO in their community organizing, community meetings and events to bring public awareness to the issue of environmental injustice and influence stronger and equitable environmental policies.

2.1 Need To Know Questions

Meeting with our client representative, Marisol Becerra; we devised the following six need to know questions for this project:

Q#1

What is the total number of coal power plants in the state of Illinois?

Q#2

What is the total toxic release of hazardous air pollutants per coal power plant?

Q#3

What is the latino population in each county? Are hazardous air pollutants disproportionately distributed?

Q#4

What is the median household income in each county? Are hazardous air pollutants disproportionately distributed?

Q#5

Are the majority of asthma cases located in counties with high levels of hazardous air pollutants?

Q#6

What is the latino population in each Chicago community area and are the two chicago coal power plants disproportionately located in these communitites?

2.2 Literature Review

"Who gets what, why, and how much?"-Bullard (2001)

Robert Bullard, the father of environmental justice developed a five point environmental justice framework that looks closely at the social and ethical questions of "who gets what, why, and how much?"1) The environmental justice framework reinforces the right of the people to be protected from environmental degradation. 2) The environmental justice framework adopts a public health model of prevention (elimination of the threat before harm occurs) as the preferred strategy. 3) The environmental justice framework shifts the burden of proof to polluters/dischargers who do harm, discriminate, or who do not give equal protection to racial and ethnic minorities, and other "protected" classes. 4) The environmental justice framework would allow disparate impact and statistical

weight, as opposed to "intent," to infer discrimination. 5) The environmental justice framework redresses disproportionate impact through "targeted" action and resources (Bullard: 2001)

The question of "who gets what, why, and how much?" has also been asked by various environmental scholars (Morello-Frosch et al 2002; Mantay 2007; Mennis and Jordan 2005). As one starts to examine communities that experience environmental injustice, the social and ethical questions lead one to ask: How can this be remedied? How can we establish equity? But, what is equity? The meaning of "equity" varies from person to person, researcher to researcher. Bullard breaks down equity into three categories: 1) procedural equity, 2) geographic equity and 3) social equity. (Bullard 2001)

Procedural Equity refers to question of "fairness," the extent that governing rules, regulations, evaluation criteria, and enforcement are applied equally upon communities in a nondiscriminatory way.

Geographic Equity refers to location and spatial configuration of communities and their proximity to environmental hazards.

Social Equity assesses the role of sociological factors on environmental decision-making (Bullard 2001)

The lack of procedural equity is briefly mentioned in Morello-Frosch et al's study on aimbent air toxics and health risks among schoolchildren in Los Angeles as it expressed concern over local government situating public schools on or close in proximity to brownfields and toxic sites. In 2007, Juliana Maantay's research study on asthma and air pollution in the Bronx explored the concept of zoning a little further. In the 1970's, New York City was gentrifying and areas zoned as industrial were zoned to be residential and vice versa. As industrial zones in New York City decreased and residential zones increased, the amount of industrial zones increased and residential zones decreased in the Bronx. As a result, industrial areas zoning laws perpetuated industrial facilities to move into areas that were once categorized as residential and where residential life still exists around industrial clusters (Maantay 2007).

Geographic equity is important to take into consideration when evaluating the close proximity and distribution of air pollution amongst communities spatially. Mennis and Jordan's study on air toxic releases in New Jersey used geographically weighted regression and explored the spatial distribution of air toxic release facilities in New Jersey listed under the U.S. Environmental Protection Agency's (EPA) Toxic Release Inventory (TRI) data as

well as the socioeconomic status by using U.S Census tract-level data (Mennis and Jordan 2005). Similarly, Maantay explored the spatial relationship between poor air quality and the locations of people hospitalized for asthma in the Bronx, New York City. Maantay focused on the Bronx, a New York State county and one of the five boroughs of New York City. The reason why this study focuses on the Bronx is due to its high rates of asthma hospitalizations and high number of toxic facilities of land use, which can increase the likelihood of these two factors to have a significantly high correlation. Like Mennis and Jordan, Maantay used the industries and polluting land uses as the unit of analysis for environmental data. Maantay went a step further and used census block groups as the unit of analysis for demographic and socioeconomic data, which is the smallest census enumeration unit available. Additionally, Maantay included asthma hospitalization cases to the study to evaluate not only the disparities of environmental hazards amongst race but also amongst health (Maantay 2007). Berhane et al's study on the long-term effects of air pollution on Children's health is currently the longest running study of its kind. There are approximately 6,500 children monitored in this study each year to assses lung growth, development and frequency of respiratory and school absences in relation to long-term air pollution levels (Berhane et al 2004). In Morello-Frosch et al's study on the case of ambient air toxics exposures and health risks among schoolchildren in Los Angeles uses spatial analysis for a portion of the study that analyzes the correlation between spatial distribution of respiratory hazards and academic performance in the Los Angeles area (Morello-Frosch et al 2002). Thus, more and more researchers are incorporating geographical information systems (GIS) into their studies to address the question of geographic equity as described by Robert Bullard (Bullard 2001).

Social equity plays an important role in environmental justice and racism studies as it assesses the sociological factors on environmental decision-making (Bullard 2001). Environmental racism refers to any policy, practice, or directive that differentially affects or disadvantages (whether intended or unintended) individuals, groups, or communities based on race or color (Bullard 2001.) Social equity is explored in studies of New York's Bronx borough, state of New Jersey, Southern California, Detroit Metropolitan Area and Chicago (Maantay 2007; Mennis and Jordan 2005; Berhane et al 2004; Downey 2004; Thomas and Whitman 1999). Liam Downey's investigation on race or income being a predictor on the distribution of Toxic Release Inventory emissions suggests that researchers should focus on race and income as a whole when looking at environmental justice rather than arguing which has more of an impact as she found both attributes to have an impact on the distribution of toxics.

Chicago is one of the largest metropolitan and segregated cities in the United States. Chicago ranks 12 as one of the top 25 most polluted cities by particle pollution. Cook County ranks 19 out of the top 25 most polluted counties by particle pollution [1]. The sources of air pollution include industry, highways, and power generating plants. Air pollutions emissions include sulfur dioxide, nitrogen dioxide, carbon dioxide, particulate matter, and ozone pollution. Maantay attempted to use national air standard data but there were only three monitoring stations, two of which were monitoring hazardous air pollutants. The low number of monitoring stations and coverage of the area was useless for the study and thus Maantay decided to document only the known sources of air pollution such as stationary point sources (industries), roads and highways. Berhane's ongoing longitudinal study on the effects of air emissions on children's health has used the appropriate emissions data since all twelve communities within Los Angeles have monitoring stations that document nitrogen dioxide, ozone pollution and particulate matter. However, most studies rely on Toxic Release Inventory data (Morello-Frosch et al 2002; Mennis and Jordan; Downey 1999), which

[1] American Lung Association

provides a list of industries that emit hazardous chemicals as recognized by EPA. Sulfur dioxide, nitrogen dioxide, carbon dioxide, particulate matter and ozone pollution are not recognized under EPA's Toxic Release Inventory database. It is possible that these studies rely on Toxic Release Inventory data due to lack of monitoring stations that document the release of such air pollutants.

Asthma is a disease that affects the lungs and it is the most common long-term disease in children. Symptoms of asthma include wheezing, breathlessness, chest tightness, and frequent nighttime or early morning coughing. Asthma attacks can be triggered by the exposure to air pollution, house dust mites, mold, cockroaches and tobacco smoke[2]. In 1996, there were 11, 926 asthma hospitalizations in Chicago, which is twice the hospitalization rate of asthma for the United States. Ten percent of the hospitalizations where for children under 21 months of age and another ten percent for those aged 66 and over (Thomas and Whitman 1999).

III. System Requirements

In order to carry out our project, we must use the appropriate systems to devise the four maps. To produce the maps, we will be using Arc Map, which is a program in ArcGIS software. ArcMap will allow us to make thematic maps to spatially analyze the distribution of hazardous air pollutants with race and level of income. Specifically, we will use choropleth maps to visually highlight the economic status, percentage of Latinos, and cases of asthma as this type of thematic map uses different shades (darker, lighter, or spectrum) to show high an low values. Thus, placing an attribute on a scale to allow anyone to visually analyze the data.

Before beginning, it is important to transfer the data collected onto ArcGIS. Data for this project was obtained from four different source. First, in order to determine the amount of coal power plants in the state of Illinois we used information from the Illinois Coalition for Balanced Energy policy[3], which presented all sites. We took note of the county in which each coal power plant is situated. To measure levels of pollution, we obtained data from the United States Environmental Protection Agency Toxic Release Inventory Explorer, which is a database accessible to the public online[4]. Each county was then searched in the TRI database to provide the amount of hazardous air pollutants on site released (in tons) from each coal power plant. The attributes in TRI hazardous air pollutants include: facility, address, city, county, state, zip code, latitude, longitude, and total onsite toxic release. Information was retrieved in a csv.file to open in excel, delete any headings and geocode into ArcGIS

To reflect the economic status and Latino population of each county we used census 2000 statistics[5]. To process, the tabular data was joined to county cartographic boundaries. The spatial object type was represented as a polygon and its attributes include: Field Name,

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[2] Center for Disease Control and Prevention

[3] Illinois Coalition for Balanced Energy Policy Coal Fired Power Plants in Illinois http://www.powerillinois.org/Materials/Mercury%20Rule.CoalPlantMap.062206.pdf

[4] EPA TRI Hazardous Air Pollutants Database http://www.epa.gov/triexplorer/facility.htm

[5] Census Data http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_submenuId=datasets_1&_lang=en

STFIPS (State FIPS code), CTFIPS (County FIPS code), Population (yr 2000), PopDensity (population divided by area/persons in square feet), White population, Black population, Hispanic population, and Median Household Income. Census data is in interval ratio level of measurement The data format for this information is shapefile, which was used to create thematic maps.

Asthma pediatric asthma data was collected from the American Lung Association's State of the Air Vital Statistics 2005 report[6] in tabluar form. The processing steps of this data was to input it into an excel .cvs file to then geocode into excel. The attributes in this data file include: Field Name, County (Nominal), Population, 18 & under, 65 & over, pediatric asthma and adult asthma. All population data, including asthma cases are documented in interval ratio level of measurement. The spatial object type for this data is not applicable. However, the number of pediatric asthma cases will be reflected through the use of graduated colors under the symbology tab in properties of the map layer.

After all the data is colleceted, we must geocode data in order to attach attributes to an Illinois by counties shapefile. Once geocded, the data must be managed and undergo a coordinate transformation to North American Datum 83 (NAD 83), which is the standard geodetic network in the North American continent. Given the fact that our data is based in North America, we decided to use NAD 83. Proceeding, our data will be ready for analysis of the data and to visually represent the outcomes through the use of graduated colors and symbols.

IV. Data Acquisiton

In pursuit of data for our project concerning environmental justice and coal power plants in the State of Illinois and the City of Chicago, specifically on the near South Side, the first choice of data to be collected are issues about health. The goal of our research originally was to utilize data about health on a localized level such as community area (Little Village/South Lawndale). We favored this approach because it would have allowed the group to conduct research and analysis one of Chicago's seventy-seven Community Areas. The limitation to our research is that there is limited data available or non-existent on specific community areas but are far more prevalent for census blocks and districts, provided on a per-county basis. Because such localized data is not readily available the group decided to pursuit health data composed on the county. For this project, the applicable county is Cook, Illinois.

Cook County, the second most populous county in the United States has data sources comprising demographics from the United States Census Bureau along with health statistics from the American Lung Association (ALA) [Asthma Analysis]. Instead of utilizing the preferred method of community area, five-mile radius research, we are utilizing county level data via the ALA and the Census Bureau to analyze levels of pollution at the statewide level in the State of Illinois.

The original direction of the project was intended to research asthma levels in the South Lawndale community area in the City of Chicago and its comparable regions within a five-mile radius. The lack of data for community areas did not change the focus of the project since we still have the ability to research demographics by census county though the direction

[6] American Lung Association
http://www.lungusa2.org/embargo/sota05/SOTA05_final.pdf

of the project has changed because we now must use a much broadly based analysis of health effects per county, therefore we do not have the ability to proceed with more in-depth research.

V. Data Analysis

The subsection data analysis contains a summary of the information products created and the processes that went into them. The process by which the four maps presented in this project were created is discussed and diagrammed to provide step by step evidence of our chosen methods to ensure a level of transparency to our client and to the future audience of this project. This section also begins to look at the problems found in creating these information products, why these information products were created, and how they tie into our clients goals.

The original intent of our group project was to document and look for correlations between polluting industries in the area of coal-fired power plants and health risks in densely populated neighborhoods. The plan was to analyze the health affects within a five-mile radius of power plants within Illinois with the intent to create a foundation for further research into the affects of pollutants from industry on local neighborhoods. In order to answer these questions we needed both the location and bounds of counties within Illinois but also demographic information (such as income level, race, gender, and the total population) which we were able to retrieve most through datasets from the U.S. Census Bureau.

We also needed the actual locations of power plants within Illinois not only to locate the plants within the state but also to create a five-mile buffer around them. This data is included in the Environmental Protection Agency's datasets along with information on pollutants. This is presented as total on-site toxic release for hazardous air pollutants including lead, mercury, and more although not including sulfur, nitrogen, and carbon dioxide. To address health affects we decided to focus on asthma rates (both for children, adults, and also chronic asthma) which are more likely to correlate to air born pollutants which we will be studying. We were able to access this data through the American Lung Association, but we are limited in that we only have data for counties which are considered to be at risk. These datasets, while limited in some aspects, allow us to meet our client's needs to document in Illinois health risks (asthma rates), pollutant output from an industrial site (power plants and some of their relevant chemical output), and creating the foundation for further research (such as locating the data on the earth's surface, like the location of Illinois and its power plants).

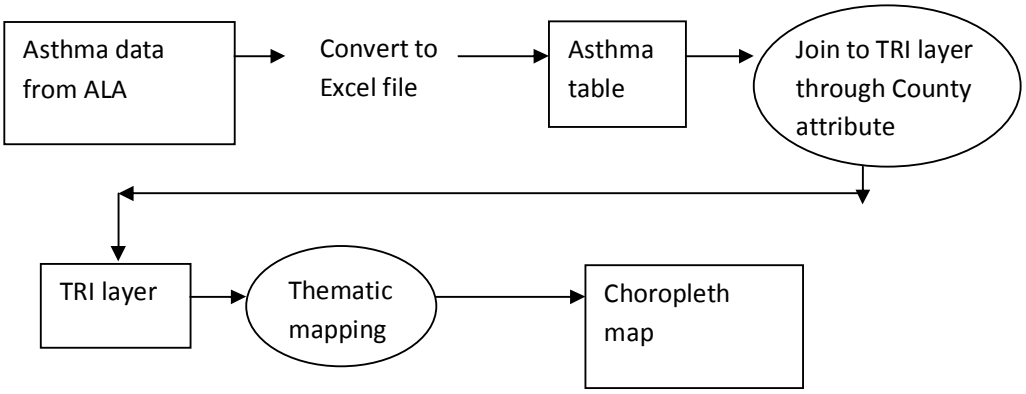
There have been problems that the group has encountered throughout the project. They have resulted from two sources: the lack of correlation between Chicago’s Community Areas and the Census Tracts and determining which type of neighborhood analysis for the South Lawndale [or Little Village] Community Area was meant to be a primary focus of the project. Nevertheless, the group has moved forward in collecting data regarding the American Lung Association’s Asthma Reports and correlating those data to the locations of coal-fired power plants in the State of Illinois and on a smaller scale in the city of Chicago, as well as to the environmental correspondents such as rivers and major population centers which are further detailed on the physical mapping of the group project.

1. Information Products

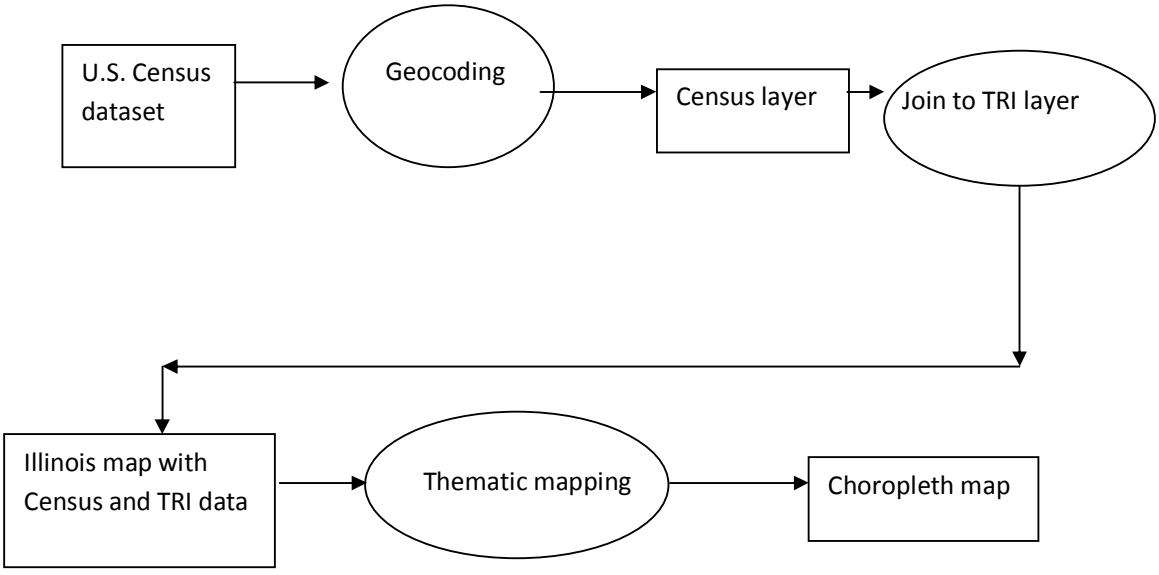
Our original need-to-know question, finding out if there is a relationship between the location of coal power plants and the socio-economic status of communities within a five mile radius, will not be able to be addressed on such a small scale. However, we are able to create

thematic maps representing the location of power plants in relation to the socio-economic status of each county in Illinois with a choropleth map (representing with different colors the economic status of each county) and with proportionate symbology representing the location of power plants. The size of these transparent symbols will also be able to answer our groups other question about the relative size of toxic output per ton from each power plant. In addition, we will be able to represent asthma rates on a separarte map in order to compare it to the other two maps that will reflect the percentage of Hispanics in each county and the percentage of low income according to the median household income in each county. Our maps also will include the textual labeling of some relevant features (such as the Illinois River) that might help for interpreting and contextualizing our findings. Another information product besides the map we can present is the map as a digital foundation for further development both as more data becomes available, and for our client to continue their work in Environmental Justice.

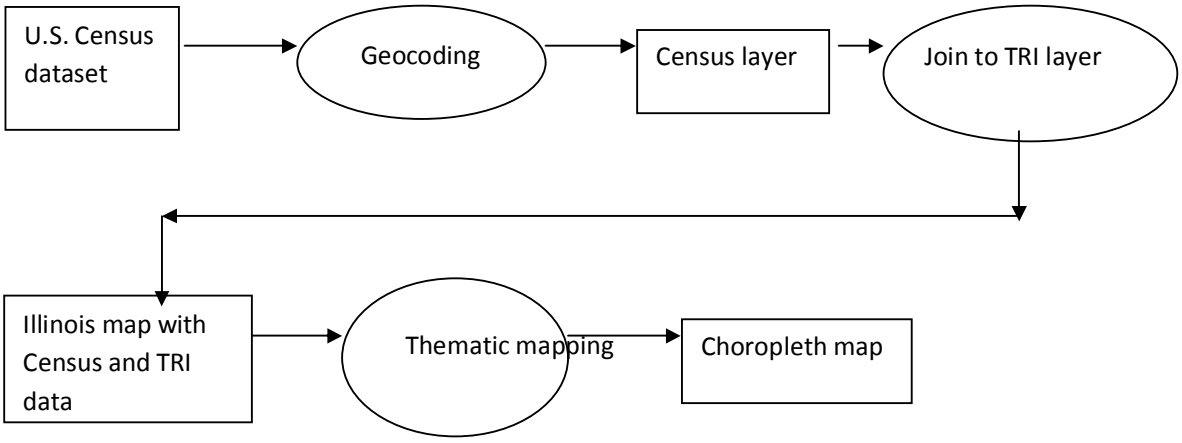
Toxic Release of Coal Power Plants in Illinois and Pediatric Asthma by County



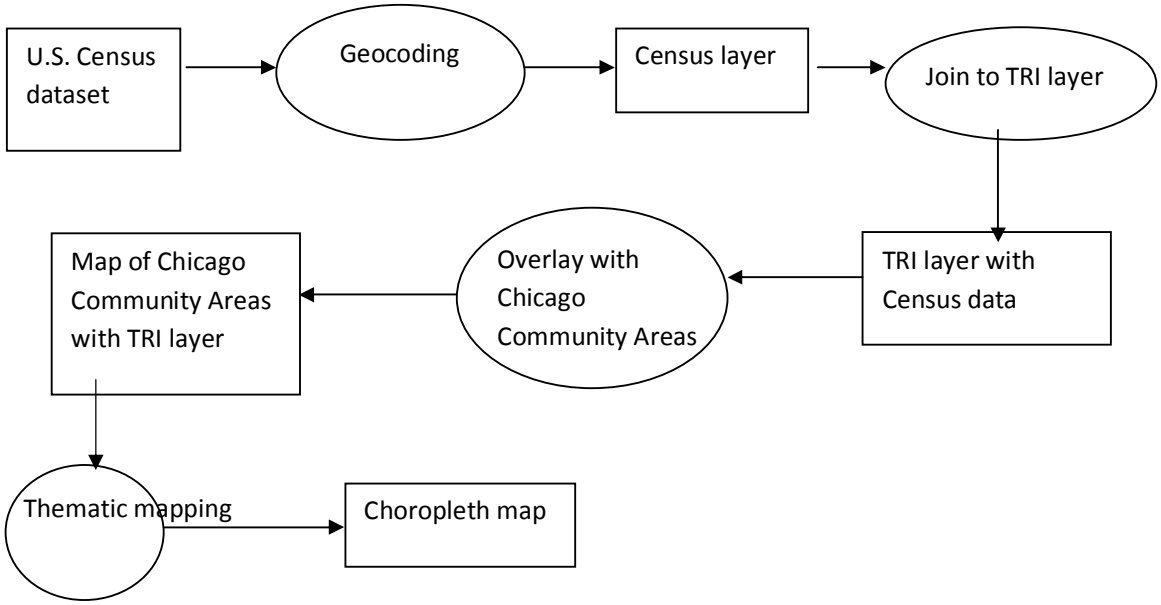
Toxic Release of Coal Power Plants in Illinois and Latino Population by County



Toxic Release of Coal Power Plants in Illinois and Median Household Income by County



Toxic Release Data of Coal Power Plants and Latino Population by Community Area in Chicago



2. Data Visualization

Each of these maps includes a legend, north arrow, scale bar, and title.

- Toxic Release of Coal Power Plants in Illinois and Median Household Income

  This map will be represented as a thematic map through the use of choropleth framework in which counties will reflect the median household income through the use of graduated colors under quantities in the symbology tab of layer properties. Under quantities, the value for this map will be median household income and there is no need to normalize the data because we are not taking a percentage out of the entire population. Rather, we are taking the median household income of each county and represent it according to the where each county's median income lies in the income scale. Also, the data classification for median household income level will be done by natural breaks as it is not arbitrary like equal interval and is based on data distribution. Proportional symbology will be used to reflect the amount of toxic release of each coal power plant. Additionally, we will include features such as rivers and label counties to familiarize our audience with the location of each county and highlight the importance of rivers for coal power plants as it allows to cool off the process of burning coal.

- Toxic Release of Coal Power Plants in Illinois and Pediatric Asthma by County

  This map will be represented as a thematic map through the use of choropleth framework in which counties will reflect the amount of children with asthma through the use of graduated colors under quantities in the symbology tab of layer properties. Under quantities, the value for this map will be pediatric asthma and total child population will be used to normalize the pediatric asthma data. Also, the data classification for pediatric asthma will be done by natural breaks as it is not arbitrary like equal interval and is based on data distribution. Proportional symbology will be used to reflect the amount of toxic release of each coal power plant. Additionally, we will include features such as rivers and label counties to familiarize our audience with the location of each county.

- Toxic Release of Coal Power Plants in Illinois and Latino Population by County

  This map will be represented as a thematic map in which each county will reflect the percentage of hispanics living there through the use of graduated colors. In order to do this, the value for this map will be hispanics and the total population will be used as a form of normalization. Also, the data classification for hispanic population will be done by natural breaks as it is not arbitrary like equal interval and is based on data distribution. Proportional symbology will be used to reflect the amount of toxic release of each coal power plant. Additionally, we will include features such as rivers and label counties to familiarize our audience with the location of each county.

- Toxic Release of Coal Power Plants and Latino Population by Community Area in Chicago

This map will be represented as a thematic, choropleth map in which each Community Area will reflect the percentage of hispanics living there through the use of graduated colors. In order to do this, the value for this map will be hispanics and the total population will be used as a form of normalization. The data classification for hispanic population will again be done

by natural breaks. The coal power plants will be symbolized as before on the map, but they will not be proportional symbols, since the importance here is the location of the power plants.

VI. Results

The information products resulted in four maps that focused on toxic releases in relation to pediatric asthma, latino population, and median household income. Three of these maps focus on the scale of the State of Illinois and one of them focuses on a much smaller scale, dealing with Chicago Community Areas.

This first map showing the cases of pediatric asthma by county throughout Illinois while also placing and measuring the emissions of coal power plants starts to reveal how these power plants can directly affect the air quality, and therefore, the health of an area. It is not an exact correlation, and there are definitely other factors that play a part, but we do see a strong connection between the locations of power plants and the areas at risk for asthma. The northwest part of the state does not have high instances of asthma and likewise does not have any coal power plants. This met our expectations in creating this map and provided a strong basis for our project

Figure-1

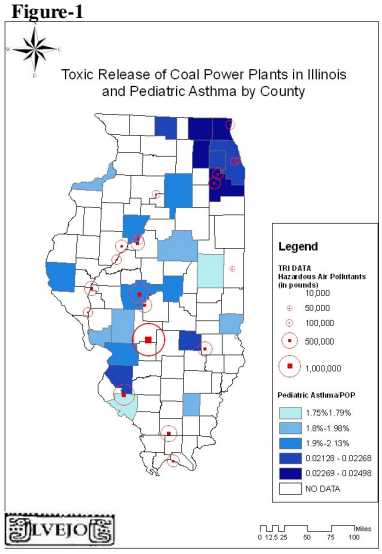
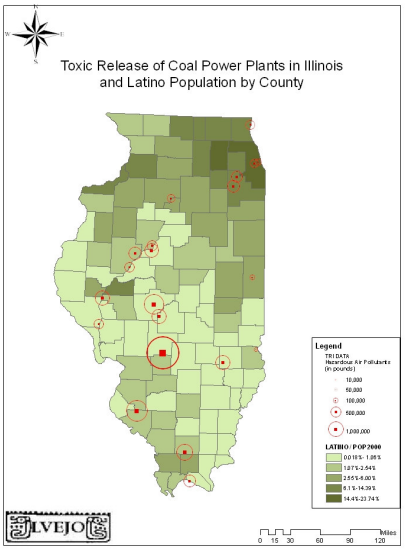
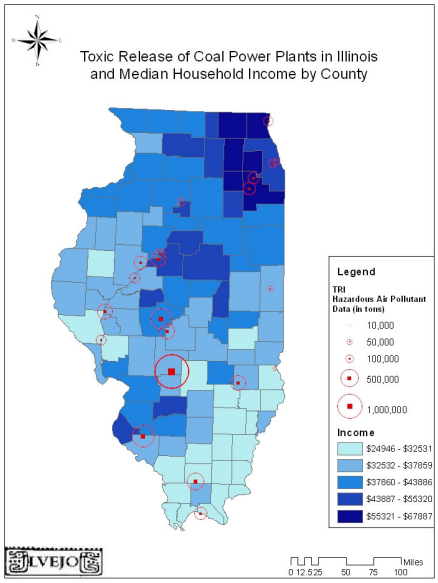


Figure-2



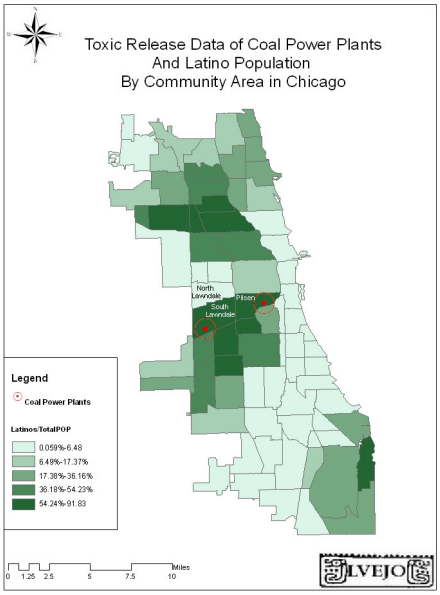
The second map, seen to the left, links together the location of power plants and location of latino populations, tying together the social justice and environmental aspects of this project to find if minorities are at greater risk or not. This map shows some correlation, but the trends here are too diverse to show a single pattern or result. This is unexpected in that we had hoped to find a defined system of minority populations being placed near coal power plants, thus reaping the dubious awards for such a location.

Figure-3



The third map approached the idea that if the coal power plants' locations did not match up with racial injustice, than maybe it is more a matter of economic factors. We worked with the median household income provided by the U.S. census and found a little more definition to the patterns here. Besides the major metropolitan areas that have their incomes skewed by smaller areas of affluence and poverty, there are some correlations between economic standing and the location of power plants. The areas that need power plants, major cities for example, have a higher economic level than the hinterlands, such as the southeast, but the power plants are not placed directly in these areas. The power plant is located in the least affluent area near the city in most cases.

Figure-4



Our final map provides the greatest amount of detail and really shows what we wanted to see. We moved to the Community Area level in place of the county level, and found that within these affluent counties, the power plants are placed in the latino neighborhoods without question. South Lawndale and Pilsen are areas of some of the highest percentage of latinos in the entire country. The county scale was not able to show this level of information. This was the result that was most interesting to our client and to our project. There are dominant trends of toxic power plants being placed within primarily latino communities, causing greater instances of pediatric asthma and health risks.

VII. Conclusions

1. Summary

The Little Village Environmental Justice Organization (LVEJO) has been working since August of 1998 to address public health issues primarily in the southwest side of Chicago (Little Village, Pilsen, and North Lawndale), but is also is also involved in city, regional, and national networks and coalitions. Our project began with LVEJO due to the presence in Little Village of the Crawford power plant. The synchronicity of the largest coal-burning, electricity generating plants being located in an area with 45% of the population living 200% under the poverty level, along with Little Village being the largest Mexican American community in the United States (outside of Los Angeles), and with the youngest population of all Chicago's 77 community area raised questions about whether power plants are disproportionately located within areas of lower socio-economic status and/or minority population.

Our group's project expanded this initial question about whether communities with a lower economic status and/or minority population (specifically Latino) were more likely to have a power plant located in their area from Little Village to the State of Illinois. This not only provided us with more cases to study (which meant that our results were more likely to be representative of a trend as opposed to a singular phenomena within Little Village), but also broadened the relevance of our project to communities throughout Illinois.

The second question raised by the presence of the Crawford power plant was whether or not the location of a power plants in an area is significant, especially in relation to the health of the local population. The assumption of LVEJO was that the release into the air by power plants of chemicals such as Sulfur Dioxide (which causes coughing, wheezing, shortness or breath, nasal congestion, and inflammation and increases infant mortality rates) might have a negative affect on the health of the nearby population.

Instead of only comprehensively researching all the health affects which might arise from the release of chemicals such as Sulfur Dioxide, Nitrogen Oxide, Carbon Dioxide, and Mercury which are emitted from coal burning power plants, we decided to also focus on the incidence of asthma in areas near power plants. This allowed us to better assess the correlation between power plants and hazardous health affects in communities.

Both of our questions, about the placement of power plants and the health affects related to power plants, needed to be approached using GIS since they were fundamentally spatial in nature. Our group succeeded in not only spatially coding data on community and county areas and their median household income levels, the percent Latino population in these areas, the location of power plants along with each power plants' toxic output in tons, but we also managed to present this information in a format which is easily understood and aesthetically pleasing. By creating these maps, along with giving our organization the data sets we used to make them, a major outcome of our project is that we have results which are useful for a variety of applications both by laypeople and those who can use our data to expand or focus our research. A project initially conceived in Little Village has now gone one step further in expanding the scope (and hopefully the impact) of LJEVO's goal of environmental justice.

2. Recommendation for Further Studies

Concluding the project took the effort of the entire group to develop ways and strategies to meeting our intended goals. Over the course of the project, the original goal was changed when faced with the challenge of a lack of resources for completion of the original purpose. Originally, the group proposed gathering data concerning coal power-plant

emissions in two Community Areas in the City of Chicago: North Lawndale and the Lower West Side. This data would be used along with health data found from the American Lung Association regarding asthma rates. Asthma rates were selected because it is a normal effect of air-pollution. Because U.S. Census data is not composed by Community Area and data from the ALA was only composed by zip code the group decided to go the direction of a county-by-county, statewide basis for gathering data. The correlation between socio-economics, health, and coal power-plant emissions would be gathered. Our group met each of those standards while simultaneously converting the projects focus to a broader basis. The goal of the group project at this point was to present the relationship between socio-economics, health, and coal power-plant emissions, along with data comprising Hispanic population rates.

A problem with our methodology was not accounting for the changing production and distribution of data on topics relevant to our project, or rather, that since our project took place over a prolonged period of time that the conditions in which we made certain steps in our project might change after we have moved on to other steps. An example of this was our inability to find asthma data by county early on in our project and moving on, only to find this data at a later date. This was not a serious problem since we were easily able to integrate this information with the data we had already procurred. In future projects we might spend time, if available, in rethinking or re-addressing problems we already deal with earlier in our project. On the other hand, our solution to this issue also indicates how easily with GIS we can add or modify the information products we already have for future work such as adding other minorities, more information on locations such as rivers, major highways, other health affects related to power plants, other toxic emitters besides power plants, or even increasing the scope beyond just Illinois to other states of even the United States. These are just a few examples of the ways in which our project could (and should) be expanded.

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Appendix A

Figure-1

Figurre-1

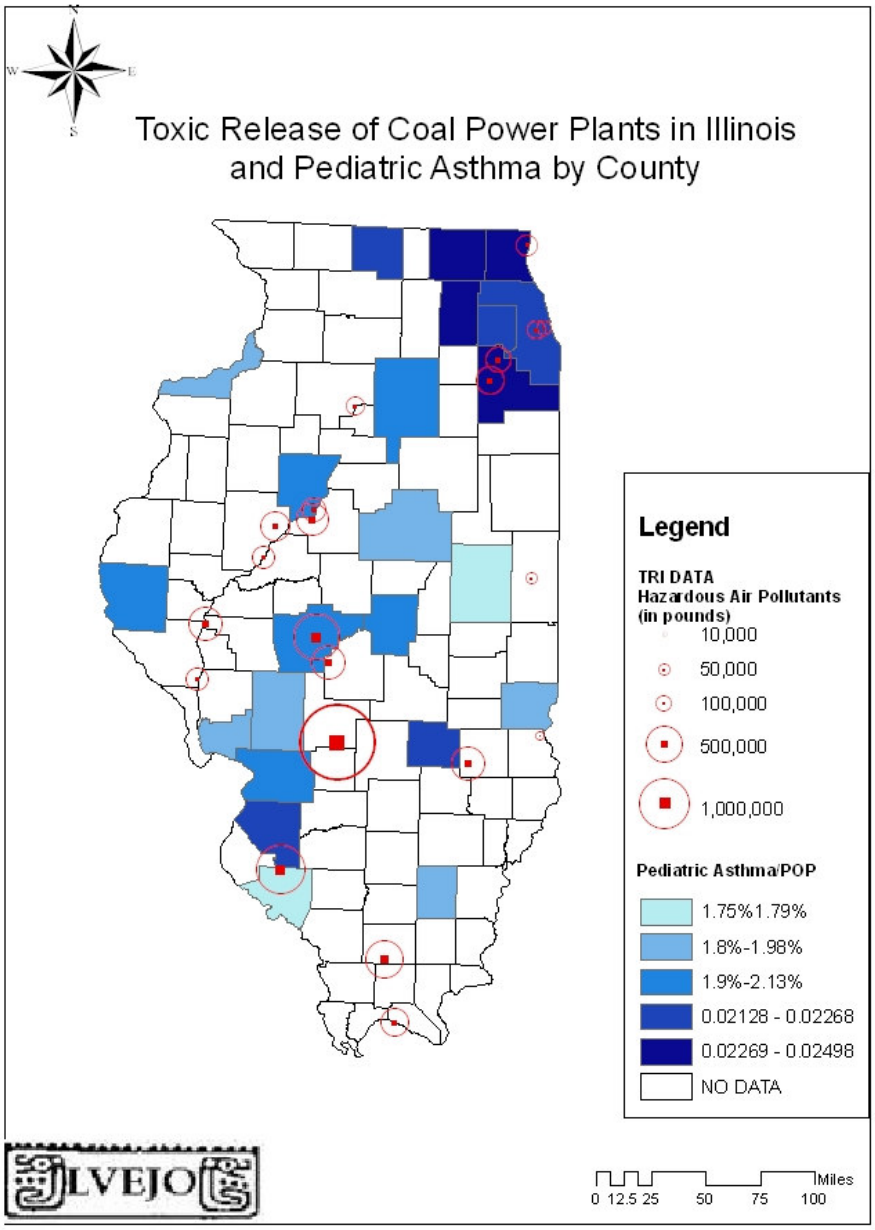

Toxic Release of Coal Power Plants in Illinois and Pediatric Asthma by County
Legend
TRI DATA
Hazardous Air Pollutants (in pounds)
10,000
50,000
100,000
500,000
1,000,000
Pediatric Asthma/POP
1.75%1.79%
1.8%-1.98%
1.9%-2.13%
0.02128 - 0.02268
0.02269 - 0.02498
NO DATA
Miles
0 12.5 25 50 75 100

Figure-2

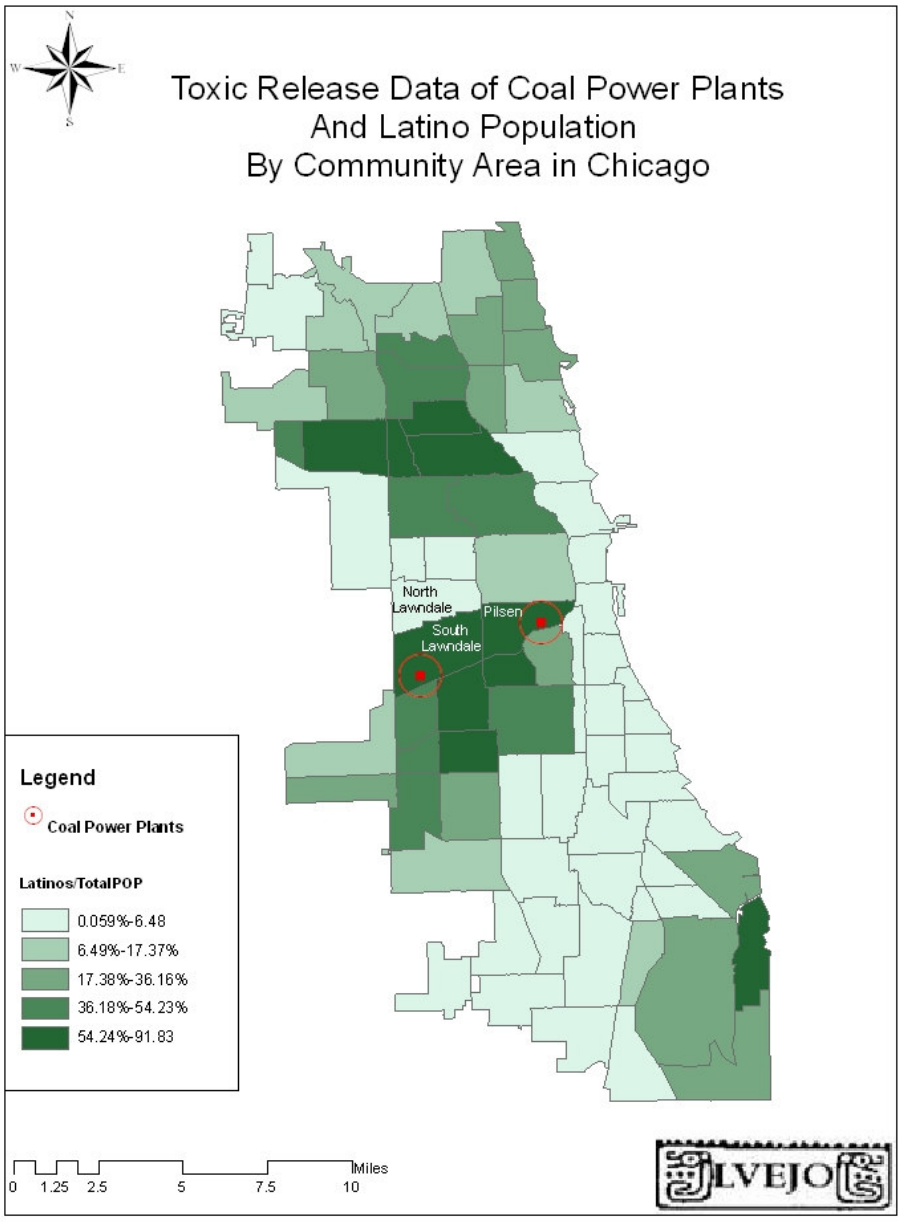

Toxic Release Data of Coal Power Plants
And Latino Population
By Community Area in Chicago
North Lawndale
Pilsen
South Lawndale
Legend
Coal Power Plants
Latinos/TotalPOP
0.059%-6.48
6.49%-17.37%
17.38%-36.16%
36.18%-54.23%
54.24%-91.83
0 1.25 2.5 5 7.5 10
Miles
LVEJO

Figure-3

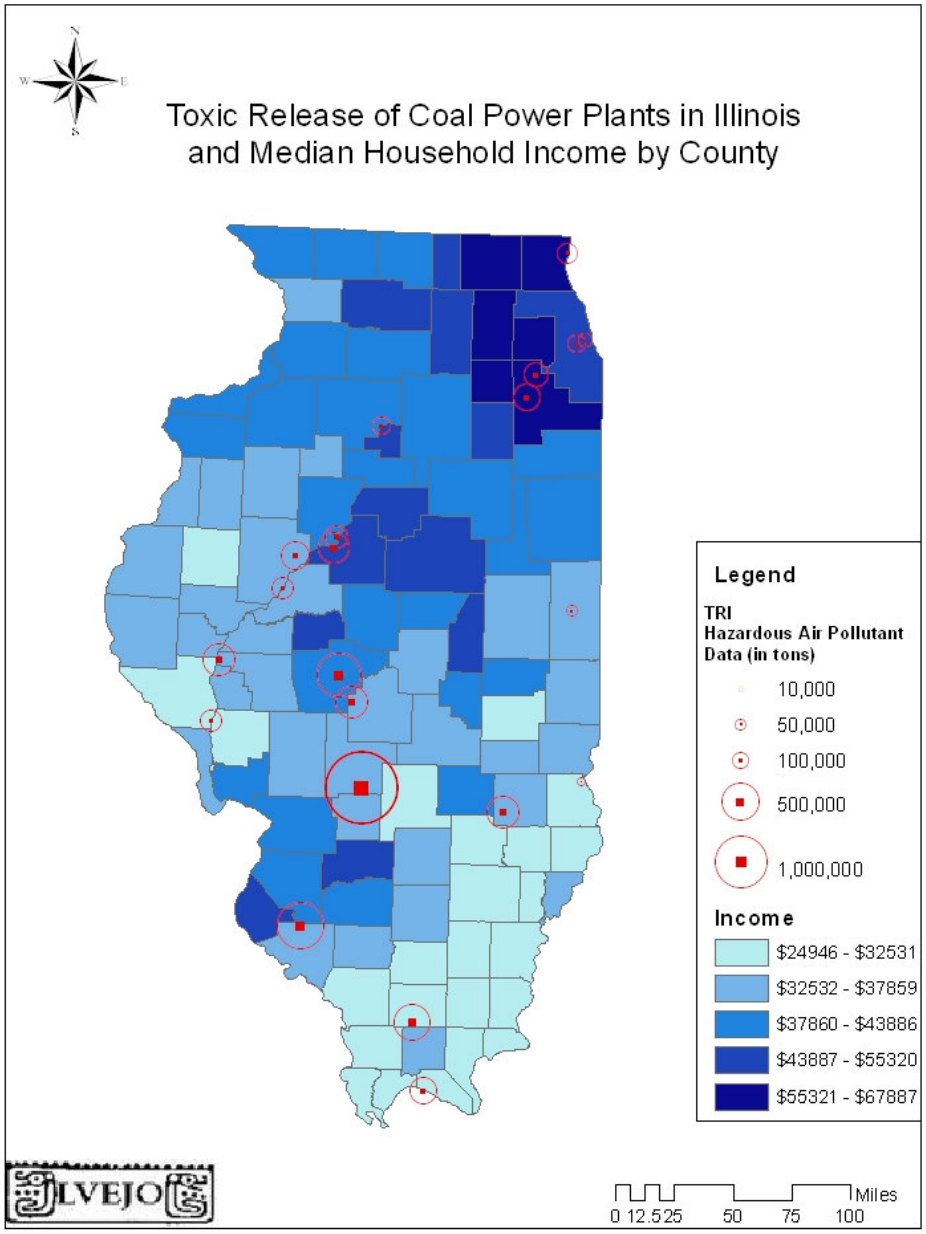
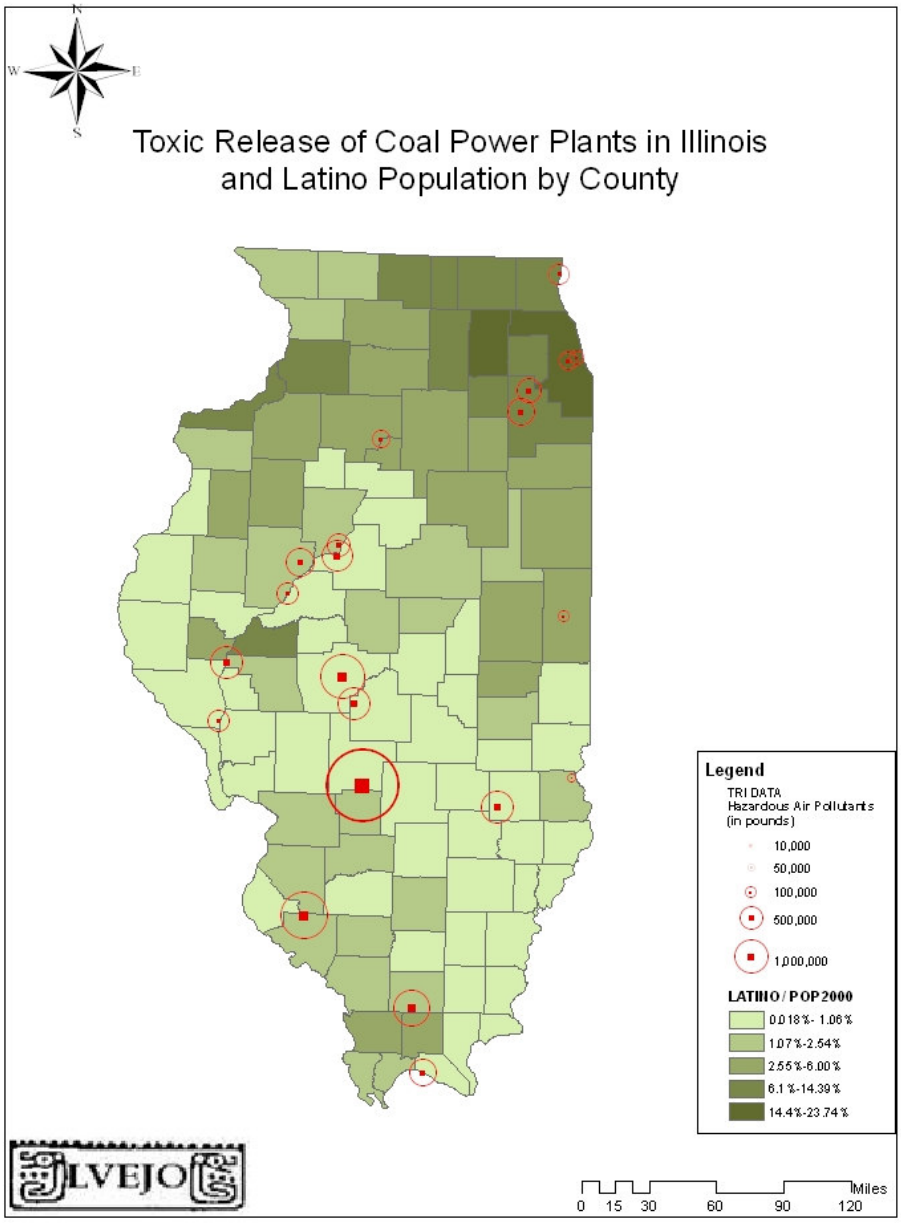

Toxic Release of Coal Power Plants in Illinois
and Median Household Income by County
Legend
TRI
Hazardous Air Pollutant
Data (in tons)
10,000
50,000
100,000
500,000
1,000,000
Income
$24946 - $32531
$32532 - $37859
$37860 - $43886
$43887 - $55320
$55321 - $67887
0 12.525 50 75 100
Miles

Figure-4


Toxic Release of Coal Power Plants in Illinois
and Latino Population by County
Legend
TRI DATA
Hazardous Air Pollutants
(in pounds)
10,000
50,000
100,000
500,000
1,000,000
LATINO / POP2000
0.018% - 1.06%
1.07%-2.54%
2.55%-6.00%
6.1 %-14.39%
14.4%-23.74%
LVEJO
0 15 30 60 90 120
Miles