Environmental Justice in Dallas County ***Revisited***: A Spatial Analysis of Landfill Sites

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GEOG 5520 – Intermediate GIS
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May 1, 2003

Urban growth patterns are commonly associated with an increase in the number of waste collection and processing facilities. The impacts of these facilities produce a lower quality of environment, which is impressed upon the surrounding populations. Inevitably affecting local health conditions, the varying forms of pollution produced by waste facilities are carried through a range of formats, including, but not limited to, toxic fumes, polluted groundwater and soils, high levels of traffic noise, unpleasant odors, blowing garbage, disease-carrying pests and vermin and reduced property values. Therefore, as a method of equality studies, the potentially harmful impacts of these sites to adjacent areas necessitate a spatial investigation into the possible correlation between the location of these sites and the economic and racial array of the neighborhoods in proximity.

Following in the footsteps of the research performed by Sanchez and Williams (2001), this project performed a GIS-based investigation of the demographics surrounding landfill sites in Dallas County, Texas. Although the work done by Sanchez and Williams included various types of hazardous waste facilities, for the sake of scale, this research was limited to looking only at functioning landfill sites in the aforementioned county. Despite these limitations, this project illustrates the potential to perform a follow-up inquiry of the previous work by extending a portion of the data to include data from the 2000 U.S. Census. By probing this newer data through post-overlay statistical analysis, further substantiation surfaced for the environmental inequity discovered by Sanchez and Williams in 2001, but demonstrated an interesting dynamic occurring within the minority population of Dallas County. Furthermore, in order to understand the environmental and demographic impacts of this type of research, the inclusion of a temporal element into the methodology exposes a sort of "continuum," through which a better overall picture of environmental impact can be expressed.

Review of Literature

In conjunction with the increased awareness of issues of environmental hazards, there is a necessity for examining the demographic characteristics of those populations neighboring the waste facilities. Numerous reports from across the United States have been written discussing the health risks associated with waste processing sites (Burner et al. 1998, Griffith et al. 1998, Hockman and Morris 1998, Ortiz and Smith 1994, Tiefenbacher and Hagelman 1999, United Church of Christ 1987). The function of these demographic and economic inquiries stems from the possibility that these facilities and their dangerous products may be located in socio-economically disadvantaged areas. Fundamentally, this type of injustice has been given the term environmental inequality or even environmental racism. If, indeed, these facilities are located among disadvantaged groups, this calls into question whether or not these portions of the population are capable of presenting sufficient political leverage, such that these facilities will not be placed around their neighborhoods. On the other hand, the question also remains whether or not these socio-economically disadvantaged groups moved into the "hazard zone" *after* the facility had already been constructed. Despite the argument of sequence, the point of this type of research maintains that each individual retains the right not to be exposed to pollutants more than any other individual, based upon race, class, religion, economic status, etc. As seen in the cited works, observing the demographics of the neighborhoods enables one to expose previously unseen issues of inequality.

The use of economic and racial data from the U.S. Census Bureau has been faithfully employed by many works in order to identify economically disadvantaged groups (Sanchez and Williams 2001). Investigation of these social elements at the census tract level is particularly efficacious, particularly in terms of demonstrating the analysis through data overlay at a level that is more targeted than at the county scale. Racial data provides distributions at the census tract level, giving a constructive visualization of the demographics of the county, along with a manageable dataset. In terms of economic diversity, Sanchez and Williams (2001) suggest the use of per capita income as a measure of economic disadvantage as opposed to median income. The logic behind this choice revolves around the nature of this research question. Considering that we want to observe the overall economic situation of the county, use of per capita is used to highlight the financial impact of individuals that may not be considered through the use of solely median income. In particular, this variable hopes to include children and the elderly, who may have an unseen impact or "strain" on the disadvantaged neighborhoods.

The literature surrounding data analysis in terms of this type of project is fairly standard. This research will follow the steps used by Sanchez and Williams (2001). In their work, the data taken from the U.S. Census Bureau was strategically manipulated through a GIS, allowing for extrapolation of critical observations concerning race, economics, and hazardous waste sites.

Methodology

The base study area for this research will be within the confines of Dallas County, Texas. As can be seen in Figure 1, the county of Dallas can be broken down into its census tracts, which will then be used to perform overlay analysis of ancillary datasets.

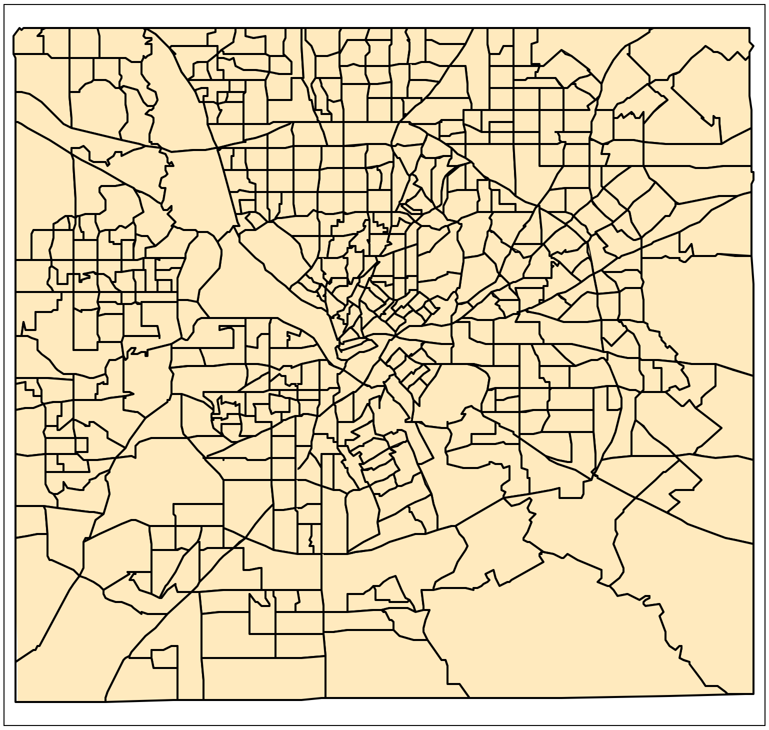

Figure 1. Dallas County Census Tracts (2000).
Taken from NCTCOG website.

Using census tracts allows for a more sensitive analysis of the dynamics of the county, rather than a broad county level inquiry. Dallas County itself lies in northeast Texas and covers approximately 908.9 square miles. The population for the county, as stated by the 2000 U.S. Census, is approximately 2,218,899, which has since grown to approximately 2,268,150 according to the NCTCOG (http://www.nctcog.dst.tx.us/almanac/~ ~co_almanac.asp?113). In 1990, the population was counted at 1, 852, 810, making for an increase of 19.8% over the 10-year period. Taken from U.S. Census statistics, **Table 1** illustrates the overall demographic changes experienced by the county in the past 10 years. The study area of Dallas County shows enormous changes in terms of its non-white population and number of people claiming Hispanic origin (any race), whereas the white population has remained fairly constant. Based upon these numbers, it is evident why concerns about race and economic disadvantages would be of some concern, especially in an active urban environment, such as Dallas County, Texas.

	Total Pop.	% White	% Non-White	Hispanic Origin (any race)	Per Capita Income
1990	1, 852, 810	1,241,455 (67%)	611,355 (33%)	315,630	$16,243
2000	2, 218, 899	1,294,769 (58.4 %)	924,130 (41.6%)	662,729	$22,603
Difference	366,089	53,314	312,775	347,099	$6,360
Total Change	19.8%	4.3%	51.2%	110%	39.2%

Table 1 Selected population demographic changes 1990-2000.
Taken from: U.S. Census Bureau 2003.

The research required using a set of GIS tasks that were capable of interpreting race and income levels surrounding landfills in Dallas County. The necessary data originated from several places, including the U.S. Census and the North Central Texas Council of Governments (NCTCOG) websites. Datasets from the U.S. Census website included breakdowns of race and per capita income on the census tract level. Use of this scale and given datasets mimics the methodology used in Sanchez and Williams's (2001) work, wherein, as stated above, the census tract permitted investigation on a more powerful scale than that of larger, countywide statistics. Furthermore, addressing income through per capita income rather than median income enhances the intensity of the investigation.

Methodologically, the flow of such research remains stringently scientific and objective. The research design followed a simple, yet the most effective route possible (see **Figure 2-** Flowchart). Fundamentally, the initial challenge of the research was amassing the proper data and placing it into usable, coordinated formats. The layers collected included: an un-abandoned landfill point shapefile, an abandoned landfill (permitted) shapefile, a county tract shapefile, and data tables for race and per-capita income generated for each census tract. The landfill point shapefile came from the NCTCOG and had a pre-defined projection in NAD 1983 (feet)

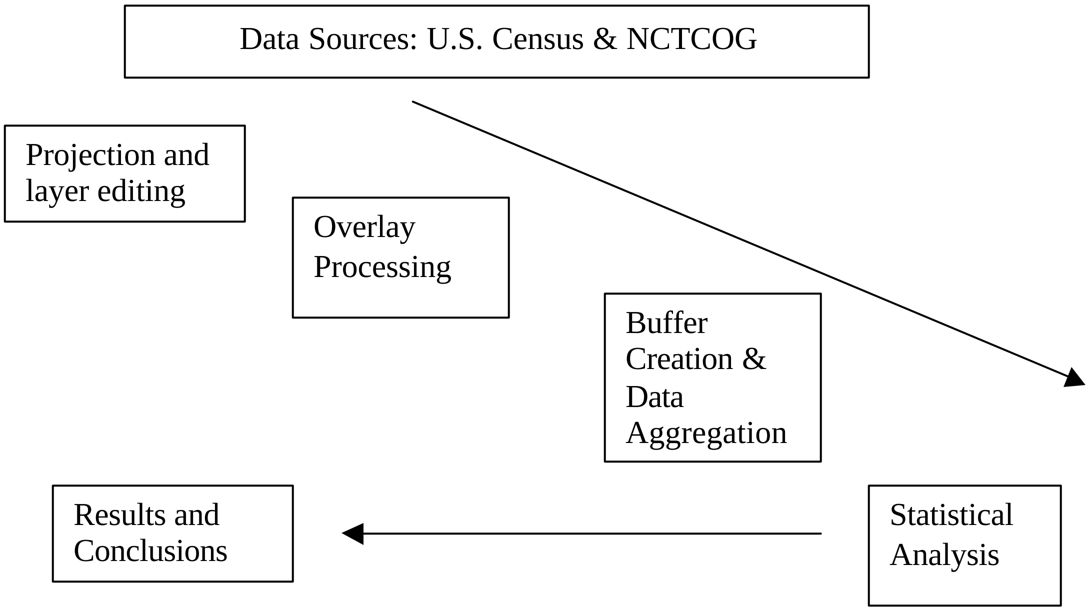

Figure 2 Research Design Flowchart

State Plane Coordinates for North Central Texas (4202). The shapefile containing census tracts from the U.S. Census Bureau was downloaded in an unprojected format and was properly defined and projected in the same SPC as the landfill file. This proved to be a learning experience in making certain that the units used in different projections matched in order to arrive at a correct extent. The steps used in geo-processing this data included clipping the point files to the tract polygons, as well as creating a manageable geo-database into which these shapefiles could be converted. Although these steps required multiple conversions, the use of a geo-database created suitable "shape area" fields in the data tables, which could be used to determine the area of each buffered area in square miles.

After the data was collected and initially geo-processed, data-joining techniques allowed for the development of new datasets, linking the race and income database with the spatial reference of the census tracts. This information was then buffered to show the impact areas, or "neighborhoods," surrounding each landfill (See **Figure 3**).

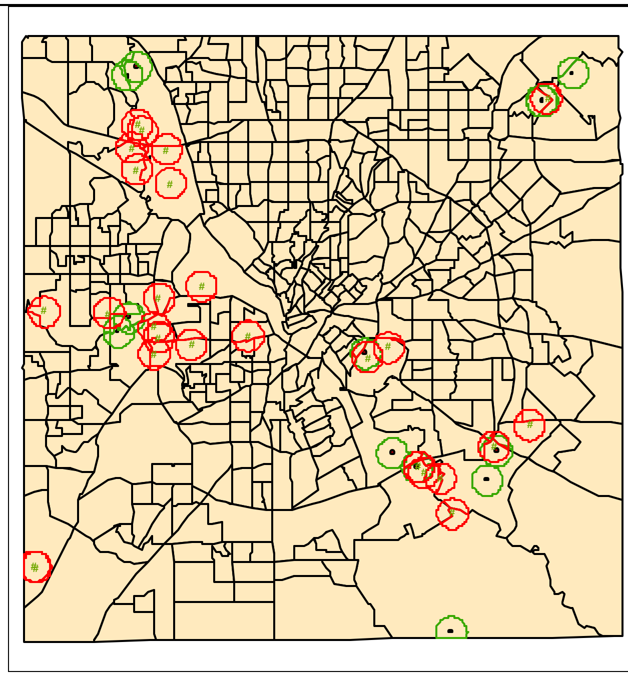

Figure 3. Buffer zones for both active landfills and permitted, abandoned landfills.

Following the model provided by Sanchez and Williams (2001), the buffer radii were designed to be the same as radii of circles with an area equivalent to the average square mileage for the census tracts. Using the geometric equation for area ($A=? r^2$), the radius for each buffer was found to be .7705mi^2, creating buffer zones that were 1.863mi^2. This proves to be a lower area than was used by Sanchez and Williams (2001), probably due to the subsequent division of the 1990 tracts. However, some of these neighborhoods overlap, causing some areas to receive a double dose of landfill impact. For the use of this investigation, however, data from each isolated buffer zone was used to determine the overall aggregated mean of the neighborhoods. In order to achieve this task, each buffer was selected and repetitious information that was associated with each tract was subtracted from the sum of the relative data field. Although this reduces the investigation of possible "double impact" encountered by some areas of overlap, the process was necessary in order to extract data from each neighborhood individually, rather than encountering skewed data due to multiple counts.

Data associated with the buffer zones was then aggregated from the census tract file. Since the square mileage for each buffer zone was known, it was possible to determine the how much of each census tract was contained within each buffer zone. Each piece of census tract that was included in the buffer zone was scaled to create proportionate data for each neighborhood (Square Mile per Tract ? Buffer Area). The portion of the zone represented by each census tract was used as a weight, from which the data from the original census tract was scaled. For instance, if the original census tract contained 50% minority and the portion of that tract within the buffer was only 10%, then the aggregated value for the variable would be reduced to 5% (i.e. 50*.10=5). The values from all the census tracts within the buffers were totaled for each tract and the duplicate records removed. This process was confirmed by a personal communication with Williams (2003). In this way, data from each neighborhood could be isolated and, then, easily transferred to a Microsoft Excel spreadsheet for analysis. Data for a total of 40 buffer zones (neighborhoods) were extracted. Thirteen of these zones were around active landfills, while 27 of the zones extended from abandoned landfills that, while they were open, had been permitted through the proper legal channels. One layer that was not included was that which contained the abandoned landfills that were un-permitted. Later addition of this data may reconstitute the current results. However, with the data layers used, the results appear to be robust enough for conclusive analysis.

In addendum to this section, I would like to note that, at first, only active landfills were used. Yet, with the fear that only 14 buffer zones would not make for a robust data set, the abandoned landfills were added. At first glance, it was interesting to note how these abandoned landfills appeared to be in the same general areas as the current landfills (See **Figure 3**). Whether this is a result of the continued use of areas already appointed for landfills, or actually a consequence of the economic and demographic nature of the area, remains to be argued.

Results

With compiled datasets, post-overlay statistical analysis proved revealing, both in terms of the current situation of landfill location, as well as in comparison to the results from the report by Sanchez and Williams (2001). By comparing the means of the two data assemblages with a *z* test, differences between the buffer zones and county averages for both attributes were discovered, one more dramatic than the other. Two separate tests were run, one for race minority percentages and another for per capita income. The initial null hypothesis states that there should be no difference between the areas contained within the buffer zones and the rest of the county. Scores for each variable can be seen in **Table 2**. Based on the 40 observations made from aggregated data around the landfills, the z scores indicate a significant difference between the neighborhoods and the whole county for per capita income. However, the z statistic for percentage minority barely surpasses the critical z value, with a p-value of 95%. Based on the z score, the results here show that one should reject the null hypothesis and conclude that there are

Minority %		**Buffers**	**County**
Mean		56.84	54.73
Known Variance		494.08	801
Observations		40	487
Hypothesized Mean Difference		0	
z score		1.6413	
Critical z value	(95%)	1.64	

Per Capita Income		Buffers	County

Mean		17032.20	24,085
Known Variance		60,860,359	327029478.7
Observations		40	487
Hypothesized Mean Difference		0	
z score		8.6067	
Critical z value	(95%)	1.64	

Table 2. Results from z-tests for both variables.

statistically significant differences between the buffer zones and the rest of the county, in terms of percent minority and per capita income. **Figure 4** depicts a map of the census tracts, highlighting those that have a minority percentage greater than 60%. **Figure 5** illustrates those tracts with a per capita income of less than $15,000. Included in both of these maps are the locations of the landfill sites, with which there appears to be an apparent connection. One condition to the interpretation of significance within these statistics exists in the fact that the z statistic for percent minority just barely crosses the line of significance. Alternative interpretations for this observation will be discussed in the conclusion section that follows.

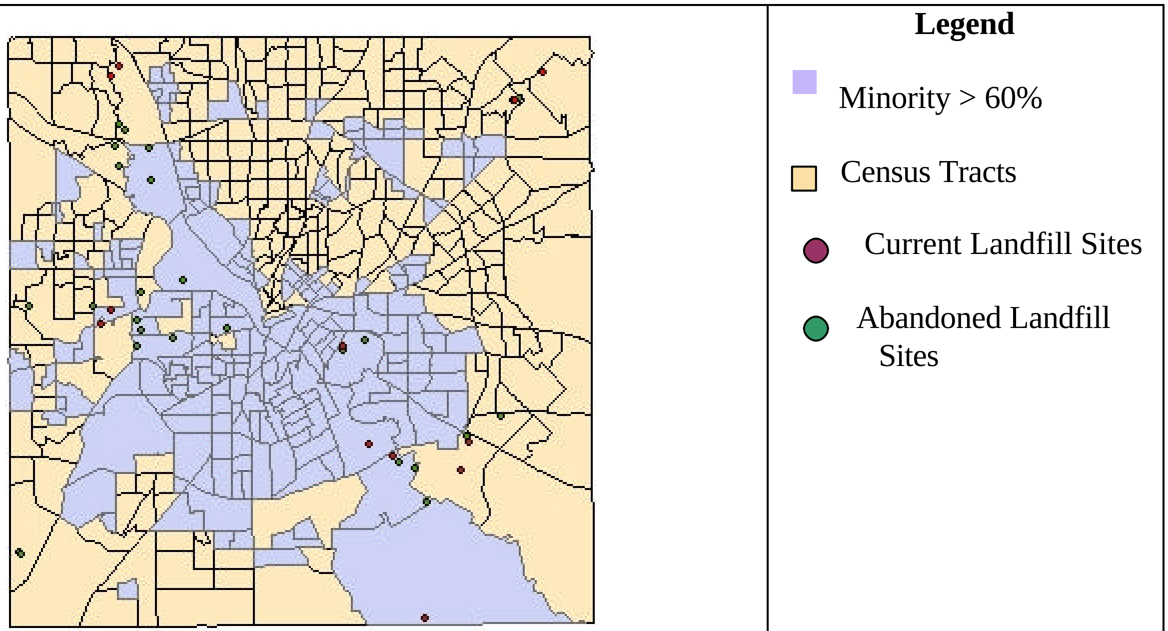

Figure 4 Landfill Sites and Census Tracts with High Minority Populations

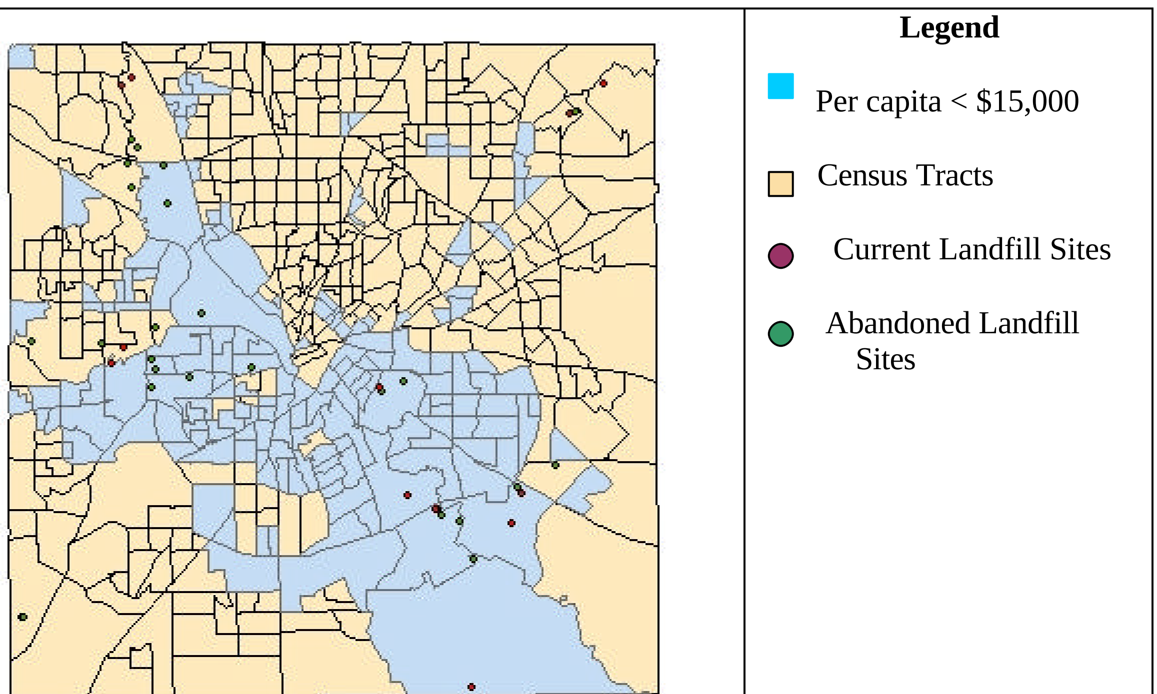

Figure 5 Landfill Sites and Census Tracts with Low Per Capita Incomes

Conclusions

Joining a Dallas county census tract shapefile with race and income datasets permitted the research to differentiate the demographics in proximity to the hazardous landfill sites. Consistent with the methodology used by Sanchez and Williams (2001), this demographic data elucidates a continued inequity surrounding the landfill sites. However, based upon the z statistic for percent minority, one could argue that this observation of significance could be incorrectly assigned due to the rather small sample size (n=40). If this is the case and the percent minority is argued to not be statistically significant, this leads one to question why the per capita income remains such a strong indicator of inequity around landfill sites. This result could quite possibly be due to the changing demographics of the county. Within the last ten years, it appears that there has been a significant increase of minority population within the county as a whole. Areas that consisted of predominantly minority populations have remained so, whereas other areas have seen an influx of minorities. However, the per capita income levels have remained significantly lower within areas around the landfills. One could argue that is factor is attributed to the overall low land value, in terms of residential area use, surrounding landfill sites. Furthermore, although minority populations are increasing, diversity of income levels are remaining the same to some degree. This might account for the strong per capita income z value and the weaker z value for minority percentage. Nonetheless, the results show an uneven distribution of these sites around areas of lower income and higher minority percentages. With the changing demographics over the last ten years, however, the initial placement of these facilities in low income, high minority areas has created specific areas that have remained on the extreme ends of the spectrum, in terms of these variables. The results indicate the continued degradation of these types of facilities in an area, despite the growing minority population in the county.

Although research of this design has been performed with revealing success, the nature of this project managed to extract a single element of that previous research and strategically employ the most up-to-date demographic information. The consequences of such an endeavor promise to not only address the issue of environmental inequity in Dallas County, but also hope to promote the continuation of such research over time. By advancing the study over a temporal landscape, a more lucid understanding of the overall environmental and political dynamics in this situation can be addressed. The welfare of disadvantaged citizens provokes this research and should prompt others to influence policy makers and scientists alike to take into account the combined impacts of industry, location, and policy.

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