DISTRIBUTION AND PROCESS OF ENVIRONMENTAL INEQUITY IN THE BRAZOS VALLEY, TEXAS

A Senior Scholars Thesis

by

CHELSEA LYNNETTE HANCHETT

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

April 2007

Major: Environmental Geoscience

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Associate Dean for Undergraduate Research: Dr. Robert C. Webb

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ABSTRACT

Distribution and Process of Environmental Inequity in the Brazos Valley, Texas
(April 2007)

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Lower income and minority communities have long borne an unequal burden of toxic pollution from environmental hazards. I examined environmental inequity, the unequal distribution of environmental hazards in minority and economically disadvantaged communities and the exclusion of community members from environmental decision making, in Brazos Valley, Texas. This project offers a broad review of unequal environmental burdens and marginalization of minority communities as a background to better understand problems in Central Texas. Geographical Information System (GIS) analysis were used to examine the distribution of potential environmental exposures in Brazos Valley, while qualitative methods assessed the role of a case study community (Bryan, Texas) in the environmental decision-making processes related to these risks.

DEDICATION

I dedicate this thesis to all who helped me along the way.

ACKNOWLEDGMENTS

I would like to thank my advisor, Dr. Wendy E. Jepson, for her invaluable assistance with this project. It would not have materialized without her patient guidance. Also providing technical assistance to this project are Dr. Andrew G. Klein, Dr. Hongxing Liu, and Bing Sheng Wu. Additionally, Dr. Vatche Tchakerian and Cathy Littleton deserve recognition for encouraging me to apply to this program and pursue undergraduate research.

I would also like to thank my parents, Robert and Lorna Hanchett, for their continual love and support and my friend Whitney Spann for her assistance in driving around Bryan taking pictures with me.

NOMENCLATURE

BBC	Bryan Business Council
BEAN	Brazos Environmental Action Network
BTU	Bryan Texas Utilities
CDSD	Community Development Services Department
EPA	Environmental Protection Agency
ESD	Environmental Services Department
ESRI	Environmental Systems Research Institute
GIS	Geographic Information Systems
HUD	Department of Housing and Urban Development
NIEHS	National Institute of Environmental Health Sciences
RCRA	Resource Conservation and Recovery Act
SIU	Significant Industrial User
TCEQ	Texas Commission on Environmental Quality
TWC	Texas Water Commission
TWQB	Texas Water Quality Board
TRI	Toxic Release Inventory
TSDF	Toxic Storage and Disposal Facility

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CHAPTER I

INTRODUCTION

The purpose of this study is to determine if environmental inequity exists in the Brazos Valley, an area that has not been subjected to an environmental equity study. The area is a rural county, buffered by other rural counties, with the exception of the urbanizing Cities of Bryan and College Station. Brazos Valley was chosen as the study as a way to illustrate how the university can contribute to and enhance understanding of the larger community. A combination of quantitative and qualitative methods was employed, including the use of Geographic Information Systems (GIS) technology allowed for spatial and statistical analysis. The inclusion of mapping non-traditional, non-registered hazardous sites allowed for a more comprehensive assessment of hazardous sites in the GIS. Additionally, using multiple data sources allowed for the development of a "hazards of place" model to guide statistical analysis and provide a more complete picture of risk in the community. Using these quantitative results, a site was selected for an in-depth case study in Bryan, Texas. Archival research of newspapers and legal databases was combined with interviewing stakeholders in Bryan. The combination of methods led to a richer study of the distribution and process of environmental inequity.

Environmental inequity is the unequal distribution of environmental hazards in minority and economically disadvantaged communities as well as the exclusion of those

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This thesis follows the style of *Annals of the American Association of Geographers*.

community members from environmental decision making (Bullard 1992, Cole and Foster 2000, Cutter 1995). There are two clear in environmental inequity research. The first is the use of GIS to map potentially toxic hazards and analyze the distribution of hazards and health threats to demographics (Glickman and Hersh 1995, Maantay 2002). Additionally, the second is the use of local knowledge, when the academic community collaborates with community based researchers (Corburn 2005, O'Fallon and Dearry 2002). Knowledge is produced that integrates the expertise of both counterparts- the place-based knowledge informs disciplinary knowledge resulting in an understanding of environmental risk and equity that is co-produced. The intent of this literature review is to situate the study in a wider body of environmental justice research, paying particular attention to the development of a GIS analysis of Brazos Valley for spatial assessment and political and participatory opportunities in siting decisions. The body of environmental inequity research is broad, and thus, only the most pertinent articles are reviewed within the scope of this paper.

Understanding Environmental Inequity

While sounding similar, environmental equity is a facet of the environmental justice framework. It is the term that is favored in this study, as it is less politically charged than the more popular term of environmental justice. Equity implies "an equal sharing of risk burdens," whereas justice "connotes some remedial action to correct an injustice imposed on a specific group of people" (Cutter 1995). Environmental equity aims to balance environmental risk throughout the environment, or eliminate them.

Cutter defines multiple types of equity, clarifying them as generational, social, procedural, and outcome (1995 114). Environmental laws ensure generational equity, such as the Clean Air Act, which protect future generations from pollution incurred today. Future generations will have the same access to natural resources as present ones, as long as these laws are actively enforced. Social equity depends upon factors within society, such as economic class, social status, gender, and race; these factors influence the degree of access to resources that members of a society possess, such as a clean environment. Additionally, this type of equity considers the role that societal factors play in resource consumption and distribution. With the country's long history of marginalizing the lower income and minorities, social equity is a problem that remains visible even after years of attempted reforms.

Cutter also examines two key concepts of equity that are pertinent to this study: (1) process equity and (2) outcome equity. The concept of process equity ties into the long-running argument of the role discriminatory intent has in environmental equity, also known "the chicken versus the egg" problem. This problem inspects how environmental equity develops, whether a potentially toxic facility is built in a minority neighborhood, or if minorities relocate to an area with the same facility, due to lower property values or unfair housing practices. It seeks to examine the reasons behind environmental inequity, like how past decisions or conditions impact current conditions (Cutter 1995). For example, real estate market dynamics or restrictive zoning limit the residential choices of minorities and lower income classes have to live (Cole and Foster 2001). Outcome equity refers to the spatial distribution of environmental hazards and how they are connected to social characteristics and demographics (Cutter 1995). While Cutter illustrates that outcome equity analysis encounters problems, such as inability to compare past studies due to disputed statistical methods or to draw conclusions due to simple coincidence of social indicators and hazards, it remains an important approach to assessing distributive justice. Distributive justice is when a group of individuals experience heavier environmental burdens than the rest of the general population, resulting in benefits to the other group and how benefits and drawbacks are distributed throughout society (Figueroa and Mills 2001).

Process equity is often paired with participatory justice, which seeks to determine how environmental decisions are made in a community (Figueroa and Mills 2001). Is a community involved in the input stages of the construction of facilities, or is it shut out? Are community members even invited to meetings where decisions will be made concerning the fate of the area, or is it a private meeting? These questions must be asked because too often in the past and continuing into today, community members in numerous locales have been denied the right to participate in democratic decision making processes (Cole and Foster 2000). Indeed, institutional racism, which consists of measures built into societal structures that denied minorities rights such as voting, still exist today. While Jim Crow laws, which stifled minorities' rights, including public segregation and poll taxes, and the Supreme Court's 'separate but equal' have been overturned by the Civil Rights Act of 1964, nstitutionalized racism still lingers in the way minorities access bureaucracy, especially due to many neighborhoods remaining selectively segregated (Figueroa and Mills 2001). An example of this deliberate racism in a current context is a report by Cerrell and Associates in California which encouraged industries and local governments to locate garbage incinerators in certain types of communities that were more likely to be politically disenfranchised. The characteristics cited included small, rural, poor, or Catholic communities, ones where residents had low levels of education, and areas that relied on agriculture or mining (Cole and Foster 2001).

The southern United States is particularly at risk for incidences of environmental inequity due to its history of slavery, as well as being the home to the country's majority of African Americans (Bullard 1992). Additionally, other changes in the South made the region very attractive to businesses, including inexpensive and plentiful labor and land (often in minority communities), weak unions, and weak environmental laws (Bullard 1992). These factors lead to a boom in polluting industries locating in the South. Communities were consulted in many cases of industrial development; however, in their haste to spur economic development, they agreed to host dirty industries. Enticed by the prospect of jobs, increase in tax revenue, and other perks, such as donations to schools or civic organizations, they signed over their right to live in a clean environment. This is known as environmental blackmail (Bullard 1992). The leaders of these communities face the dubious choice of no development or dirty development. Often, high unemployment is present, and leaders choose the option that will somewhat relieve it. However, once polluting industries take root in a community, other cleaner industries are less likely to settle there, trapping the area in a cycle of toxics.

Community-Based Knowledge

Local knowledge is defined as “knowledge that does not owe its origin, testing, degree of verification, truth, status, or currency to distinctive… professional techniques, but rather to common sense, causal empiricism, or thoughtful speculation and analysis” (Lindblom and Cohen 1979). It includes “information pertaining to local contexts or settings, including knowledge of specific characteristics, circumstances, events, and relationships” within a community (Corburn 2005). The focus on the involvement of the community in public health issues has been present since the nineteenth century. Gaining momentum with the Settlement House movement, the most well know example was Hull House led by Jane Addams and associates in Chicago. Workers with Hull House kept notes with information garnered by conversations with community residents and then applied this knowledge to improve and tailor future programs. They also put the burden of collecting knowledge in the hands of those in the community, “encouraging community residents to record and share their experiences with others in the community, the general public, and decision makers” (Corburn 2005). These methods lost popularity until the mid-twentieth century, with the advent of such events like the release of Carson’s *Silent Spring* in 1962 and the passage of the Medicaid and Medicare Act in 1965, which again popularized tying together the health of a community with the processes that occurred in it (Corburn 2005).

The rediscovery of collaborating with locals has led to the use of street science and co-production of knowledge in communities that may otherwise have not been studied. Co-production of knowledge requires an exchange of information, rather than just the one way process of reporting that occurs at meetings and hearings. It can be seen that while the procurement of local knowledge requires community participation, not all elements of involving the community will result in co-production. The aforementioned methods are tied together, as they link the academic community to the local one. Resources, including materials and people, are pooled from each sphere, resulting in findings that could not have been found with simply one method or the other (Corburn 2005). This method of conducting research leads to results that are relevant to the lives of those researched.

Some governmental agencies, such as the U.S. Environmental Protection Agency (EPA) and the National Institute of Environmental Health Sciences (NIEHS), have adopted the practice of procuring local knowledge. NIEHS has developed a community-based participatory research methodology, with six guiding principles. These principles include the encouragement of active participation at all levels of research and co-learning between researchers and the community, guidance of the community in selecting environmental health issues for study, production of meaningful results, adaptation of research methods to the culture of the community, and the definition of the "community as a unit of identity" (O'Fallon and Dearry 2002). Following these guidelines may not ensure success of the project, but it helps to define the goals and expectations of researchers and the community. Community-based participatory research requires a high degree of communication between the two, but with effort, can lead to many benefits, including the collection of higher quality and relevance of data collected and the establishment of research and community organizational infrastructure. This could result in future research and continued collaboration (O'Fallon and Dearry 2002).

In 1992, the EPA established the Office of Environmental Justice to assess how the federal government enforced environmental regulations. In 1994, environmental equity was further institutionalized when President Bill Clinton signed Executive Order 12898, which held the EPA accountable for the equitable distribution of federal program money in minority and low-income communities. Moreover, this order requires the agency to draft a plan for reform (Petrie 2006 474). Executive Order 12898 requires community involvement in the remediation of a site on the Superfund National Priorities list and is documented in EPA Records of Decision, which detail methods of remediation to be used. The community is engaged by keeping the citizens informed of developments at the site by comment meetings and public hearings, where the EPA listens to and addresses community concerns (Petrie 2006 475). However, the partnership between the community and the federal government can fail when there is a feeling of mistrust on the behalf of the community. Some minorities, ethnic or racial, may not trust the government, due to past or current failings, including faulty information and personnel issues (Petrie 2006 476). An effort must be made by governmental representatives to repair injured relationships by producing positive results for these communities in a timely manner.

Environmental Justice in Texas

Cases of environmental inequity within the state of Texas are known but understudied. Four examples illustrate the diversity and extent of environmental equity issues spanning in the state. The studies address problems, including municipal waste disposal siting issues in Houston, agricultural waste storage in northeast Texas, petrochemical plant emissions on the Gulf Coast, and limited access to water in the Texas colonias (peri-urban, underserved subdivisions dominated by low-income, Mexican American households).

Bullard investigated claims of unequal siting of municipal waste in the African American communities of Houston in 1978. He found that all but two of the city's seventeen privately and publicly owned waste disposal facilities were located in African American communities. Not just lower income communities were targeted; Northwood Manor, a middle income neighborhood, played host to a garbage dump. The study was a part of a class action lawsuit filed by African American homeowners against Southwestern Waste Management, Inc. and began Bullard's lifelong commitment to investigating environmental justice claims (Bullard 1992). One of the first publicized cases of environmental inequity, the methods pioneered in this study were later used by others hoping to rectify environmental justice in their communities. From this project, Bullard began to develop the concept of environmental racism, a prominent theory in the body of environmental equity research.

Winona, a small town in the northeast of Texas, is rooted in agriculture where farming and ranching is the primary industry. A new industry moved in the early 1980s, owned by the American Ecology Environmental Services Corporation. This company planned to build salt water injection wells for waste disposal purposes. Instead of this environmentally accepted practice, untreated waste was dumped into deep wells. Contamination of the aquifer used as the town's water supply resulted. Members of the community began experiencing a myriad of unexplained symptoms, such as aches, nosebleeds, vomiting, and shortness of breath. Clusters of rare cancers developed. In response, Phyllis Glazer developed Mothers Organized to Stop Environmental Sins, which protested the company's willful negligence and the government's willingness ignore the problem. Through picketing at the site and talking to the press, among other measures, their organization was able to prolong the lawsuit against the company to where it closed due to loss of revenue (Glazer, Flukinger, Hargrove, Legator, and Cromer-Campbell 2006).

Finally, an environmental problem that is gaining recognition is the plight of those that live in colonias along the Texas-Mexico border. A colonia is an unincorporated community that often lacks basic resources, such as a water and sewer system, and can feature substandard housing. They grow alongside Texas cities with sister Mexico cities, like El Paso and Ciudad Juarez or Brownsville and Matamoros. Border residents face many environmental risks, including untreated sewage entering the water, unauthorized garbage dumping on the land, and pesticides contaminating the land, air and water. People are mainly employed in agriculture and at maquiladoras, which exposes them to chemicals used in those industries. (Schmidt and Scott 2000). The amount of multiple exposures that colonia residents face is large and is compounded by the lack of cooperation between the United States and Mexico in environmental affairs

Over the past twenty years, the realm of environmental equity research has developed into a respected field with a wide variety of methods utilized. It encompasses both qualitative and quantitative methods in its use of GIS mapping and databases, combine with community based knowledge garnered through interviews. While the aspects of environmental equity continue to be redefined and renewed, it will remain a presence in multiple disciplines for years to come.

This thesis adds to the body of environmental equity work conducted in the state of Texas. It also takes a novel approach to selecting a study site, using spatial analysis of hazardous sites in order to select an area for a qualitative case study. Methods such as this have not been seen in the literature thus far.

The next chapter of the thesis delineates the methods used in the quantitative and qualitative components of the study, while chapter three features the results from these components. Discussion of the implications from the obtained results comprises chapter four. The ultimate chapter summarizes the thesis and details the need for vigilance by the government and citizens to prevent future cases of environmental equity.

CHAPTER II

METHODS

Analytical Parameters

When reviewing the methodologies of past studies, it is important to remember the evolution and refinement of the GIS infrastructure in the United States since 1980. As the personal computer rose in prevalence, software packages were created in order to manipulate spatial data. Over the past twenty years, GIS technology has been used to investigate different aspects of environmental equity. An entire spectrum of environmental risks has been investigated using quantitative data input into a GIS. There are three main types of studies based on the site data used. The first, the most prevalent in the field of environmental equity, focuses on static sites of industrial pollution (Been and Gupta 1996, Maantay 2002, Saha and Mohai 2005). Next are the studies that focus on the transportation networks that border or divide area of study, such as highways and railroads (Jacobson, Hergartner, and Louis 2004). Finally, and related to the second facet, there are the studies of air pollution's effects in disenfranchised communities (Fisher, Kelly, and Romm 2006).

Many environmental justice studies examine the current implications of inequity due to the siting of hazardous waste facilities. These inquiries seek to determine if environmental equity currently exists in the study area; this method is known as cross-sectional analysis (Mohai and Bryant 1992; Bullard 1995). Others, however, study the effects of a facility since the inception of its siting, known as longitudinal analysis (Saha and Mohai 2005). This process observes the impact of a facility in a community and the changes in demographics over time in order to determine if discriminatory intent was present when the facility was built (Been and Gupta 1996; Pastor et al. 2001). Groups often considered at risk include any racial or ethnic group that is not Caucasian and people who rent their dwelling. For the purposes of this study, inequity is defined as a percentage of any at risk group in a buffer zone that is above its respective county average. A site will be considered equitable if at risk populations are less than or equal to the county's numbers (Glickman and Hersh 1995).

The "hazards of place" model examines the "vulnerability and multiple hazards in a place [and] encompass both biophysical and social vulnerability" (Cutter et al 2000). This model recognizes that multiple environmental risks are present in everyday life and often overlap. When only a single hazard is chosen to study, this leads to a misrepresentation of the actual degree of exposure. By mapping a large variety of environmental hazards, it gives a more complete description of the level of risk within a community. This concept was adopted within this project using Hemmerling and Colten as a model (2004).

A buffer placed around the facility will analyze areas within the confines of the boundary, known as buffer containment. Multiple types of buffers exist for different kinds of analysis; care must be taken to choose the type of buffer that will best represent the dispersion of pollutants. Doughnut buffers consist of concentric circles with varying radii (DeMers 2002). It is useful for illustrating intensity of exposure in a simple way, especially when creating maps for public use, as it is easy to conceptualize. However, doughnut buffers can be limiting in their generality. Some hazardous substances may only have an effect on a population that is within yards of the facility, while others may be so toxic that it affects people up to several miles. Based on the literature, the doughnut buffer is the most common in environmental equity research (Glickman and Hersh 1995, McMaster et al. 1997, Chakraborty and Armstrong 1997, Neumann et al 1998, Sheppard et al. 1999). Next is the irregularly shaped plume buffer based on several factors, including local weather conditions, topology, and the type of hazardous substance released from the facility. The construction of this type of buffer requires calculations that combine all variables and can be complicated. However, it provides a better model of the dispersion of pollution than a doughnut buffer. Most likely due to the complexity of implementing it in a GIS, the plume buffer is seen in remarkably fewer studies such as Glickman and Hersh (1995) and Chakraborty and Armstrong (1997), who use it to model air pollution from hazards.

Related to buffers is the concept of centroid containment, where the center of density of the spatial unit is calculated using population data. Only spatial units with a centroid inside the confines of the buffer are counted for exposure purposes (Mennis 2002). A centroid is easy to calculate when the polygon is simple, such as a rectangular census tract. However, since not all tracts are regular and may have many sides, the calculations can become complex (2002). This is the least common type seen in the literature (Neumann et al. 1998).

Data Sources

The narrow scope of this project necessitates a small temporal window. Data from the 2005 United States Environmental Protection Agency (EPA) Toxic Release Inventory (TRI) and Toxic Storage and Disposal Facilities (TSDF) registry was used, as well as active and historical Superfund sites. Other data sources include the most current listing of registered dry cleaners and any waste transfer station in operation, which was garnered from the Texas Commission on Environmental Quality (TCEQ) website. Only current listings in the telephone directories were used for non-registry environmental hazards.

The federal government maintains several databases of industrial and commercial sites that release chemicals or other waste into the environment, whether by planned or fugitive emissions. These databases are the TRI, TSDFs catalogued by CERCLA, and Superfund sites, all accessible online at the EPA website (www.epa.gov). Superfund is the common name of the Comprehensive Environmental Response, Compensation, and Liability Act, enacted by the US Congress in 1980, as a response to the environmental degradation in Love Canal, New York. The revenue from chemical and petroleum industries funds environmental remediation. Contaminated hazardous waste sites are entered in an EPA registry for removal or remedial actions (U.S. Environmental Protection Agency 2003). Many studies include Superfund sites as a part of their analysis because it is considered to be a consistent source of information that is available on a national level (McMaster et al. 1997 and Sheppard et al. 1999).

The Resource Conservation and Recovery Act (RCRA) was created in 1976 and amended in 1984 and 1986. Its purpose is to monitor active TSDFs from the creation of the waste until disposal. The EPA's Office of Solid Waste administers this policy through issuing permits to TSDFs and relies on a system on biennial reporting. Hazardous, municipal and industrial waste is tracked (U.S. Environmental Protection Agency 2006_A). Again, since this data is disseminated by the government for public use, several studies use TSDF sites as a part of their analysis (Been and Gupta 1996 and Boer et al. 1997).

The TRI, mandated by the Emergency Planning and Community Right to Know Act of 1986 (EPCRA), increased in scope by the Pollution Prevention Act of 1990. Public and private industrial facilities provide information concerning toxic chemical releases and waste management practices, then compile data into an accessible format. These entities self-report biennially to the EPA. Facilities included are those where hazardous wastes are created, collected, stored, treated, or disposed; only active sites are required to report current activity. 650 chemicals are reported and include known persistent, bioaccumulative, and toxic chemicals (PBTs) and carcinogenic compounds (U.S. Environmental Protection Agency 2006_B). Since the TRI is a consistent, established database, many studies use TRI sites as a dataset. (Perlin et al. 1995, Centner et al. 1996, and McMaster et al. 1997).

Additional sources must be used to gain a larger perspective on multiple exposures and the distribution of environmental hazards in a community. Data from non-registered sites, such as auto-body welding shops, on-site drycleaners, electroplating facilities, and waste transfer stations, need to be incorporated into the database, although it is hard to find a comprehensive listing (Mantaay 2002). These facilities are uncommon in environmental equity because they do not produce enough waste to report to state and federal agencies, although they may be required to have a permit (Maantay 2002).

Auto-body welding shops can release hydrocarbons and isocyanates from paints, chromium from metal plating, and silica from sandblasting, which can escape into the environment. Silica is a known carcinogen (particularly lung cancer) and can cause chronic bronchitis and scarring of tissues due to inhalation of the substance (National Toxicology Program 2005). Isocyanates can cause asthma, toxic pneumonitis, scarring of the tissues, and sensitization of the skin due to inhalation and surface contact. The processes used in on-site dry cleaning can release hydrocarbons, such as perchloroethylene, into the soil (US OSHA 2004). Perchloroethylene is a probable carcinogen and suspected liver, kidney, neurological, and reproductive toxicants. Trichloroethylene is another solvent used in dry cleaning and is classified as a liver toxin and a probable carcinogen. Exposure to both of these chemicals is though inhalation and skin absorption (National Toxicology Program 2005). Small waste transfer plants are a problem because household and industrial waste can easily escape when in transit, or when loaded and unloaded at a processing facility.

Telephone directories provide contact information accessible by industry. The online directory sponsored by Southwestern Bell (www.switchboard.com) was used to look up sites by industry and zip code, as well as a traditional telephone book that encompasses all areas of study. Each facility's physical address and description was included in the database, which was compiled in Microsoft Excel using the dBase IV format.

The availability of US Census data has made collecting data about community populations simple. The agency collects basic demographic data such as race, ethnicity, income, age, and number of dwellings that are renter occupied. However, a drawback of US Census data is that it is collected every ten years, in which the demographics and the subsequent face of a community can rapidly change. If the study site is at a coarser scale of analysis, such as a city or region, data from local governments can be used, such as from public health departments (Maantay 2002).

While beyond the scope of this study, it is important to note other methods that are used for data acquisition at the local level include community health surveys and air pollution tests. Community health surveys help researchers catalog medical problems experienced by residents, such as asthma and cancer. These surveys do not have to be completed by medical professionals, but by community activists who have attended workshops training them in this method. This makes it a very attractive tool to those trying to build their bank of local knowledge. Using this dataset, researchers can detect clusters of illnesses that may be caused by exposure to pollution and environmental hazards (Lerner 2005). Another method that is popular among community activists is sampling of air in a community with an environmental hazard present. They construct a piece of equipment that takes a sample of air and can be made for a small sum of money. On days when air quality is evidently bad, activists take a sample of the air and also take note of any present qualities of the air, such as smell, taste, or color of smoke or haze. These samples are then tested in a laboratory for chemicals (Lerner 2005).

Spatial Unit of Analysis

Environmental justice research requires analysis at a defined spatial unit. However, different units yield different findings, such as the existence of environmental equity (Cutter 1995). This problem is known as the Modifiable Area Unit Problem (Openshaw 1983), the problem of applying aggregated data at a single level of analysis different from the level of aggregation. This can interfere with results. Finding the appropriate scale for research can be difficult, as a county or zip code may be too large to produce meaningful results. Also, if the researcher is conducting a longitudinal analysis, certain pieces of data may only be available at coarser scales, such as average family income (Most et al. 2004). A smaller scale of analysis may not improve an analysis because essential data may not be available. The U.S. Census Bureau does not publicly release any data below the block level and does not release financial information below the tract level, two important datasets to determine environmental equity. Additionally, a spatial unit also depends on one’s conceptualization of community, as there are varying personal definitions of what constitutes a community, some of which do not fit into a discrete spatial division.

There are three operational definitions of community (Williams 1999). The first, political jurisdiction consists of boundaries drawn by the state, such as counties or cities. Neighborhoods are the second type of spatial unit used in research, defined by homogeneity in race or ethnicity, in addition to other factors, such as education and income. A neighborhood does not have a set size; it can be very small or large, encompassing some or all of other spatial units like census tracts. Also, a neighborhood changes over time, making longitudinal analysis harder, as the population's characteristics may change over the years, thus changing the neighborhood. Finally, there are data constructs that can be used for spatial analysis, including zip codes and census designated boundaries, but have little meaning in terms of the jurisdictional relations of a community.

Boundary effects offer another spatial problem. Spatial coincidence analysis assumes that risk is uniform across a spatial unit where a hazard is present. However, this does not take the hazard's positioning within the spatial unit into account. The hazard could be located near the border of another spatial unit, placing that population at risk as well (Mohai and Saha 2006).

The level of analysis used in this study is the census block, the finest level of data that is offered by the U.S. Census to the public (Hemmerling and Colten 2004). The data was obtained in shapefile and database formats from Environmental Systems Research Institute (ESRI) at their website (www.esri.com). Other features such as roads also were downloaded from this source. The area of study includes Brazos County, subtracting the distorting factor of College Station, due to its student population. Students can influence the data, due to their tendency to rent properties and have lower incomes, while not being victims of environmental inequity. This presents the potential to interfere with the results, leading to erroneous conclusions. Additionally, counties that share a border with Brazos County are included in the analysis, in order to include any influences on neighboring census tracts that transcend geographical boundaries. These counties are Burleson, Grimes, Leon, Madison, Robertson, and Washington.

Creation of the GIS

Several data sets were constructed. The first consisted of government registered sites: the EPA's Superfund site listing, the 2005 National Biennial Report on TSDFs, and the 2005 TRI. All Superfund sites in the area of study were included, whether the status was active or archived. No TSDFs were found in the study area, using the state level report listing all TSDFs in Texas. In order to be included in the data set, TRI sites had to have reported any kind of emission of waste. If the company only filed for a permit, but did not report any emissions, the company was excluded from analysis. Two additional datasets were constructed using the TCEQ registry on permits awarded to onsite dry cleaners and waste transfer stations. The next dataset was constructed from telephone books. Two sources were used: an online telephone registry hosted by Southwestern Bell and a hard copy compiled by the Associated Publishing Company, White Directory Publishers, Hearst Holdings, Inc. The *Brazos Valley Area-Wide Phonebook* covers all counties included in the study. Entries listed under "Auto Body Repairing & Painting," "Auto Customizing," "Metal Fabricators," and "Metal Finishers" that fit the geographical criterion were included in the database.

The base map was created using data available from the U.S. Census. Shapefiles of the census blocks in the area of study were downloaded from the ESRI website. The original data was in the TIGER/Line file format, which ESRI converted into a format compatible to ArcMap. Line features, including roads, railways, and waterways, were also downloaded in a shapefile format from the same sources. This data was then converted to an appropriate, consistent datum and projection in Arc/INFO and loaded into ArcMap 9.2 Since the city of College Station is a distorting factor, it has been excluded from this analysis. Any census block that is contained by or intersects the city limits of College Station has been eliminated from the base map. This was done by selecting by location and selecting manually any block that met these criteria.

Using the databases, the hazardous sites were entered into the base map created in ArcMap. Physical addresses were converted into geographic coordinates through the use of address geolocation using the Google Maps application programming interface http://perso.orange.fr/universimmedia/geo/loc.htm). The geographic coordinates were written into a point file and then built into a shapefile using Arc/INFO.

Buffer Use in Study

Doughnut buffers of distance of 50 meters, 100 meters, and 500 meters were placed around each non-registry facility in order to model the potential interaction of the industry with the surrounding communities (Maantay 2002). Larger doughnut buffers of 500 meters and 1000 meters were placed around national registry sites. This type of buffer is used to model the decrease in the strength of pollution with distance. Since the national registry sites are larger and produce greater amounts of pollution than non-registry sites, the buffer size was increased to capture a greater amount of potential exposure. The smallest, innermost ring of the buffer captures the fenceline population, or those who live right next to the hazard. The population that is bounded by the outer buffers represent a more dispersed group of people, who experience a lesser degree of risk but still greater than the at-large population. The centroid method was used to determine the extent of the buffer. If the buffer covers the centroid of the Census block's area, it was included in the analysis (Mohai and Saha 2006). This method is meant to prevent the capture of small areas of large census blocks, as it is less likely that the population centroid is located there.

The analysis also takes into account the exposure of multiple hazards. Since it was found that many hazards overlap one another, an arithmetic overlay was implemented. This grid represents the magnification of risk in an area where multiple hazards exist (Hemmerling and Colten 2004). A value of one was given to each instance a buffer contained the centroid of a Census block. The results from each Census block were added and placed into a density database in order to determine the risk resulting from multiple hazards.

Bivariate correlation using Pearson correlation and a two-tailed test of significance determined if the results from the density database were significant. The various social indicators were tested against the density index. Results from these tests guided the selection of a specific community for further case study.

Criteria for selecting a case study community included a statistically significant result for at least one of the social indicators using the density analysis and a significant density of industries.

Qualitative Methods

Qualitative research involves how human environments and experiences are cogently realized and situated in a theoretical framework. Methods are broken down into three broad categories: oral testimony, which includes interviews; textual analysis, which involves archival research; and participant observation, which can range from passive viewing of events to actively involvement in advocacy (Winchester 2005).

Additionally, similarities and differences between qualitative and quantitative methods exist intrinsically, however, while acknowledging the difference in methods, one method should not be viewed as superior. The bias that is present in all research must be admitted, as no researcher can ever remove all subjectivity. Mixing methods, known as triangulation, provides depth to a project. By including multiple types of methods, the personal and the general population's view on a topic is more easily seen (Denzin and Lincoln 2000).

Ethical questions surrounding qualitative research are a concern, especially those stemming from the power of the researcher. Feminist and poststructural frames have added to the validity of qualitative methods by realizing that different realities exist, thus giving power to the previously marginalized. However, the voices of the marginalized can be changed by the researcher's perception and interpretation. This position of power over the subject must be recognized (Winchester 2005).

Qualitative research is concerned with how human behavior and experiences, the examination of structures which are created by humans is sensible. Structures are the frame on which societies hang; an underlying structure can be found in any relationship humanity has, whether it is with other humans (familiar structures), the environment (agricultural structures), or even with something seemingly non-organic, such as the economy (capitalist structures). These elements do not exist within a vacuum; each structure is connected to a multitude of others, making it vastly harder to study. Ultimately, it is up to the researcher to discover how the structure they are examining fits into the overall framework of society: when the structure originated, how it evolved, and how it exists today (Winchester 2005).

Recognition of positionality is crucial when creating knowledge through either quantitative or qualitative methods. Positionality is the acknowledgement of the researcher that the "sort of knowledge made depends on who its makers are" (Rose 1997). Each person has a different philosophy about life, and even when researchers try to remain objective, this philosophy will have an impact on the way they interpret data. To think that one can have complete objectivity is to deny one's place in the world. Fully recognizing the way experience shades perception and then using that perception to reflect upon the research leads to further insights (Katz 1992). When dealing with issues of race, culture, and gender, stating one's experience with these issues is necessary. A researcher that is a member or any or all of the above groups will have a very different view on issues that link back to them than a researcher that does not.

A classic method of qualitative researchers is interviewing. This technique, when used well, can yield quality information that can be obtained no other way. Open response interviewing allows for the respondent to reply using their own words rather than those of the researcher, as a survey would not. The researcher learns, by actively listening, what is important to the respondent and can use this to shape the course of the interview while it is still ongoing. Rapport between the two parties is delicate- it can be slow to build and easy to tear down. The greater amount of rapport that the researcher builds, the more likely a respondent will feel at ease and is more likely to provide valuable answers (Dunn 2005).

In order to gain insight into the daily experiences of those who live in a community potentially affected by environmental inequity, interviews with governmental employees, activists, and residents were conducted. Approval by the Internal Review Board was granted before any interaction with subjects began. Interview questions included those directed at descriptions of personal histories, experiences with the environmental hazards, and actions against the environmental hazard.

Contacts for interviews were garnered from the websites of local community organizations and government. An email was sent to potential interviewees, explaining the scope of the project and the privacy of the individual. Initial contacts either consented to an interview or suggested other potential contacts, snowballing the amount of contacts made. When an interview was conducted, the individual was asked if they would consent to tape-recording. Some did not, so notes were taken in longhand. Interviews lasted from 30 minutes to one hour and were semi-structured, using previously constructed questions as a guide to conversation but not limiting the scope of the discussion. At the end of the interview, the individual was asked if they had anything else to discuss and were thanked for their participation.

Identification Number	Background Information
A1	Employee, Bryan non-governmental agency
A2	Employee, additional Bryan non-governmental agency
B1	Employee, City of Bryan
B2	Employee, City of Bryan
C1	Plaintiff in class action lawsuit
C2	Witness in class action lawsuit

Table 1: Description of Interviewees

CHAPTER III

RESULTS

Quantitative Results

Using the GIS database, maps were created to display the spatial variability of hazard distribution. Figure 1 depicts the hazardous of place of Brazos County, with a close up of the city of Bryan. Bryan has a greater environmental risk than the surrounding areas, due to the higher degree of overlap between industries' influence area. Figure 2 also features a greater density of hazards in the city of Brenham, while the census blocks surrounding the city remain free of coincidence with any of the five types of sites selected for this study. This does not mean that this part of the county is free of environmental contamination or bears a lesser environmental burden. It could simply mean that the hazards mapped for this study are not evidential in the county.

Geographic Scale	White	Black	Hispanic	American Indian	Asian	Renter
Brazos County	-0.016	0.020	-0.026	-0.026	0.056**	-0.014
Bryan Study Site	0.023	-0.030	-0.177*	-0.177*	0.109	-0.080
Burleson County	-0.059	-0.037	-0.027	-0.010	-0.010	-0.047
Grimes County	0.001	0.117**	0.017	-0.026	-0.002	0.035
Leon County	0.059*	-0.008	-0.002	-0.010	-0.022	0.032
Madison County	0.041	0.049	0.020	0.034	-0.004	0.047
Robertson County	0.007	0.026	0.028	-0.004	0.052*	0.087**
Washington County	0.000	0.173**	0.038	0.002	0.102**	0.146**
* Significant at the 0.05 level ** Significant at the 0.01 level						

Table 2: Summary of Bivariate Statistical Analysis

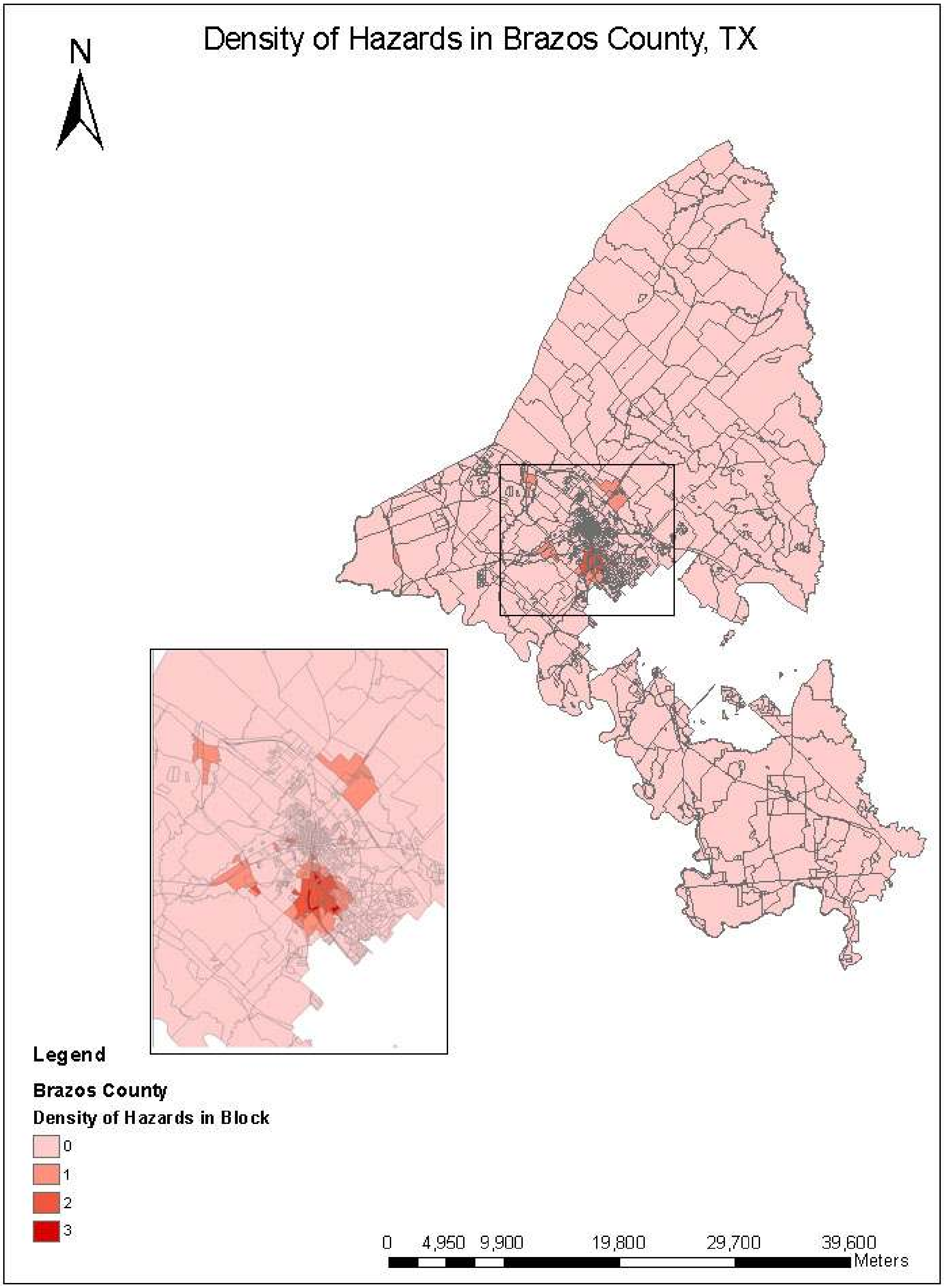

Figure 1: Density of Hazards in Brazos County

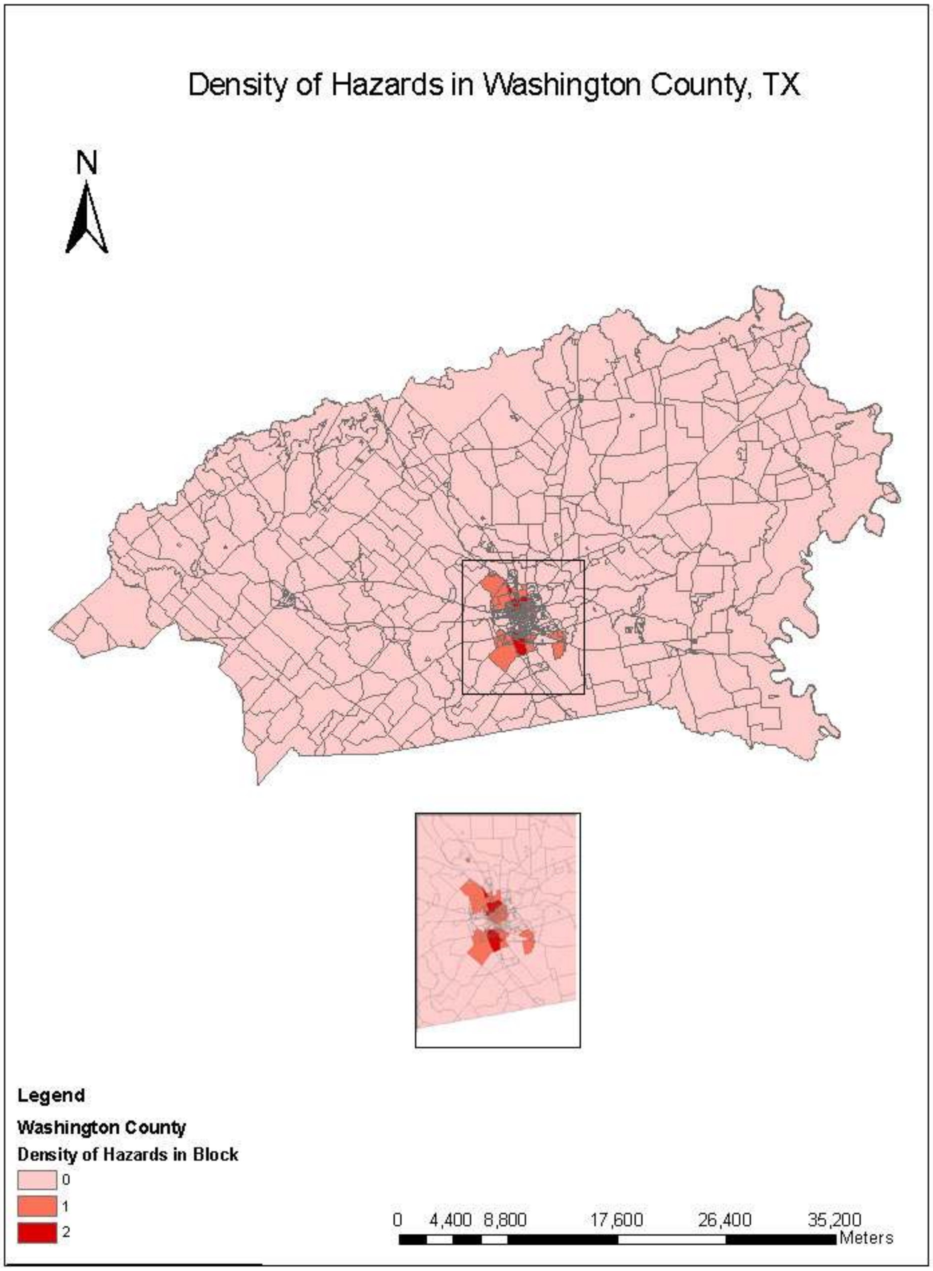

Figure 2: Density of Hazards in Washington County

Statistically significant results were yielded from five of seven counties. The result from Leon County was excluded, as the population of whites was not one of the social indicators considered to indicate a lack of environmental inequity. It was found that the positive correlation of the coincidence of hazards density and the population of Asians per census block was significant at the 0.01 level in Brazos County, as well as in Washington County. Washington County also displayed positive correlation of the density of hazards and the population of African Americans and rented houses at the 0.01 level. Grimes County experienced positive correlation with a significance level of 0.01 between the population of African Americans and hazard density. Finally, Robertson County encountered positive correlations with hazard density for both the Asian population and the number of occupied rented housed, with a 0.05 and a 0.01 significance respectively.

While Brazos and Washington Counties were both considered for the study site location, due to the density of the hazards in Bryan and Brenham respectively, Bryan was ultimately chosen. Several factors played a role in this decision. First, the proximity to the site was very advantageous to conduct the qualitative part of the study, such as enabling the facilitation of archival research and facilitating interviews. Additionally, the influence of Texas A&M University on the city was particularly intriguing. The site is located in the City of Bryan, specifically, the area bounded by 30th Street to the north, South College Avenue to the east, West Villa Maria Road to the south, and Groesbeck Road to the west (Figure 3). The sites that were included in the local analysis are listed in Table 3.

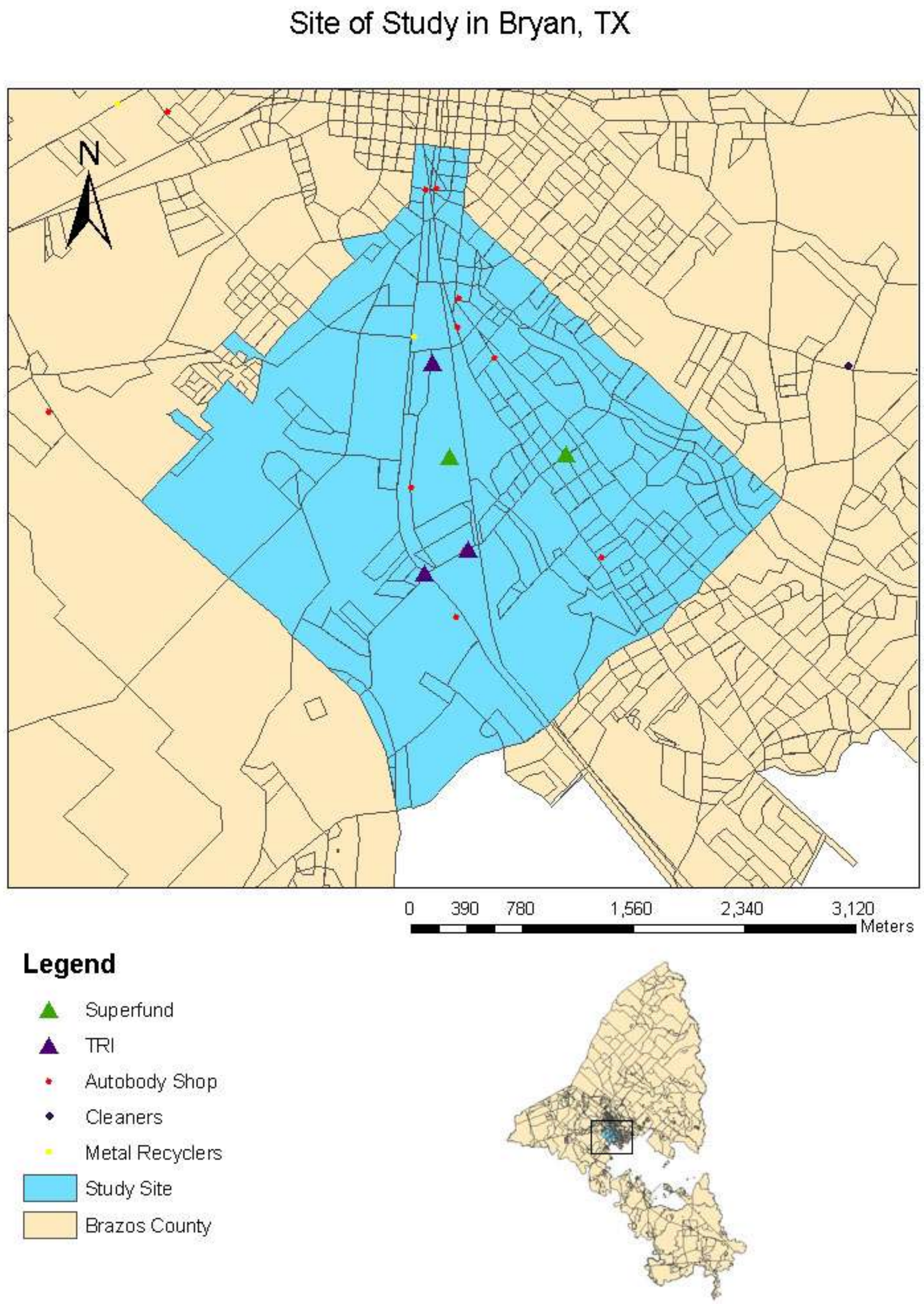

Figure 3: Location of Study Area

Company	Address	Zip Code	Description	Potential Releases
A&M Twin Body and Paint	103 Koeing St.	77801	Autobody Shop	Chromium, silica
Bryan Auto Body	2002 Fountain Ave.	77801	Autobody Shop	
Casey's Auto Sale	118 Hardy Rd.	77801	Autobody Shop	
Court Automotive	700 Finfeather Rd.	77803	Autobody Shop	
George's Body Shop	200 E. 32nd St.	77802	Autobody Shop	
Krause Paint And Body	622 W. Carson St.	77801	Autobody Shop	
Lapp's Paint and Body	409 Burnett St.	77803	Autobody Shop	
Maaco Collision	1300 S. College Ave.	77801	Autobody Shop	
Juan's Auto Shop	2600 Finfeather Rd.	77801	Autobody Shop	
Valley Recyclers	1504 Finfeather Rd.	77803	Metal Recycler	Trace metals, untreated grabage
Arkema Corportation	201 W. Dodge St.	77801	Superfund Site	Arsenic
Kent Moore Cabinets	1460 Fountain Ave.	77801	TRI Site	Xylene
Alenco Windows	615 W. Carson St.	77801	TRI Site	1, 2, 4-trimethylbenzene, diisocyantes, hydrogen fluoride

Table 3: Industries Located in Study Site

Qualitative Results

When conducting interviews with members of the community about their experiences with environmental hazards in Bryan, one particular theme arose. During the early to mid-1990s, a class action lawsuit involved many residents in the city. The lawsuit was against a chemical manufacturer located in the dense concentration of hazards selected for the study site. This case exemplifies the concept of distributive justice, as only select residents were affected by the contamination from the plant, not the whole city. Those who lived closest to the plant suffered the most. However, they were able to rectify their unequal burden through a lawsuit, which required the company to continue its cleanup, enforcing an equal action of the law.

Actors

Residents affected by the contamination emanating from the Elf Atochem site formed an advocacy group called Citizens Against Spilled Arsenic (CASA) to organize their actions against the company. This group eventually formed the first plaintiffs involved in the class action lawsuit. Although they only met twice, the organization served as an important method for the dissemination of information to the public and members regarding the case (Hanchett_E 2007). A resident expressed her frustration with Elf Atochem as “they’ve been allowed to continue operating despite continued problems. We shouldn’t have to deal with this” The plaintiffs listed in the lawsuit that became a class action lawsuit were all founding members of CASA (Austin American Statesman 1992). One of the plaintiffs in the class action lawsuit did not know that his house was located less than a mile away from an arsenic plant until the TWC posted a notice on his front door in 1991. He had bought the house over ten years ago (Hanchett_E 2007).

Elf Atochem began as Texas Cotton Poisons Inc in the late 1930s. The company was purchased by Penn Salt Company in the 1944, which became Pennwalt Corporation in 1969. Pennwalt merged with Atochem in 1989, which then merged with Elf Aquitane in 1992. Arsenic contamination resulted from practices before the 1970s, when chemical effluent was stored in open wells and seeped into No Name Lake, located on the industry’s site. An average of 65 – 70 employees was kept at a time, varying seasonally, due to the nature of the demand of cotton defoliant (Sulak 1993_B).

Governmental Action in the 1970s and 1980s

In July 1971, the residents of Bryan were notified by a Texas A&M University graduate student of elevated levels of arsenic in Finfeather Lake at the Environmental Action Committee meeting. Arsenic levels exceeded the maximum allowable levels set by the Texas Water Quality Board (TWQB) in 1970. Water from the lake, located on private property, flows past 30 properties and into lakes owned by the city. While the company no longer discharged arsenic into the water, John Baen, the student researcher said that "the arsenic buildup has been through a period of years, and has perhaps permanently contaminated the supply to County Club Lake." Additionally, the company had changed methods of treating arsenic on site; instead of discharging it untreated, a chemical reactant was added to the lake to make the arsenic sink to the bottom, "chang[ing] the lake from a dumping ground for dangerous arsenic waste into a huge experimental chemical vat" (Griffis 1971).

A hearing was held in late July 1971 by the TWQB concerning the arsenic contamination resulted in a lawsuit brought against the company in two years later. The lawsuit was aimed to halt the seepage of arsenic into the water system by removing the soil from the bottom of the lake, as well as fine Pennwalt $1000 per day of noncompliance (Gray 1974). Pennwalt claimed efforts in remediating the site and a company spokesman extolled their commitment to the environment. He proclaimed that "we are really helping the environment… with our newest development in pesticides" (Bryan-College Station Eagle 1975). In 1976, the lawsuit was settled, with Pennwalt instructed to remove arsenic tainted sediment from Finfeather and Municipal Lakes. Costs were projected at $500,000 (McKaskle 1976).

It was found that wastewater emanating from the facility seeped into the lakes, “degrading the lake bottoms.” These lakes feed into the stream network of Brazos County, which empties into the Navasota River (McKaskle 1976). Remediation finally began in January 1978. Pumping water out of the lakes took two days and removal of the sediment began directly after. Sediment was transferred from the lake beds to a clay lined pit, which was to be capped with a clay cover after the clean up ended. The project was estimated to last one year (Lindsey 1978). Excavation continued until 1981 when Pennwalt successfully petitioned to halt remediations, stating that if they continued, they risked contaminating the water table. The TWQB granted their request in August and allowed the company to refill the lakes. However, part of this agreement required that Pennwalt continue their monitoring program (Snell and Palmer 1981).

Both lakes were refilled in July 1983, after extensive testing and final approval by the Texas Department of Water Resources (Puckett 1983). Pennwalt was required to continue testing for 10 years, as well as claim liability for any future cleanup actions, in an amendment to the state’s 1976 order (Snell 1983). By this time, Bryan constructed a spillway and drainage ditches around Municipal Lake to serve as flood protection.

Governmental Actions in the 1990s

In 1991, the TWC examined allegations regarding Elf Atochem violating previous agreements with the state entity. Elf Atochem was accused of illegally dumping untreated effluent into a lake on its property, which connects with two lakes owned by Bryan ($Sulak_B$ 1991). An independent contractor tipped off the commission to the illegal emission, occurring when contaminated groundwater was undergoing remediation. The water was pumped directly into the lake. When the contractor tried to notify plant officials, he was rebuffed, as well as when he contacted executives at the United States headquarters ($Hanchett_G$ 2007).

Additionally, a pile of arsenic tainted soil sat on the plant's property for almost a year. The soil had been scraped off of the ground during the plant's expansion ($Sulak_A$ 1991). No fence surrounded the pile and no signs were present notifying people of the risk. Children's footprints and buckets were found on top of the hill ($Hanchett_G$ 2007). Elf Atochem remediated the pile, sending it to Oklahoma the next month. About 135 tons of soil was sent in 60 trucks ($Sulak_B$ 1991).

TWC officials gave the company 30 days to negotiate remediation efforts on 1 April 1992, or else face a $10 million dollar fine, which was originally levied in January. The fine was the largest threatened against a company by the state at the time. Officials also said that Elf Atochem had been slow to respond to communications from the commission regarding clean up efforts (Associated Press 1992). The company was faced with another fine in September 1992. Elf Atochem paid $900,000 to the EPA stemming from the same set of violations the TWC charged them (Staff and Wire Reports 1992).

Eventually, the company paid the state $2.5 million dollars in penalties, while acquiescing to multiple points of the agreement. These included a property buyout of houses along the drainage channels between Finfeather and Municipal Lakes and a performance contingency which stated that if the company did not adhere to all of the terms of the agreement, they would pay $1 million dollars (Sulak$_{A}$ 1992). The discovery by the city of a warehouse filled with 2,000 drums of powdered arsenic trioxide in February 1993 led to Bryan requesting that Elf Atochem secure the site. Broken windows allowed people to reach in and touch the barrels (Sulak 1993$_{A}$).

Elf Atochem suspended production on 30 July 1993 (Toland 1993). The company permanently closed on 6 October 1993. While the company vacated the site, they were still liable to finish remediation. Remediation efforts were estimated at $26 million dollars (Brown$_{A}$ 1993).

Legal Action

Three homeowners sued Elf Atochem at the beginning of 1991, starting off a chain of events that would lead to one of the biggest class action lawsuit settlements at the time. The lawsuit claimed that their property was contaminated with arsenic originating at the Bryan plant. It also stated that the site released "obnoxious" odors and loud noise (Hiney and Sulak 1991). Following this initial action, a second set of homeowners filed suit in 1992, making the same claims. This suit charged the company with "grossly negligent and reckless transportation, storage, use, and disposal of arsenic and/or arsenic compounds proximately resulted in widespread, pervasive arsenic contamination" (Hiney and Sulak 1992). Some of these plaintiffs settled later that year, even though they did not receive "as much as we wanted, but all right" (Sulak$_{A}$ 1992).

Those who remained in the case became a part of a class action lawsuit in November 1993. U.S Federal Magistrate Judge Calvin Botley confirmed the lawsuit as eligible for class action status, since as many as 10,000 people within a set radius of the plant could join (Brown$_B$ 1993). Another component of the lawsuit was a group of families who claimed that their children's birth defects were caused by arsenic. Settlement of the lawsuit came in early 1995, with settlement figures ranging from an estimate of $55 million to $100 million dollars (Schwartz 1995). The final settlement was for $55 million dollars to be paid over seven years. $4 million dollars of the money was paid to fund a medical monitoring program, tracking voluntary participants for ten years (Hiney 1995). The program is administered by Scott and White Clinic (Hanchett$_G$ 2007). Bryan received $4.8 million dollars in the settlement, part of which city officials planned to use for legal and consulting bills relating to the case (Bergmann 1995).

Award checks were sent to the families of children with birth defects, a category of 434 claimants, on 22 August 2002. Monies ranged from $6,503.62 to $26,361.40 (Crowley 2002). The Settlement Administrator's office declared all settlement funds disbursed on 29 May 2003. Medical monitoring began in November 2002; the program was meant to detect effects from arsenic in uninsured claimants. Other award amounts totaled $4,000.00 for those with personal medical claims and an average of $223.00 for those who lived or worked in the area (Crowley 2003).

The following section explores the role of procedural justice in the city of Bryan. The city's vigilance against protecting citizens from potential environmental threats is examined. The local government is the level that is most accessible to citizens, due to size, location, and mission. It is the city's duty to serve only the citizens of Bryan, and it has the opportunity to prevent or correct environmental inequity using its legislative processes. If citizens find that the city government is not meeting their needs or enforcing the law equally, other outlets exist for corrective action in the community.

Governance in Bryan, Texas

Currently, the City of Bryan has a limited environmental monitoring program. The Environmental Services department (ESD) monitors three types of environmental actions within the city: those who operate grease traps, collect medical waste, or discharge wastewater into the sewage system. All parties who practice these actions are required to obtain a permit from the city. A random yearly check is conducted at businesses that operate a grease trap or collect medical waste in order to ensure compliance. If the party is found to be incompliant with regulations, fines and corrective action are levied. Chronic issues with compliance will lead to the revocation of a permit ($\text{Hanchett}_{\text{D}}$ 2007).

Only industries that are classified as a Significant Industrial User (SIU) are required to report their discharges into the city's sewage system. A SIU is considered to be a user that discharges over 25,000 gallons of processed wastewater into a water treatment system. Bryan houses 15 industries classified as SIUs and requires them to self-report the results of water testing quarterly and annually, as required by the Industrial Pretreatment Program administered by the EPA. Substances that are monitored include chemicals like ammonia and liquids like oil and grease. Additionally, an environmental compliance officer visits the site annually to guarantee the facility's compliance with the law, although the city does not collect water samples at each site. If the facility is found to be in violation, whether through the report filed with the city or by the compliance officer examination of the site, it is fined. The fine is calculated by the amount of contamination that exceeded the levels agreed upon in the permit, as the additional contamination stresses the city's water treatment facility capacity to process water(Hanchett$_D$ 2007).

A storm water treatment program has also been developed by the city, although it is not implemented. Created in order to comply with a potential TCEQ mandate, the program is ready to be enacted immediately when the mandate is realized. It will require industries to treat storm water runoff from their properties before discharging it into the city's storm sewer system. Developed several years ago, the mandate comes no closer to becoming realized policy (Hanchett$_D$ 2007).

The ESD is notified of the establishment of a new industrial company in two ways. The first allows the department no input into the siting process as they are notified after an industry has purchased an already existing site for continued operation. A waste assessment card is filled out by the industry when they request a connection of services by Bryan, Texas Utilities (BTU). Primary concerned with wastewater concerns, the card is then given to the department to discuss wastewater permitting before the connecting the industry. In contrast, the department is more active in the creation of an industrial site on a previously undeveloped piece of land. Being a part of the Site Development

Review Committee allows the ESD to have input into the construction of the building, as they are able to review the site application and accompanying documents, such as environmental impact statements and engineering diagrams. This committee is interdepartmental, which allows for a bevy of concerns to be addressed adequately. The ESD focuses primarily on questions concerning the waste stream of the industry and how Bryan can accommodate the demands of the facility (Hanchett_D 2007).

Publicly funded housing in Bryan is administered by the city's Community Development Services department (CDSD). Any housing development that utilizes Department of Housing and Urban Development (HUD) funds must comply with federal environmental laws, including Executive Order 12898. The administrator for this department reviews an environmental impact statement concerning the site, which includes an environmental justice investigation, before approving the proposal and forwarding it on to the city manager. When it is approved by the ranking city official, the Community Development Block Grant is released to the developer (Hanchett_F 2007).

Social Infrastructure in Bryan, Texas

Bryan operates a telephone hotline where citizens can report incidents of illegal dumping and other environmental complaints, such as unpleasant odors emanating from a facility. Citizens are encouraged to report emergency and in-progress incidents to the city police department. The city records the complaint in a database and sends an environmental compliance officer to investigate the claim within a week. A remedy for the site is enacted by the city if it has the capacity; otherwise the site is reported to the

Texas Commission on Environmental Quality for action on their behalf. For the citizens of Bryan, this hotline is one of the few steps for recourse for environmental actions, as a complaint must be registered in the hotline for it to be investigated (Hanchett_D 2007).

However, the ESD has not heavily marketed the hotline, citing lack of personnel and budget. Thus far, it has depended on publicity gained from public events like the Household Hazardous Waste Day, Earth Day, and the Bryan Leadership Academy, public service announcements on the radio and the Bryan government television channel, and telephone listings. It is a goal of the department to increase awareness in the community of this service through additional advertising in radio and television. Another possible avenue for citizens is to speak at the city council's monthly meetings. However, these meetings are only held bimonthly and only allot two minutes per speaker; the citizen also must sign up before the council meeting is convened (Hanchett_D 2007).

Additionally, various non-governmental organizations exist that citizens can join to bring attention to environmental issues. A new environmental organization called the Brazos Environmental Action Network (BEAN) has splintered off from the Brazos Progressives. BEAN began meeting in fall 2006 and is interested in local environmental issues, such as coal-fired power plants in Brazos Valley. The organization meets once a month. At the meeting that was attended by the researcher, 11 people were present to listen to a representative from Environment Texas speak about the condition of the Texas state parks system. Plans were made to hold a cookout in from of the state representative's office in order to generate attention to inadequate funding for the system. Also, the community is served by the Lone Star chapter of the Sierra Club. However, this organization meets in Austin, making it inaccessible for many people, especially the lower income.

Political Environment in Bryan, Texas

A large amount of responsibility for environmental quality was side-stepped in the interview with the representative from the ESD. All monitoring of TRI and former Superfund sites were delegated to the TCEQ and EPA, entities located far outside of the community. The city official interviewed did not express any kind of interest in even a cursory monitoring program, preferring to keep procedures the same. The lack of monitoring was not explained, whether as a financial issue or a personnel issue. The city seems content to depend on the self-reporting system the TRI utilizes and the reports by Superfund site engineers. Thus, the city will continue to rely on citizen-driven reporting of contaminated sites for newly developing environmental conditions (Hanchett_D 2007).

Even more frightening is the lack of awareness of environmental conditions within the departments of the city. When discussing the Elf Atochem site, a city administrator expressed interest in purchasing tracts of land from Arkema Inc. (the current owners) for use as low income housing, as the land has been remediated and believed that it could pass an environmental impact statement (Hanchett_F 2007). However, the representative from the ESD admitted to knowledge of "hotspots of contamination" left on the facility's site (Hanchett_D 2007). A witness for the plaintiffs in the class action lawsuit against believes that it would be "criminally negligent to encourage anyone to live there- it would be homicide" (Hanchett_{G} 2007). Two individuals associated with non-governmental agencies in the city stated that the company offered to sell land to their organizations for residential development, but refused ($\text{Hanchett}_{B,C}$ 2007). One said "[our clients] have enough problems with the loss of respect and dignity. We didn't want to add to that by making them live on top of poison" (Hanchett_{B} 2007).

Could Environmental Equity Occur Again in Bryan?

Another actor must be examined when discussing environmental quality in Bryan. Developed in 1987, long after the siting of the Elf Atochem plant, the Bryan Business Council (BBC) actively works to attract commercial and industrial development in the city (Avison_{B} 2007). By attracting businesses to this area, the council hopes to expand Bryan's tax base, as well as generate employment (Levey 2003). Seven members who own businesses were selected by the Bryan City Council to serve on the council. Funding for the council is provided by several means, such as royalties from the sale of land in the Bryan Business Park, rent from the hanger of Coulter Field, and logistical support from the City of Bryan. This support totaled $53,060 in the 2003 fiscal year, in the form of free man hours from administrative assistance. While they can only offer potential businesses modest incentives for locating in the Bryan Business Park, the council can make suggestions to the City Council to grant tax abatements and other benefits to recruits (Hamilton 2004).

Under a decision made by the Texas Attorney General's Office, the BBC can hold closed meetings, as it is not required to adhere to the Open Meetings Act. The decision was made because the committee was created as a nonprofit group instead of a city agency. This decision allows the BBC to conduct all of their affairs without the public ever knowing the process behind outcomes orchestrated by the group. The president of the council, Richard Perkins, stated that closed meetings were necessary to the group's mission, as open sessions "could really jeopardize some development in Bryan. Developers are very, very sensitive to seeing their names on the front page of the newspaper" (Hamilton 2004). Several city councilmen objected to the development, as they consider the BBC as funded by the city.

In 2007, four members of the BBC abruptly resigned, some refusing to give a reason. Only three members and the director remain ($Avison_B$ 2007). Bryan officials plan to pursue an audit of the council's budget and the structure of the organization. Information gained from the audit will help guide the Bryan government's decision to whether the BBC neESD changes to make it more efficient ($Avison_C$ 2007).

A study completed by an independent contractor targeted potential areas for development or revitalization, including the Bryan Municipal Golf Course and Coulter Field (Levey 2003). Projects that the BBC helped to realize include the Sanderson Farms chicken hatchery in the Bryan Business Park and the Texas A&M University System Health Science Center ($Avison_C$ 2007). However, one of its most alarming actions is the deal they brokered between the city and Toyo Ink Manufacturing Co.

Toyo Ink, manufacturer of printing inks, organic pigments, and additional chemicals, is the city's newest industry (Ikehara 2007). Construction is projected to end by May 2008. Construction will cost $20 million dollars. Bryan will abate 70 percent of the company's taxes that year, decreasing to 10 percent in 2015, while waiving building and water/sewer fees. The BBC conveyed 22 acres in the Bryan Business Park, contingent upon Toyo Ink maintaining good credit ($Avison_C$ 2007). Toyo Ink estimates that their business will create over 20 skilled jobs. They cited Bryan's "competitive incentives package, excellent land location and condition, good access to the city even from areas outside the US, and proximity to a large pool of skilled labor, essential service and transportation infrastructure" as the impetus for selecting the site (Ikehara 2007).

A similar Toyo Ink site that produces printing inks, located in Addison, Illinois, reports releasing cobalt and manganese compounds as a part of its TRI report. In high doses, exposure to manganese can damage the brain, liver, and kidneys, as well as developing fetuses (ATSDR 2007). High doses of cobalt can cause dermatitis, as well as affect the heart and lungs. (ATSDR 2007). Exposure to both of these elements can occur through breathing emitted particles or by encountering contaminated soil (ATSDR 2007). The company has registered with the TCEQ, listing the site as an adhesive and ink manufacturing facility. It has applied for an air permit, which is currently pending (TCEQ 2007).

It remains unclear, due to the closed meeting structure of the BBC, whether any evaluation of environmental or health risks occurred. Citizens of the community had no opportunity to question city and company representatives about how this development will impact lives. No one was notified of Toyo Ink's interest in Bryan or the measures to clinch the agreement. Lack of transparency is meant to keep citizens from participating in the decision making process; closed meetings made Toyo Ink's arrival into a complete surprise for citizens. The best way to quell dissent is to prevent discussion from occurring.

CHAPTER IV

DISCUSSION

The use of GIS allowed for the visualization of potentially hazardous sites across the Brazos Valley. Multiple hazards were viewed in conjunction with the demographics of each census block. The structure of GIS mapping allows the user to add another dataset when it is created without interfering with other datasets. Therefore, GIS can appropriately model a complex environment, where hazards can be viewed separately or together. It is an especially helpful tool to quantify the "hazards of place" model. Two locations were found to have a higher concentration of hazards as compared to the surrounding areas. The cities of Brenham in Washington county and Bryan in Brazos County had much higher densities of multiple hazards and potentially present a higher risk to citizens in these cities than any other city in the seven counties studied.

Several possible reasons exist for the higher rates of industrialization in these two cities as compared to others in the region. First, they are both located on major secondary freeways, State Highway 290 and State Highway 6 respectively. This location provides an advantage to industries who wish to receive and transport good by truck freight. However, this does not explain why Madisonville, in Madison County, did not develop a density of hazards, as it is located on Interstate Highway 45. Perhaps the answer can be discovered further back in history, when towns depended on railways for transportation. Both Brenham and Bryan were the sites of the conjunction of multiple railroads, used for shipping agricultural goods (Christian 2006 and Odintz 2006). With transportation infrastructure, with multiple destinations, already in place, this attracted industries that utilized the railways for cargo transport. Elf Atochem was one of those anchor companies that could have attracted more industries to develop in the same industrialized area.

Quantitative methods informed and guided the selection of the in-depth case study. While no evidence of environmental equity was found within the area of study, Bryan density of hazards still provided an interesting topic of discussion in interviews concerning how residents and providers of services experienced these hazards. As the interviews began, the Elf Atochem story was present in every narrative. Eventually, this narrative was determined to be crucial to Bryan's environmental history. Interviews were structured around the topic of Elf Atochem and key actors were identified in the case study.

The concepts of distributive and procedural equity were examined in context with the Elf Atochem case of the early 1990s. Pollution from the Elf Atochem plant affected only a part of the city, which were those who lived and worked around the plant and those who lived along the creek where contamination passed. These residents and employees suffered an unequal distribution of risk in the community. However, this was corrected by legal action. The settlement money was only awarded to those who lived or worked in the area for a set amount of time (Crowley 2002). No money was awarded to those who used the parks that were contaminated by arsenic.

Elf Atochem was made to clean up its plant site several times, mainly due to the actions of the TWC. This commission ensured that the company adhered to the law.

However, it took several years to force compliance and complete remediation. Another entity, the Texas Air Quality Board, did not take any action, even when they found evidence of high levels of arsenic in the air (Sulak 1992_B). Multiple agencies refused to claim jurisdiction to clean up a warehouse filled with arsenic, even when they were already involved with clean-up efforts at other sites (Sulak 1993_C).

Several steps can be taken to attain environmental equity. Community awareness is one of the key elements of attaining environmental equity. Citizens should explore their communities, seeking out potentially hazardous sites. Many environmental problems are allowed to go unchecked simply because people do not know or do not ask. If they find a site in their community, a dialogue can be opened with the operator of the site. Citizens demanding to be involved in decision making processes at the industry or governmental level can realize change in their community by asserting their right as a stakeholder to be heard.

Another party that is responsible for ensuring a clean environment for all is the government, whether at local, state, or federal levels. Local governments may try to plead that they do not have the resources to monitor local hazards. However, they are on the figurative "front lines." City councils and mayors can enact change much faster than higher levels of government. They have the flexibility that is required to respond promptly to the concerns of citizens. An effective monitoring program need not cost the city a large amount of money if they engage citizens and encourage them to report overt signs of pollution.

Prevention of environmental inequity is crucial, as it can save lives and heartache. Vigilance against both large and small environmental hazards can safeguard the community. In the words of one who was affected by arsenic contamination in their home, “if I could take back moving there, I would. It’s the biggest mistake I’ve made” ($Hanchett_E$ 2007).

CHAPTER V

CONCLUSION

The first chapter of this thesis examined the theories and methods that drive quantitative and qualitative methods within environmental equity research, while chapter two described the methods used in the quantitative and qualitative components of this study. The next chapter analyzed the results garnered from the research and then segued into a discussion of the implications from the obtained results.

Environmental equity forces governments to consider the effects of industry on the citizenry. A "growth at any cost" mentality should now be considered outdated. No company is worth the revenue if it comes at the detriment to human life, especially if it impacts marginalized populations at a greater rate. These issues can be prevented if communities take steps to protect themselves from potentially hazardous industries and demand that these industries practice clean and efficient processes before taking root in the community.

APPENDIX A

Interview Guide

Interview Questions for Governmental/Social Services Personnel

1. What is your role within the organization?
2. In what ways do you interact with community members?
3. Do you know of any community residents from this area (refer to map constructed during quantitative section of project) using your organization's services?
    a. If so, how did they use the services?
4. Have community residents approached you with concerns about environmental quality issues, for example, pollution?
    a. Were you able to help them with their concerns or direct them to another organization?
5. How are residents included in environmental decision making processes?
6. Do you feel that environmental quality affects how your organization provides services?
7. Do you feel that environmental quality affects these residents' quality of life?
8. How do you monitor environmentally hazardous sites?
9. Are there any other areas of concern that are not on this map?
10. Do you have anything to add before we finish the interview?

Interview Questions for Community Organization Representatives

1. How long have you lived in this neighborhood?
2. How long ago did you become involved in community organization?
3. How did you become involved in community organization?
4. What actions has your organization taken to help your community?
5. Is pollution (i.e. smells, noises) noticeable around the facility?
    a. At what times is it most noticeable? How long have you noticed it?
    b. Do you try to document the pollution through a log or photographs?
6. Have there ever been any incidents at the facility that affected your life, such as a leak or a spill?
7. Do you feel that this facility affects the overall quality your life?
8. Are other residents aware that there is a problem?
    a. Are they involved in this organization?
9. Have any employees ever spoken to you about their company before?

10. Are there any other areas of concern that are not on this map?
11. Do you have anything to add before we finish the interview?

APPENDIX B

Maps of Selected Social Indicators

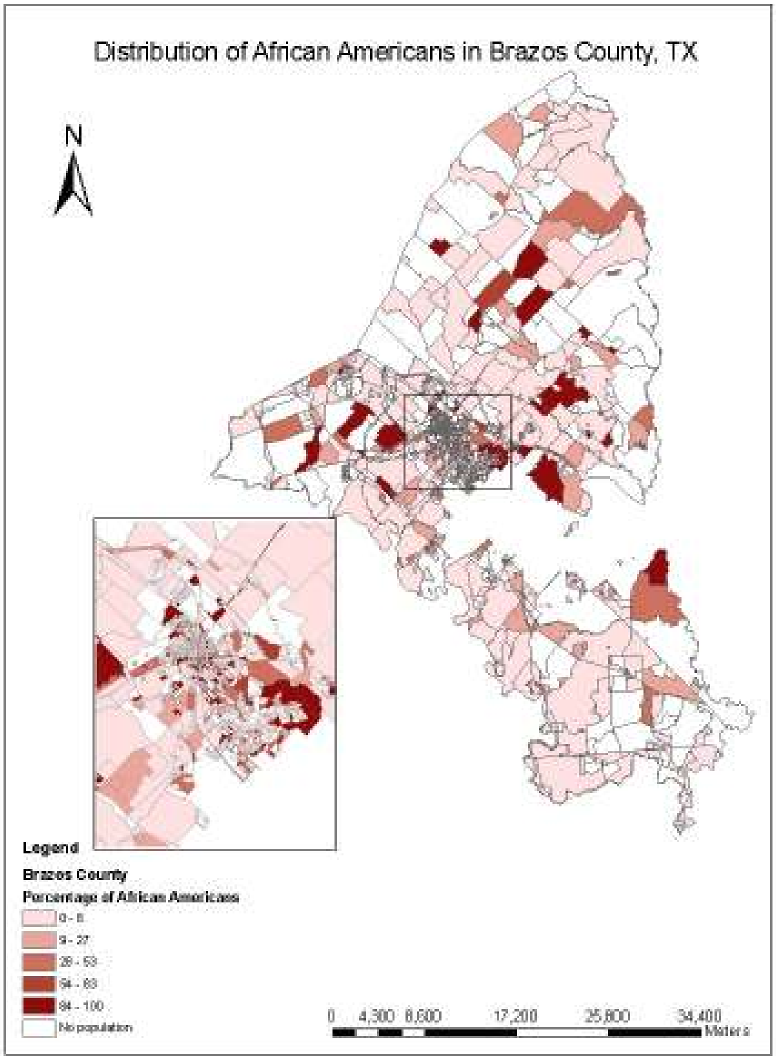

Figure 4: Distribution of African Americans in Brazos County

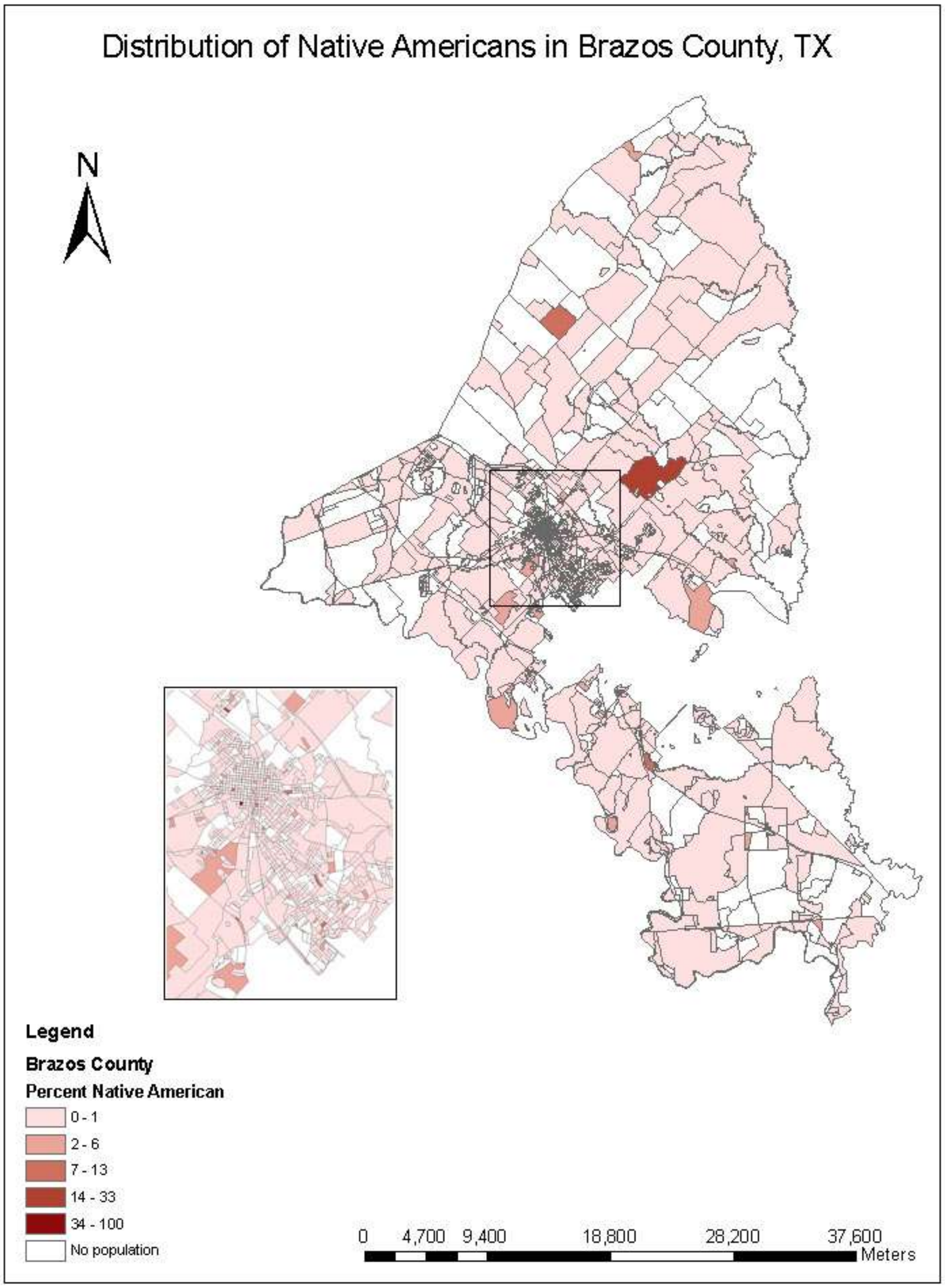

Figure 5: Distribution of Native Americans in Brazos County

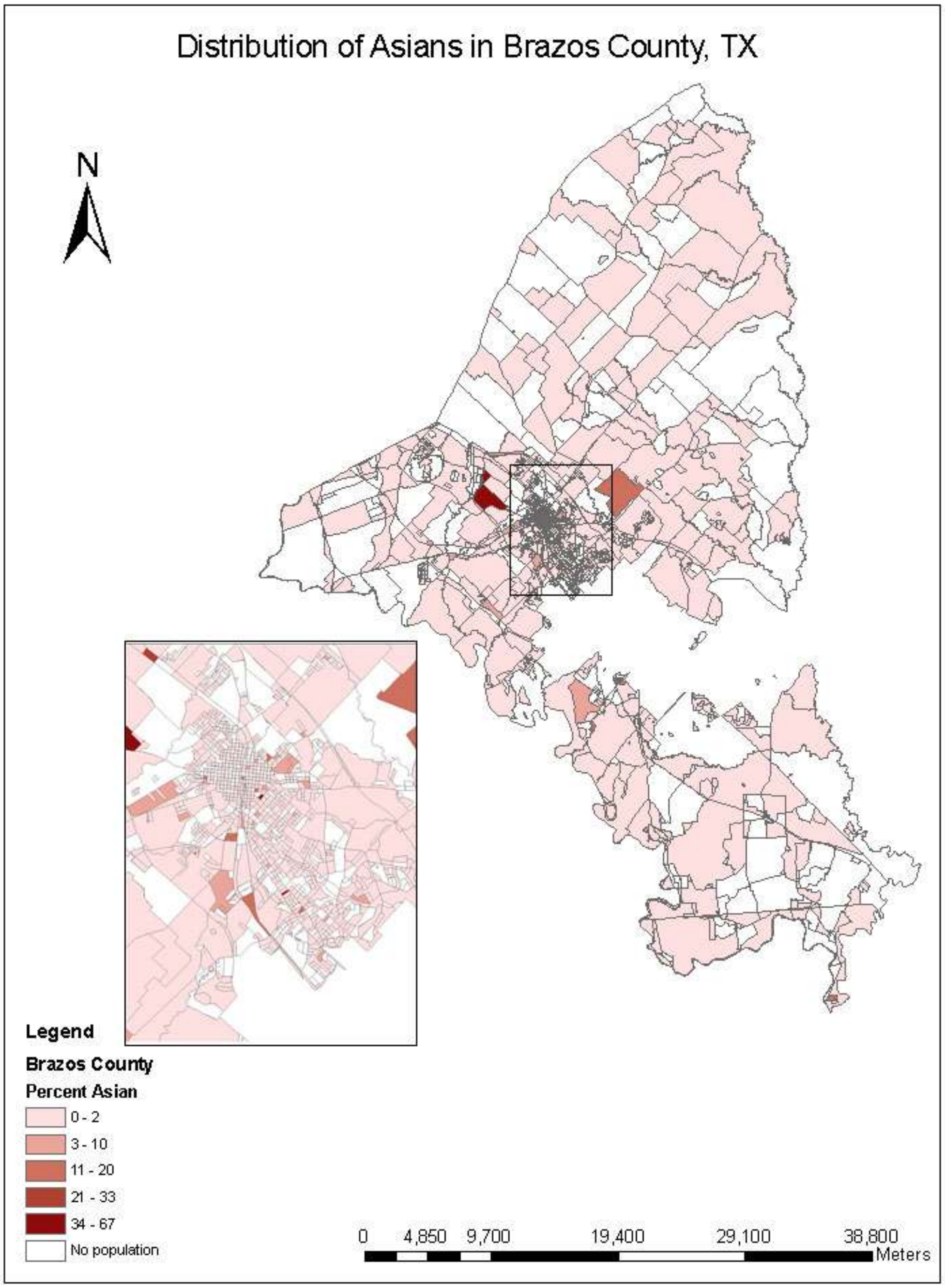

Figure 6: Distribution of Asians in Brazos County

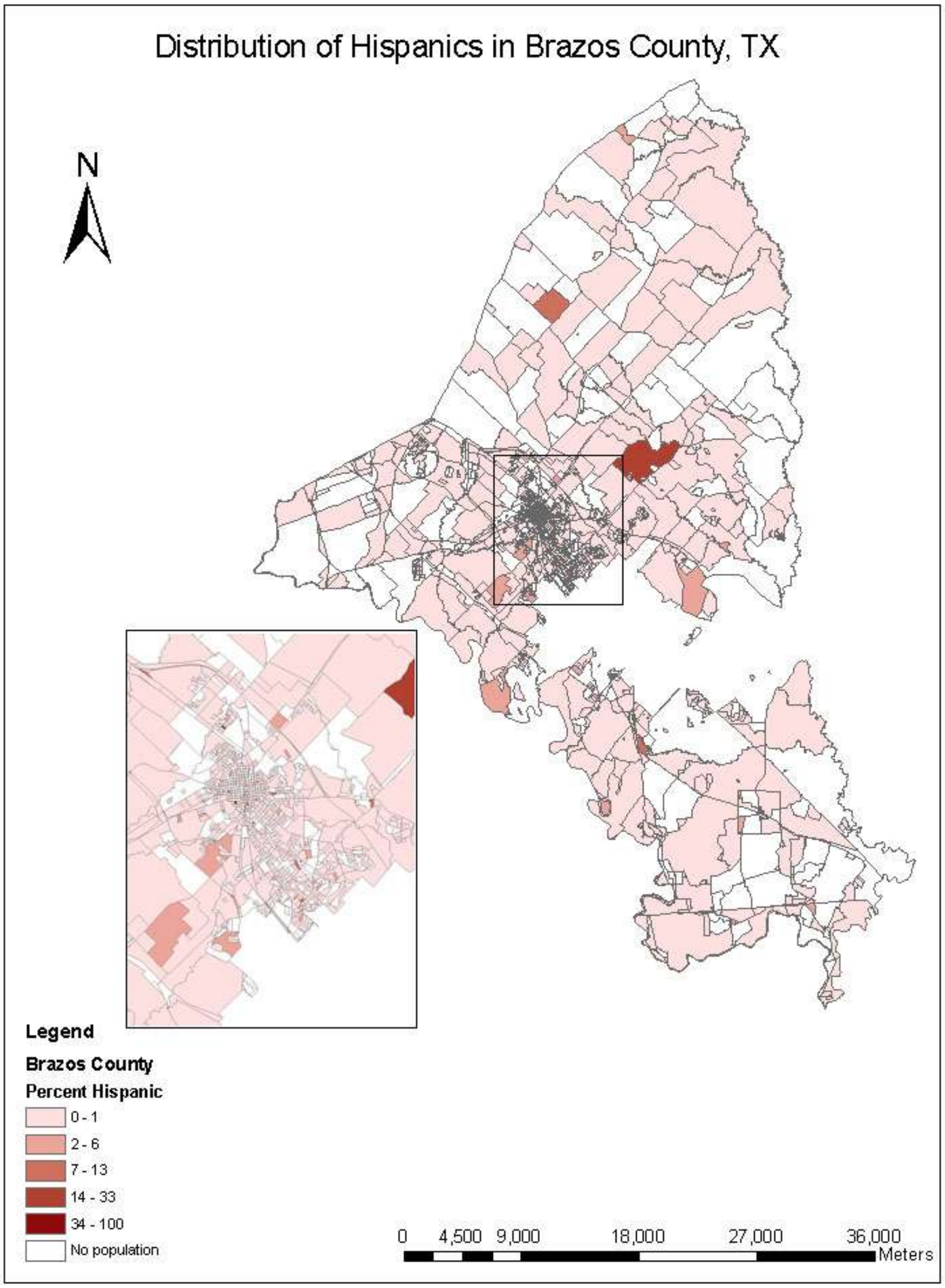

Figure 7: Distribution of Hispanics in Brazos County

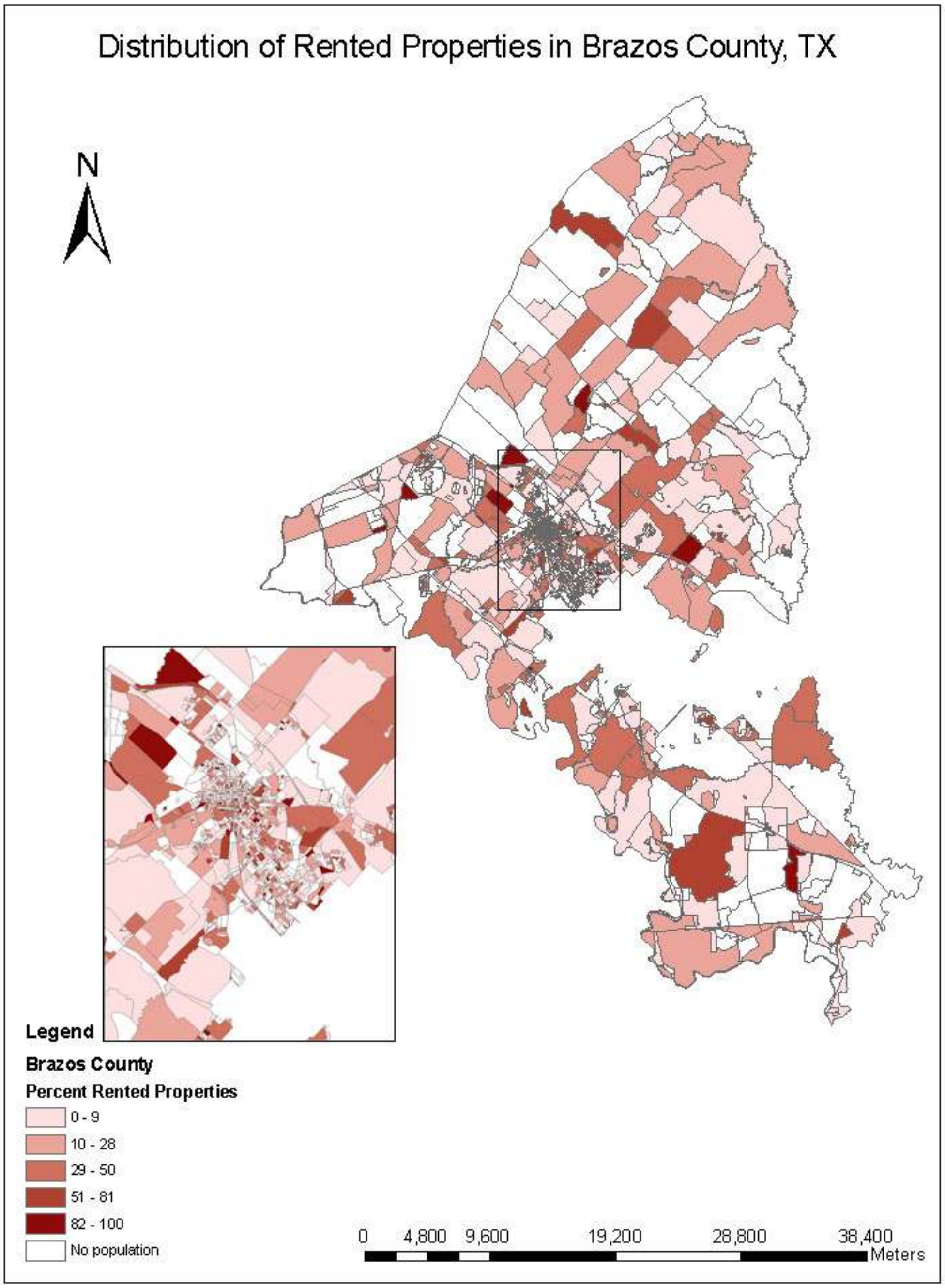

Figure 8: Distribution of Rented Properties in Brazos County

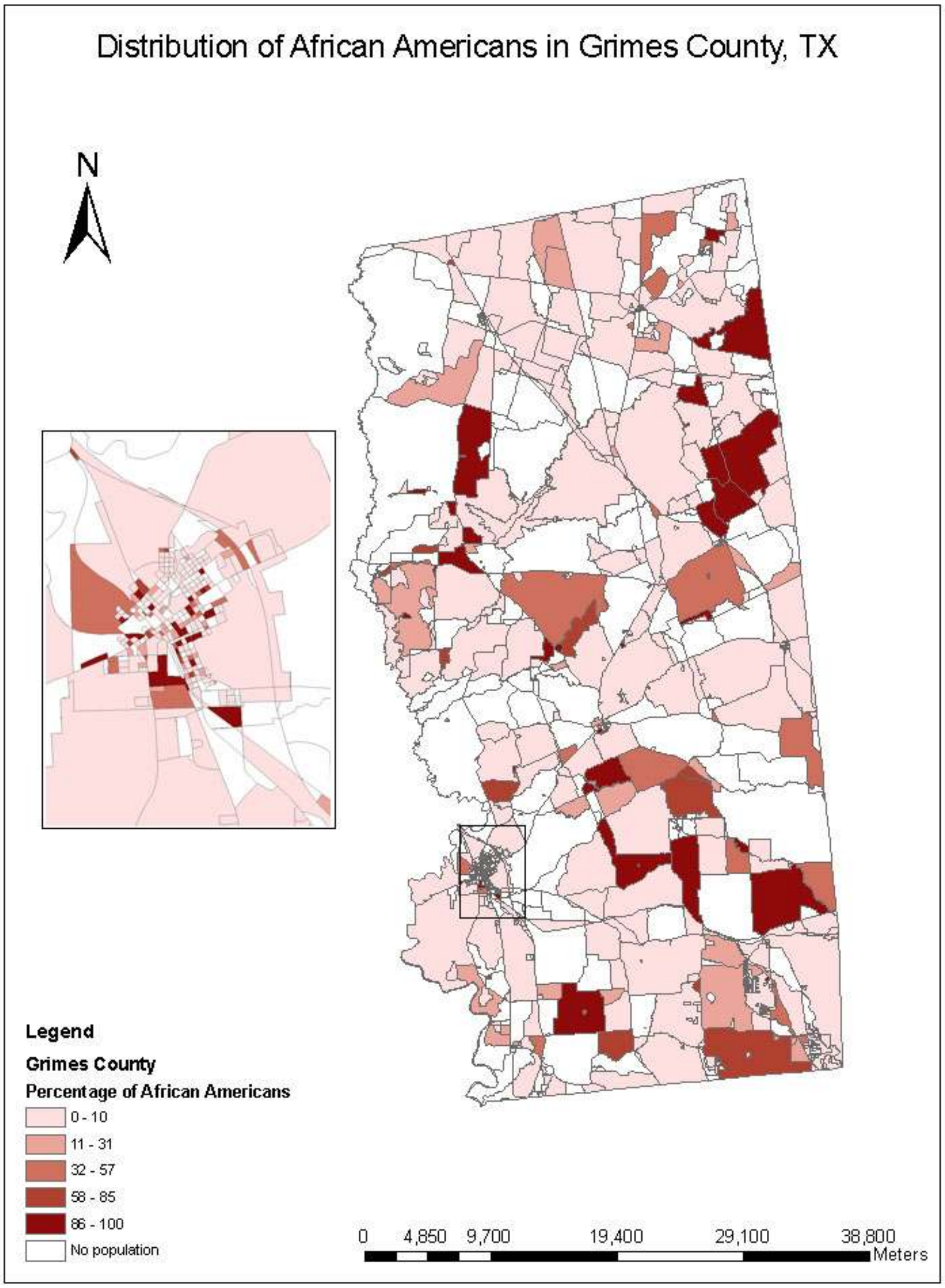

Figure 9: Distribution of African Americans in Grimes County

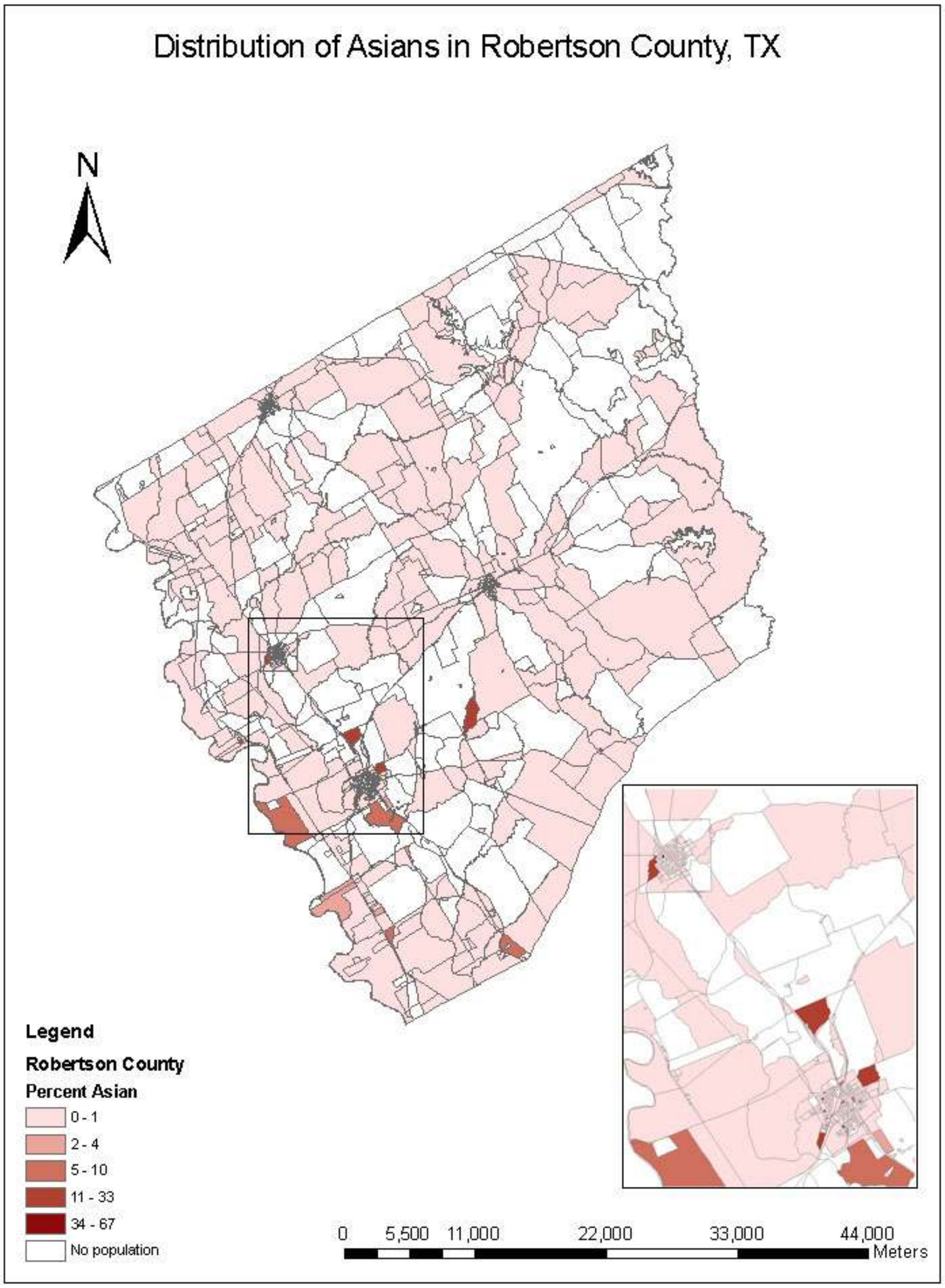

Figure 10: Distribution of Asians in Robertson County

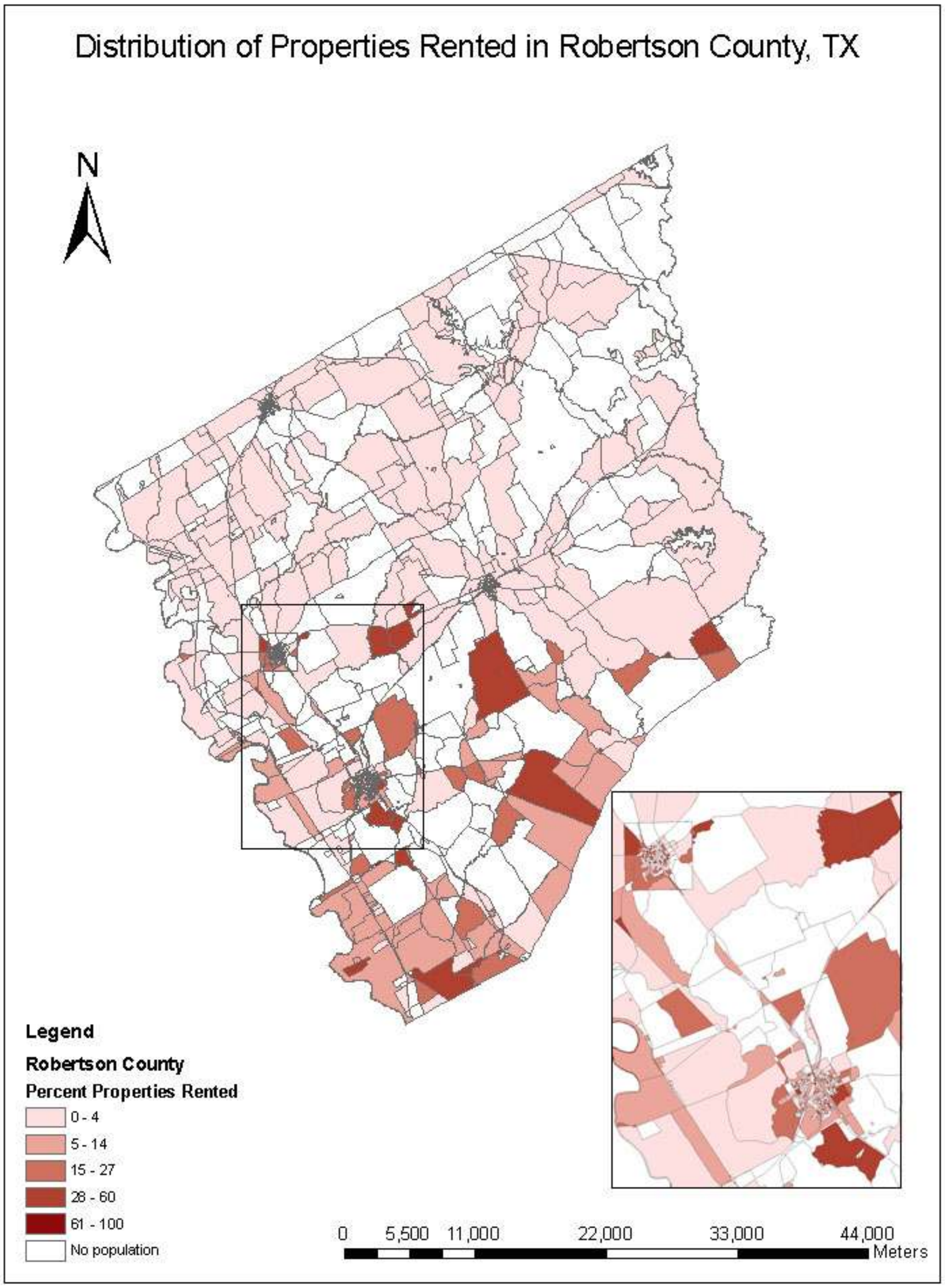

Figure 11: Distribution of Rented Properties in Robertson County

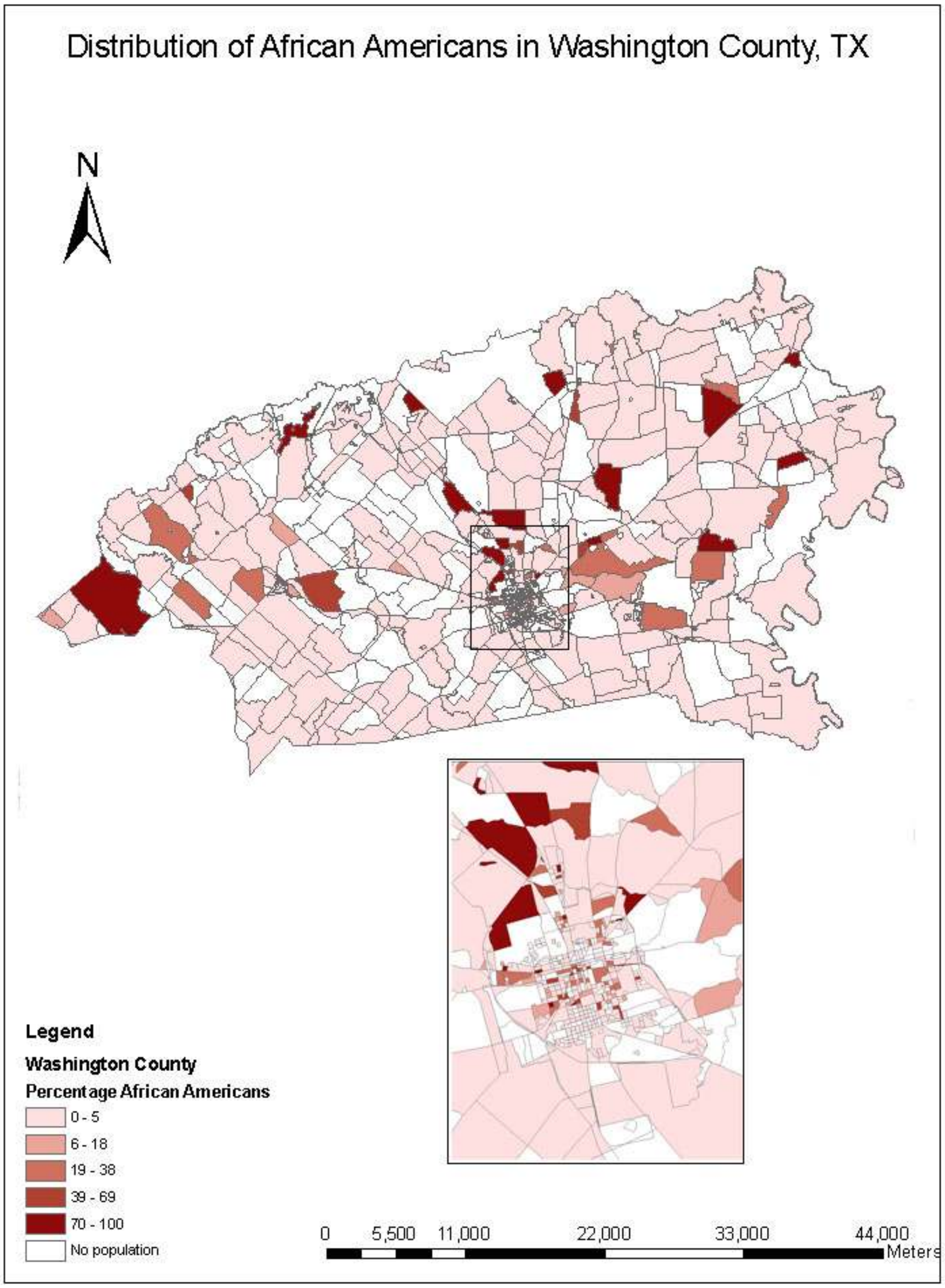

Figure 12: Distribution of African Americans in Washington County

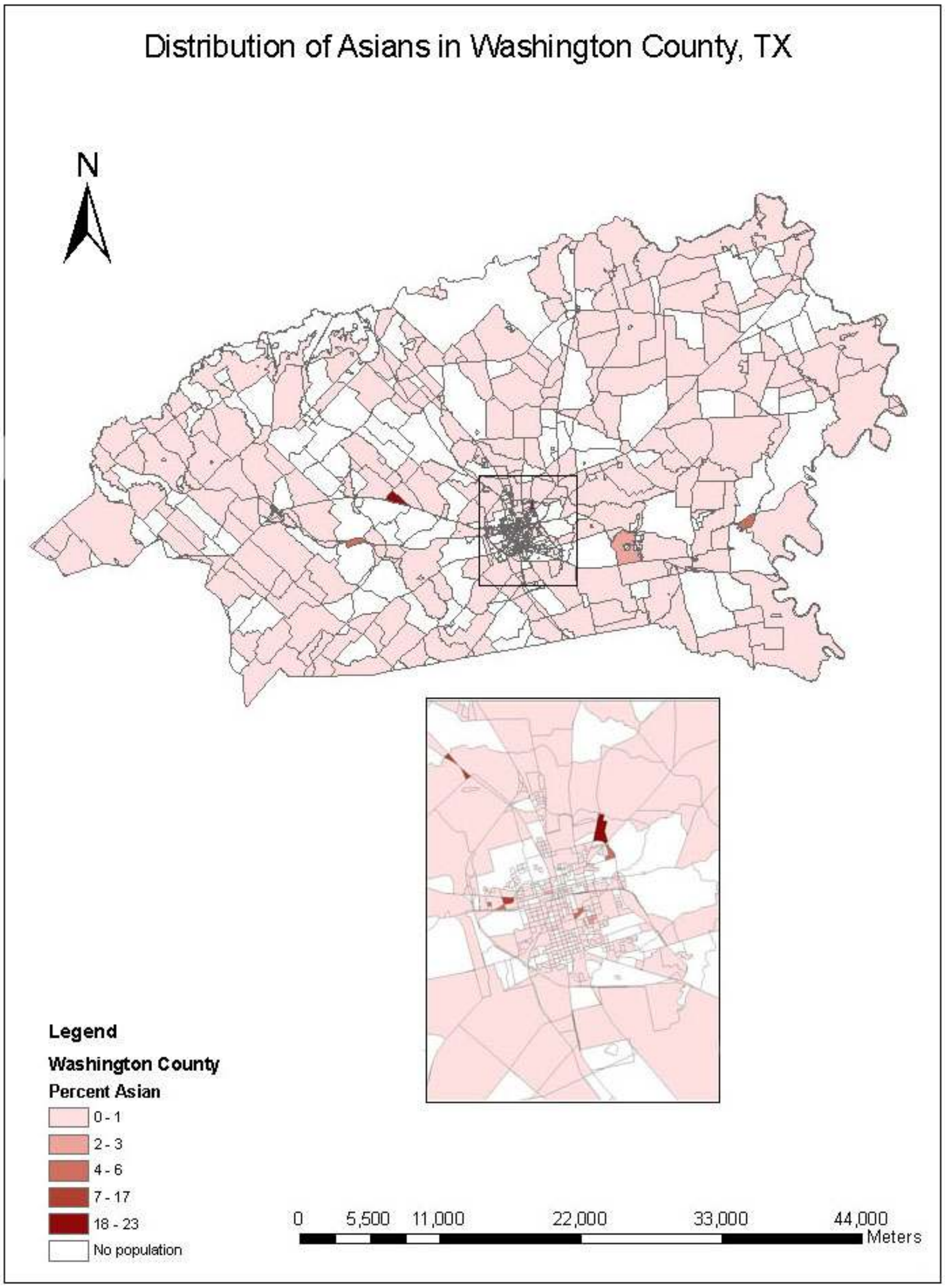

Figure 13: Distribution of Asians in Washington County

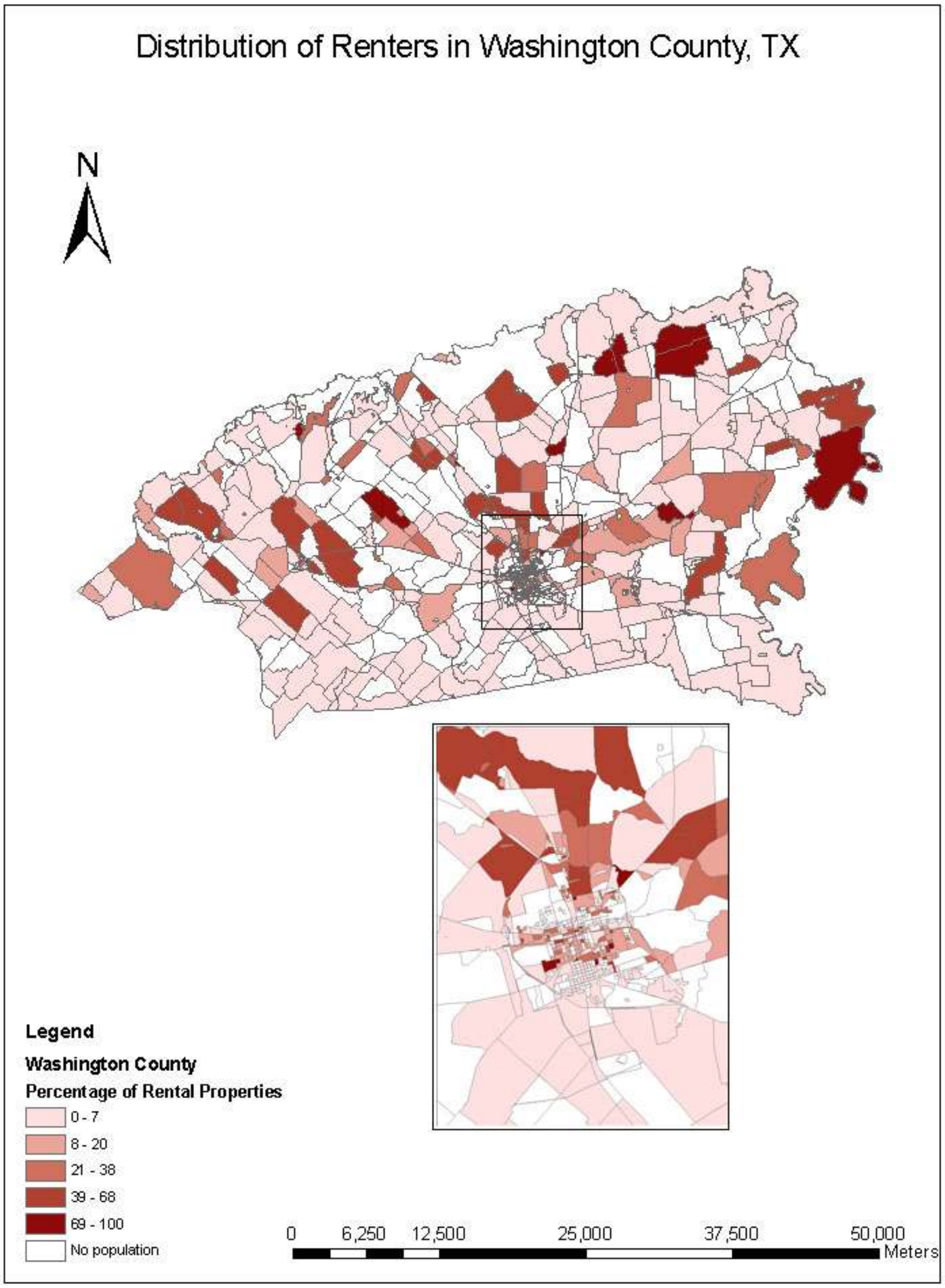

Figure 14: Distribution of Rented Properties in Washington County

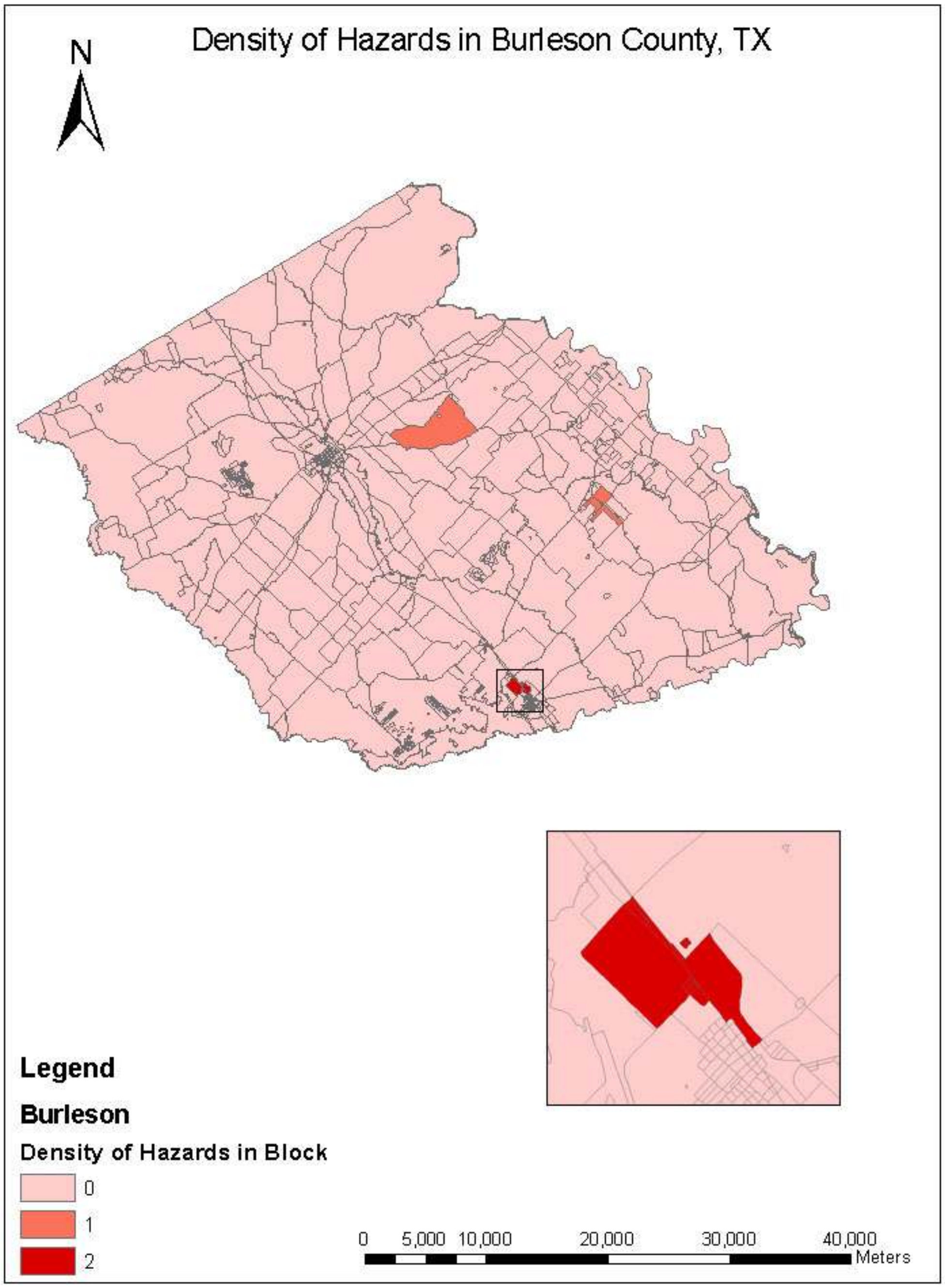

Figure 15: Density of Hazards in Burleson County

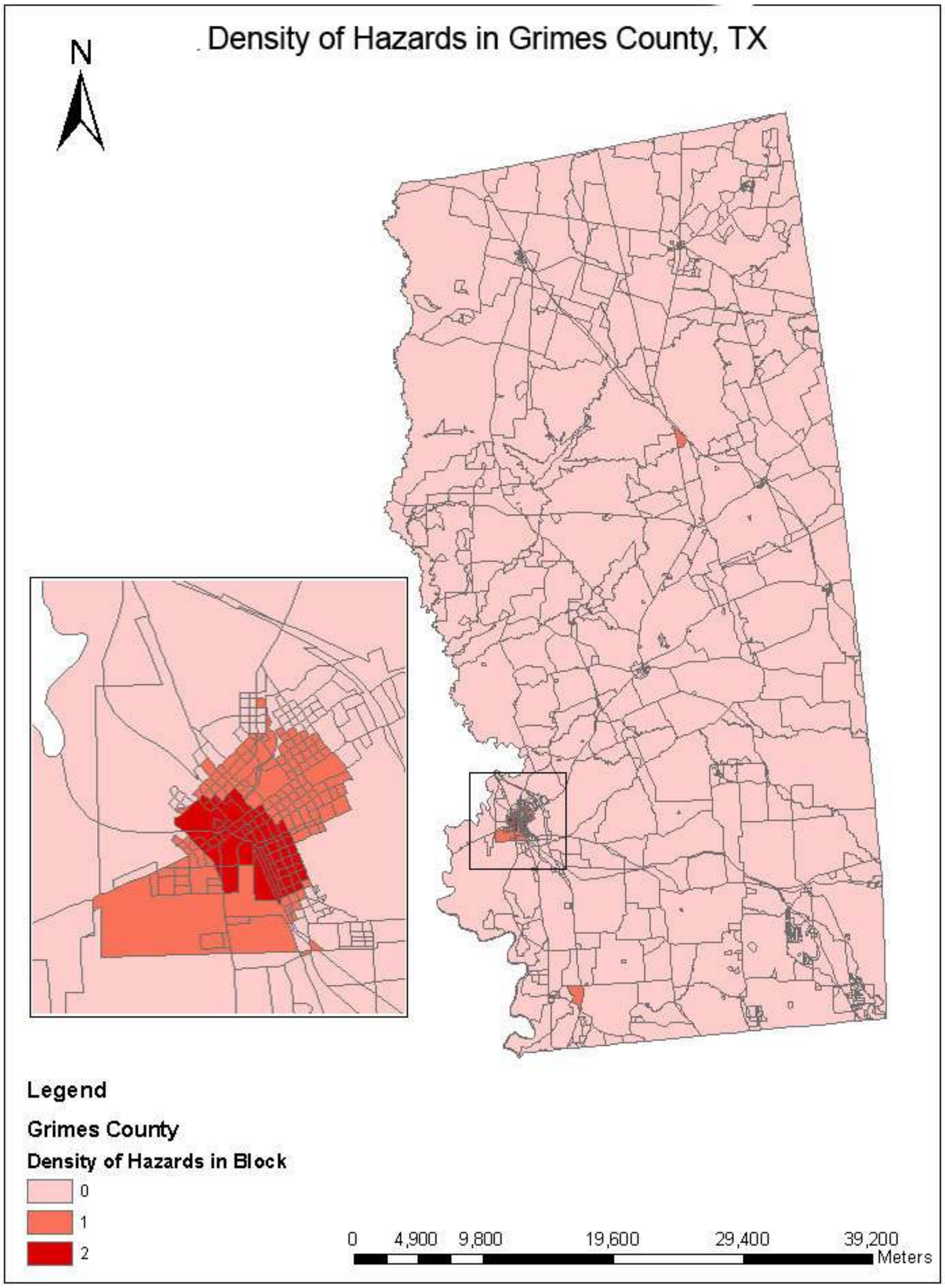

Figure 16: Density of Hazards in Grimes County

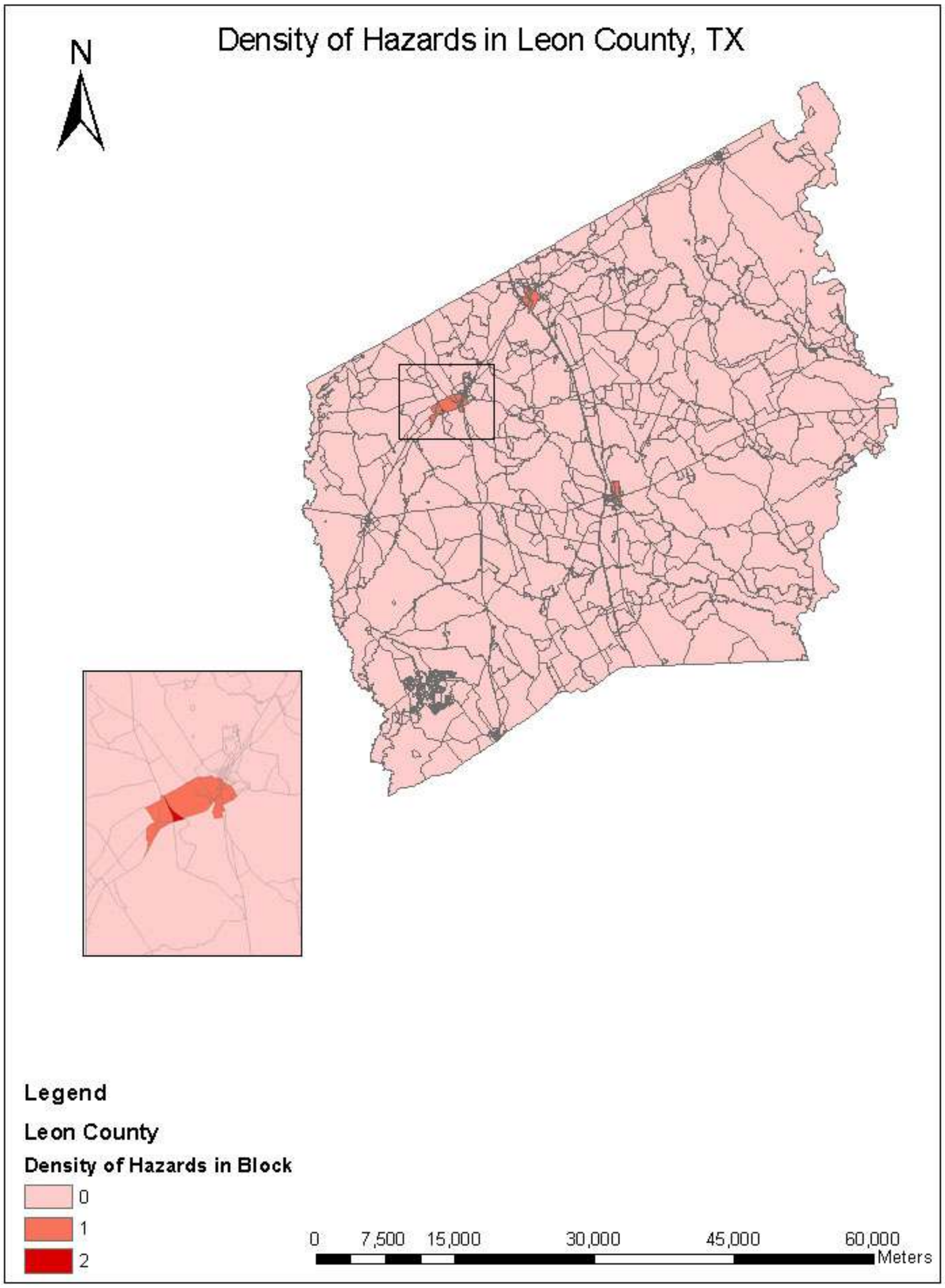

Figure 17: Density of Hazards in Leon County

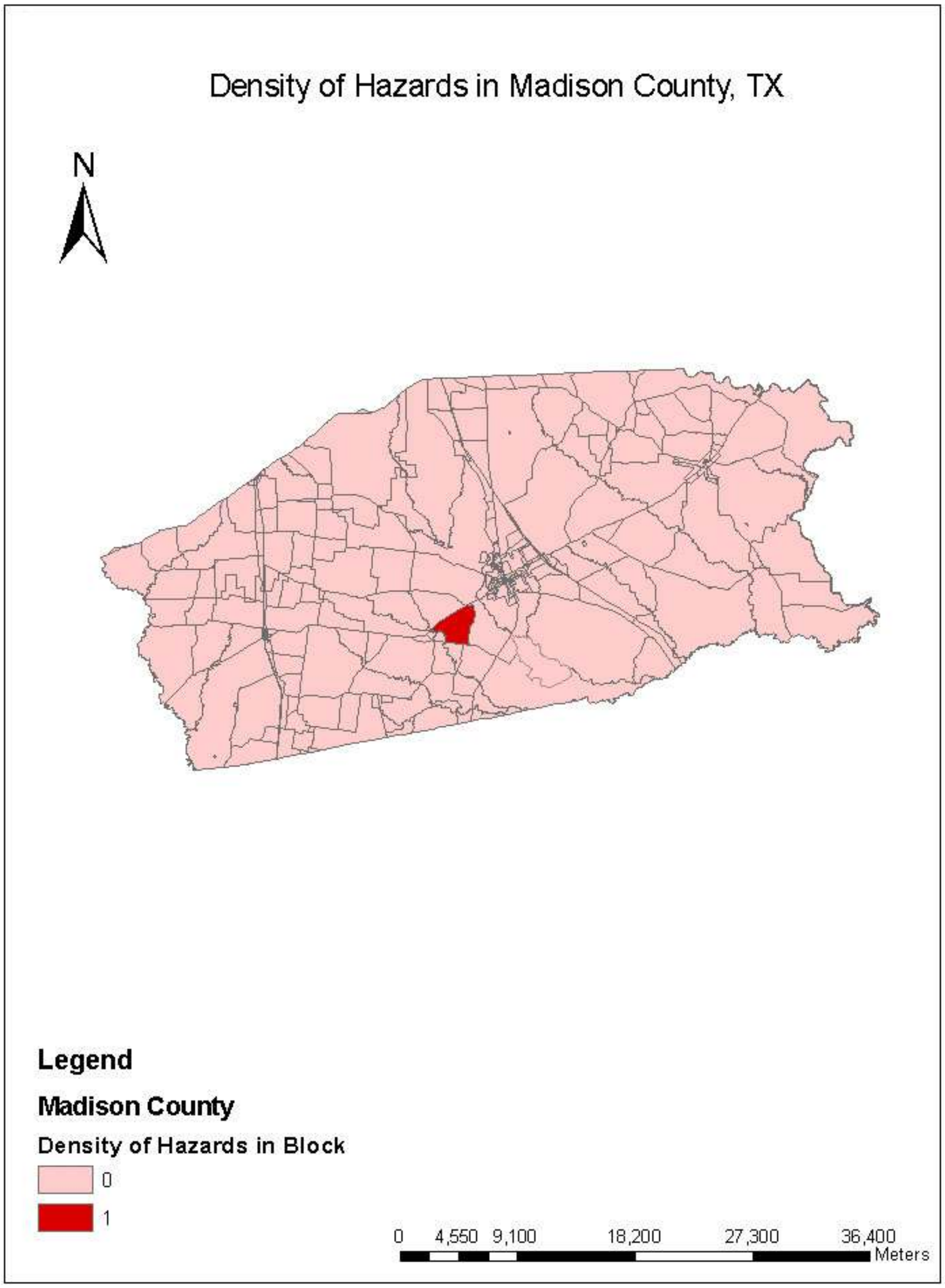

Figure 18: Density of Hazards in Madison County

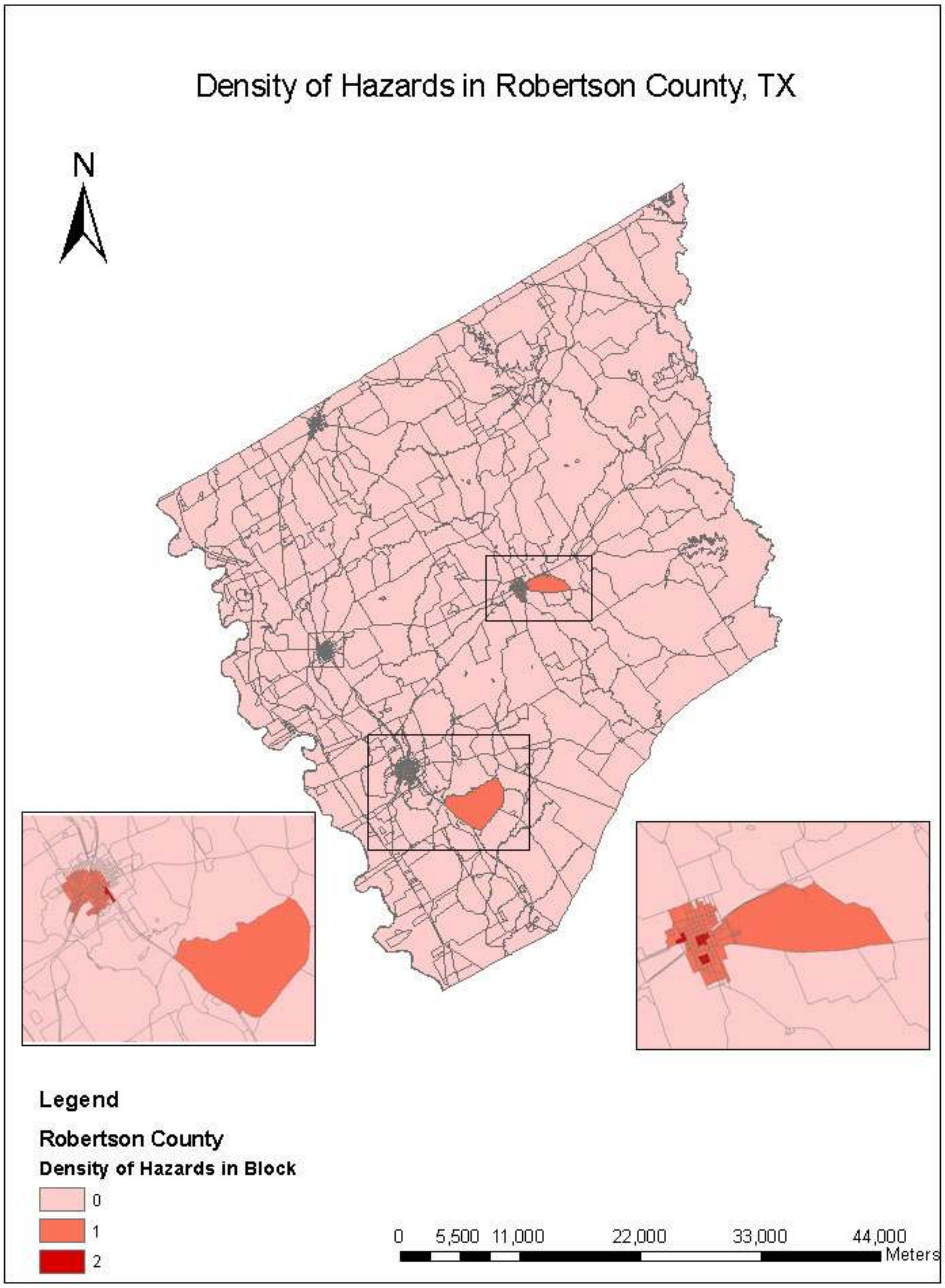

Figure 19: Density of Hazards in Robertson County

APPENDIX C

Figure 20: Former Elf Atochem Plant Site (Hanchett$_A$ 2007)

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