

# A Spatial Analysis of Socio Demographics Surrounding Landfill Sites in the Dallas - Fortworth Area of Texas

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**Abstract:** An increase over the past decades occurred in the number of wastes produced and disposed into landfills. These facilities produce a lower quality of environments, which impact the surrounding population and inevitably affects the public health conditions. This research performed a spatial analysis using GIS to investigate the demographics surrounding landfill sites in the Dallas-Fort Worth area. This research utilizes data from the 2015 US Census Bureau to identify selected socio-economic variables within the landfill sites' surroundings.

The spatial distribution result shows that there are disproportionately exposed minorities and low-income populations in Tarrant and Dallas Counties to the environmental hazards. The study is useful to local agencies and community-based organizations (CBOs) seeking to advocate for their communities.

**Keywords:** *Spatial Analysis, Landfill, Environmental Justice*

## I. INTRODUCTION

Over the past decades, there has been compelling evidence confirming the existence of racial and socioeconomic disparities in the distribution of environmental hazards. Research has shown that minority and low-income communities have been exposed to a higher level of environmental pollution and health risks than other society at large [1, 2, 3]. In response to this convincing evidence, the civil rights movement was founded in the 1960s to raise awareness of the disproportionate exposure to toxic pollution [4]. Subsequently, Executive Order 12898 was enacted by President Clinton in February 1994, requiring every federal agency to address the inequalities and achieve the principle of environmental justice in the United States [1].

Environmental Justice (EJ) is defined as the "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" [5]. The EJ movement was founded on environmental equity, the belief that every person has the right to a safe environment. However, this principle is seldom realized in the United States because analysis and research still show that minority and low-income neighborhoods are still relegated to bear the burden from toxic waste sites [6, 7, 8]. Prior researchers have conducted several analyses to demonstrate racial and socioeconomic disparities in the distribution of environmental hazards. Despite the progress made to recognize environmental inequalities, scholars still found some considerable variations in the magnitude of socio-demographic disparities [9].

The earliest research found racial disparities associated with hazardous facilities [10, 11], while some

researchers found income to be a significant factor [12]. However, some studies have found no variation and disparities in race and income associated with the presence of environmentally hazardous sites [13].

The likely source of these uncertainties has been attributed to the use of a conventional method (Unit Hazard method) to address and assess racial and socioeconomic disparities associated with the presence of environmental hazard facilities [9, 14]. Also, most of these researches were cross-sectional, meaning that the socio-demographic characteristics of the neighborhoods hosting the landfills were analyzed at a specific point in time.

These kinds of analyses do not adequately address the trends or magnitude of disparities over time. Although there are longitudinal analyses available on environmental justice, these studies are few and have led to confusing and contradictory findings [15]. Therefore, to fill in the research gap, recent studies need to be carried out to examine whether racial and socioeconomic disparities persist in the location of hazardous waste facilities in the DFW region.

Conversely, most cities in America have experienced increased population growth and diversity over the last decades, and these trends are expected to continue [16]. The Dallas-Fort Worth (DFW) is the largest metropolitan area in Texas [17], and according to [18], it will become the third-largest metropolitan area in the U.S. (behind New York City and Los Angeles) by 2030. The increased population growth rate has led to an increase in the consumption of human-made and natural resources [19]. Subsequently, the increased consumption of resources will increase trash production to disposed of to the landfill. According to the [20] report, American generates more municipal solid waste per person than any other country, with the average person generating about 4.3 pounds of waste per day [20]. However, according to the [21] report, an average person in the DFW generates about 7.22 pounds of waste per day, which is higher than the average generated in the United States per day.

In 2016, approximately 34.73 million tons of solid waste was disposed into landfills in the state of Texas [22]. Although tremendous efforts have been made to minimize the amount of waste disposed of by engaging in comprehensive recycling programs [23], the EPA (2014) reports still show that over 55% of the waste generated each year ends up in one of over 3,500 landfills in the United States. The continuous production and disposal of trash into landfills will jeopardize neighborhoods' environmental and health quality surrounding the toxic waste facilities. Several research types have shown that the environmental degradation due to landfills emissions has also led to health conditions such as asthma, diarrhea, cholera, and tuberculosis more than the residents living far

away from landfill sites [24, 25, 26, 27]. Several kinds of research have linked landfill sites to adverse health issues such as Cancer, Leukemia, congenital heart disease, low birth weight, chronic respiratory diseases, etc. [27]. The health impacts on these vulnerable populations are further amplified by several other socioeconomic factors such as poverty, lack of access to proper healthcare, healthy food, unemployment, lack of education, and public transportation [28]. Therefore, to determine the current socio-demographics surrounding communities at proximity to the landfills, a spatial investigation into the probable correlation is necessary. This study aimed to evaluate the socio-demographics surrounding the landfills in the DFW area to determine if the environmental inequalities still exist.

## II. STUDY AREA

The Dallas–Fort Worth (DFW) occupies a large area in the North Central and the Prairies and Lakes region of Texas. It occupies a total area of 9,286 square miles, out of which 8,991 sq. mi is land and 295 square miles is water [29]. The DFW is the largest metropolitan area in Texas [17] and the fourth largest in the United States, with a total population of over 6.83 million, according to the 2015 estimate of the US Census Bureau. The DFW has experienced a consistent increased rate in population growth and diversity. According to the US Census Bureau (2016), the DFW population grew by approximately 31.31% from 5,204,126 in 2000 to 6,833,420 in 2015. The DFW comprises twelve counties, namely: Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise County [30]. According to the 2017 TCEQ list of active landfills in Texas, there are nineteen (19) active landfills sites in the DFW area. Seventeen out of the nineteen sites are Type 1, while the remaining two sites are Type IV. The Type 1 landfills are in eight counties: Collin, Dallas, Denton, Ellis, Hunt, Johnson, Parker, and Tarrant Counties. Figure 1 below shows the map of the Dallas-Fort Worth region with the twelve counties and all the active Type 1 landfills. The map reveals that Dallas County has four landfill sites, making it the county with the highest number of landfill sites.

## III. METHOD

The Geographical Information System (GIS) is used in this study to spatially evaluate and compare the socio-demographic disparities surrounding the landfill site in the DFW region. The data utilized was retrieved from several places, including the North Central Texas Council of Governments (NCTCOG) and the US Census websites. The landfill shapefile was downloaded from the TCEQ website and had a pre-defined projection in NAD 1983 (feet) State Plane Coordinates. The landfill shapefile comprises of both the active landfills point shapefile and the abandoned landfill (permitted) shapefile. The current location of the landfills was verified by using google earth maps. The census tract hosting each landfill was identified using the US Census Geocoder, a web interface tool used to convert addresses to an approximate coordinate – longitude and latitude that includes the census geography the address is within [31]. The Census boundary shapefile was downloaded from the US Census Tiger line. DFW's racial and socioeconomic data were from the 2015 American Community Survey- 5 years' estimate, retrieved from the US Census Bureau database. The unit of analysis is at the census tract level. The datasets collected from the US Census website include a breakdown of race/ethnicity, median household income, median housing property, and educational attainment. These variables were used in prior Environmental Justice (EJ) research [32, 3] to assess demographic disparities in environmental hazards distribution. The selected variables were chosen because they identify and represent the community's minority group and well-being.

## IV. RESULTS

A descriptive statistic was calculated for the selected variables presented in Table 1 below to investigate the DFW's racial and socioeconomic characteristics. The total number of census tracts sampled in 2015 census tracts was 1,324. The results show that the white populations are the predominant racial groups with mean values of 48.38%, followed by Hispanics 28.45%. DFW's median household income is \$65,178, and the percentage below the poverty level is approximately 15%. The median housing value of the area is \$180,103.

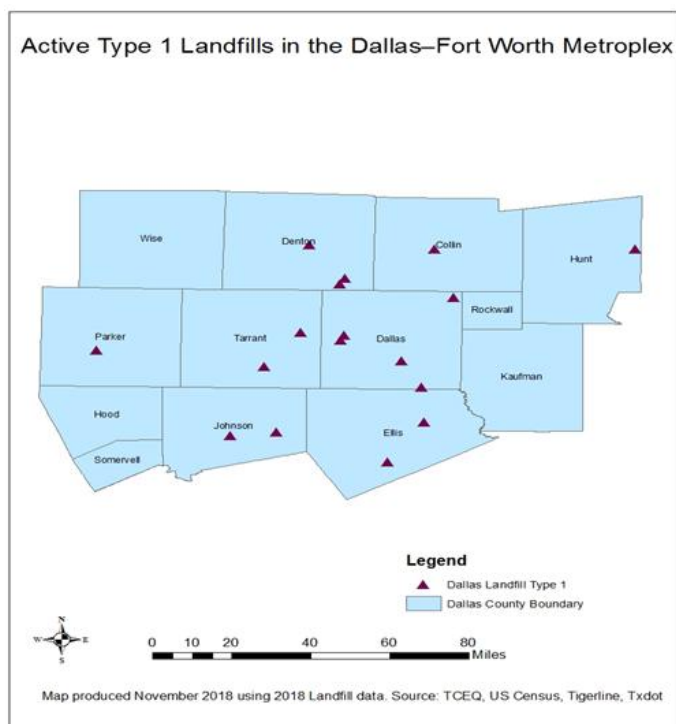


Figure 1: Type 1 Landfills in the Dallas-Fort Worth

Table 1: Descriptive statistics for selected variables in DFW

Variables	2015	
	Mean	Std. Deviation
Total population	5,161	2,513
% white	48.38	26.51
% Black	14.98	17.77
% Asian	5.755	8.22
% Hispanic Population	28.45	21.92
Median Household Income	\$65,178	\$34,123
% Person below poverty	15.55	12.52
Median Housing Value	\$180,103	\$141,493
% Less than high school	16.99	15.27
% High school graduate	22.78	9.64
% Some College no degree	21.876	6.62
% Bachelor and over	21.09	12.98
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Source: US Census data 2015– American Community Survey – 5-year estimates

Figure 2 shows the percentage of the White population in DFW in 2015. The result shows that most census tracts with a higher proportion of Whites are in Wise, Parker, Hood, Kaufman, Johnson, and Hunt Counties, further away from the landfill sites and Dallas and Tarrant Counties. Figure 3 displayed the proportion of the African American population in the DMA. The census tracts hosting the highest proportions of African Americans (i.e., greater than one standard deviation above the mean [32.75%]) are concentrated in Tarrant and Dallas County, where most of the landfills are located. The percentages of Hispanic population displayed in Figure 4 show that most of the census tracts with the highest proportions of Hispanics (i.e., greater than one standard deviation above the mean [50.37 %]) in Dallas, Ellis, and Tarrant Counties where the majority of the landfills are located.

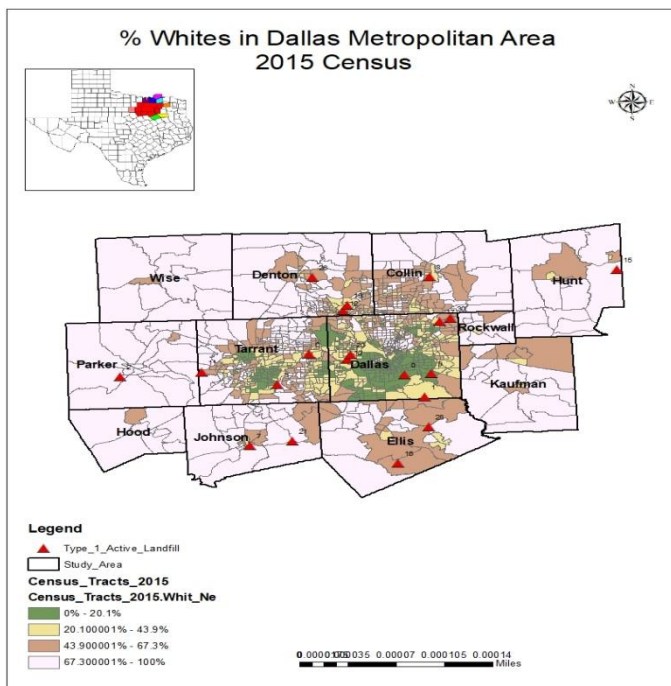


Figure 2: Proportion (%) of White population, DMA (2015)

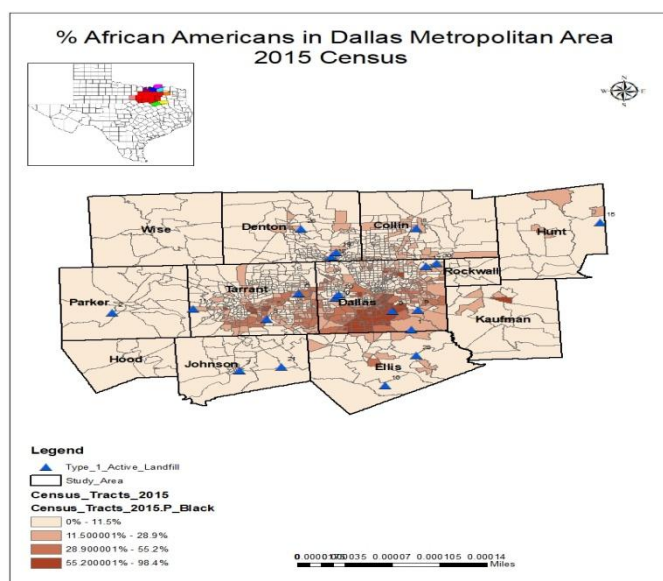


Figure 3: Proportion (%) of African American population, DMA (2015)

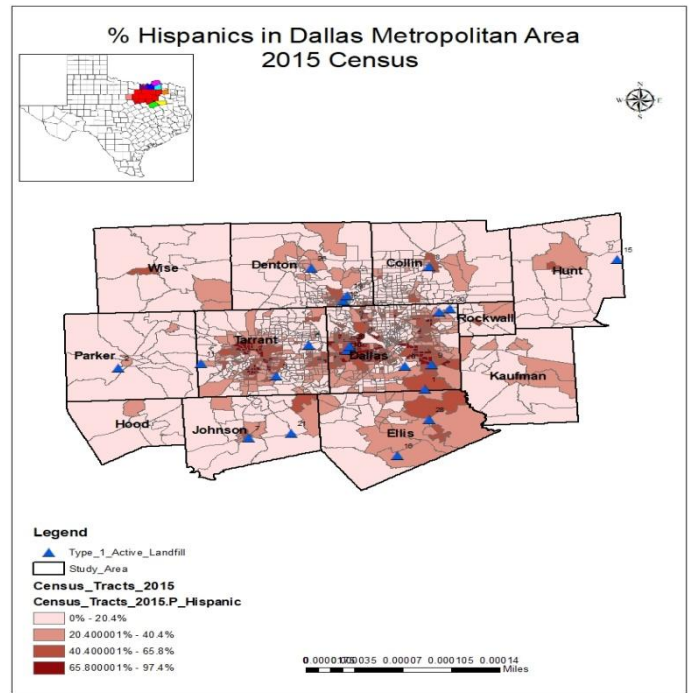


Figure 4: Proportion (%) of Hispanic population, DMA (2015)

The socioeconomic indicators in Table 1 show that the median household income was \$65,178 in 2015. Figure 5 reveals that the census tracts with the highest median household incomes (i.e., greater than one SD above the mean [\$99,301]) are in Tarrant, Dallas, Denton, and Collins Counties, further away from the landfill sites. While, the census tracts that host people with household income less than \$44,450 are in Tarrant and Dallas Counties, and some few census tracts in Johnson, Dentins, and Collins Counties, closer to the landfill sites.

Also, from Table 1, the median housing value of DFW was \$180,103 in 2015. Figure 6 shows that the census tracts with the highest median housing values (i.e., greater than one SD above the mean [\$321,596]) are in Dallas and Tarrant counties, further away from the landfill sites. In contrast, the census tracts with the lowest median housing value (i.e., less than \$131,000) are concentrated in Tarrant, Dallas, Kaufman, Ellis, Hunt, Wise Counties, and some part of Collins County, but all within the neighborhood surrounding the landfills sites.

The educational attainment revealed in Table 1 shows that the mean value of people less than high school graduate was approximately 16%, while the percentages of people with a bachelor's degree were 21%. Figure 7 reveals that people with less than high school graduates live in the census tracts closer to the landfill (Tarrant and Dallas Counties). In contrast, a higher proportion of people with bachelor's degrees live further away from the landfills in Collins, Denton, Dallas, and Tarrant Counties.

**DISCUSSION**

This study used Geographic Information System (GIS) technology to examine neighborhoods' racial and socioeconomic disparities close to the landfill site. Looking at the DFW region results, the map reveals that out of all the counties in this region, Dallas, Tarrant, south of Denton, and northeast Ellis Counties are the most vulnerable counties to environmental hazards. In total, these counties host twelve out of the seventeen Type 1 Landfills in the areas. Dallas County is hosting the most facilities with four (4) landfills sites, Tarrant County is hosting two (2), Denton is hosting three (3), and Ellis is hosting three (3) landfills sites. These counties, especially Dallas and Tarrant Counties, have a higher concentration of Hispanics and African American percentages residing close to the landfill sites, while the proportion of White are lower closer to the landfills and increases across the varying distances further away from the landfills. Although the DFW region has experienced an increased population over the years, which might have contributed to the increase in the percentage of people of color, the outcome of the result supports the scholars who found racial disparities associated with hazardous facilities and claim that minorities are disproportionately exposed to environmental hazards [3, 11].

The result also revealed that the census tracts that host low-income populations are in Tarrant and Dallas Counties are most vulnerable to environmental hazards. Few census tracts in Johnson, Denton, and Collin Counties, closer to the landfill sites, also host some low-income populations. This evidence also supports the claim that the low-income population is exposed to environmental hazards [12].

Also, the finding reveals that the census tracts hosting landfill sites in the DFW area have lower property values than the non-host areas. The reduced property value closer to the landfills or the affordability of these neighborhoods' properties could have attracted minorities population with low-income. The reduced value of properties in these neighborhoods supports the claim that the landfill's presence could significantly impact the value of properties around the sites [33, 34]. Similarly, the percentage of people with less educational status tend to live closer to the landfills site in Tarrant and Dallas Counties. The educational attainments can contribute to the resident's awareness of public health and environmental risks, thereby informing their decisions on where to live.

**CONCLUSION**

The outcome of our findings reveals that a higher percentage of the minorities and low-income people resides in the communities hosting the majority of the landfill sites in the DFW area. Also, a higher proportion of people with less than high school graduates live close to landfills. Likewise, the host census tract's property values are lower than the census tracts not hosting a landfill. Although we cannot determine if the landfill sites were there before migration into the neighborhood, the outcome of the findings shows that people of color and low-income are most vulnerable to environmental and public health hazards. Therefore, this study can serve as information to be used by local and federal agencies for future siting of landfills in the DFW area. Denton, Tarrant, and Dallas Counties host more waste disposal sites than the other counties in the Dallas area, so they should not be considered for future siting of landfills in the DFW region.

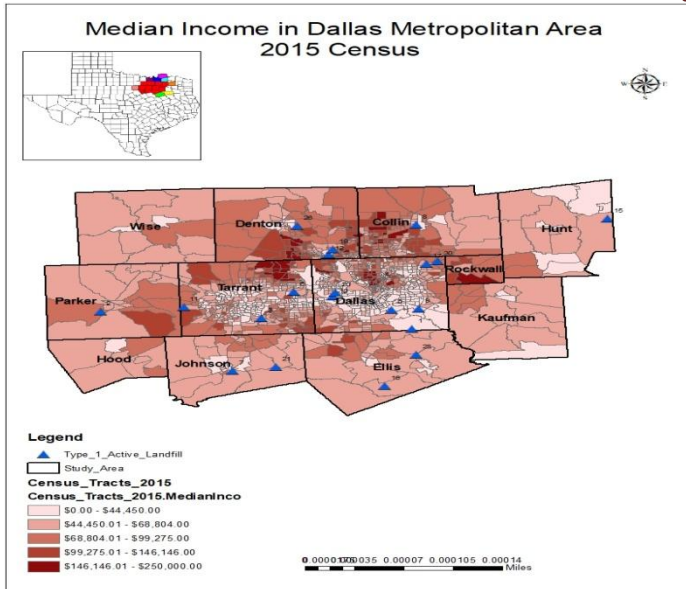


Figure 5: Median Household Income, DFW (2015)

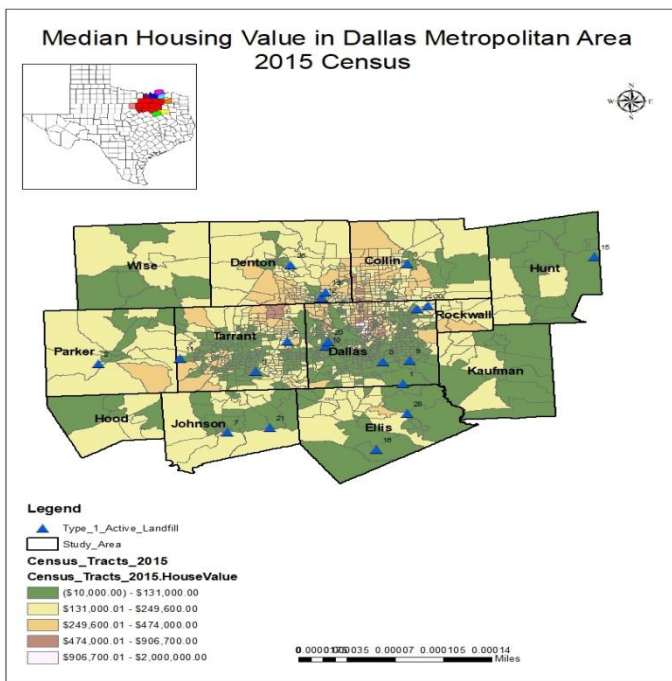


Figure 7: Median Housing Value, DFW (2015)

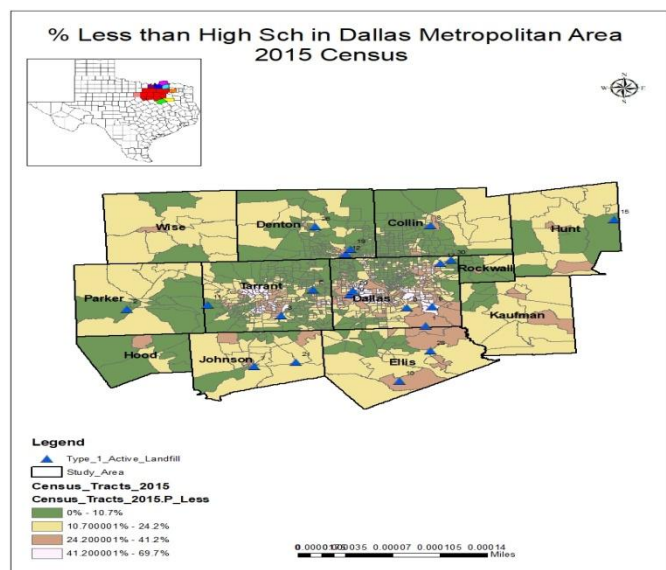


Figure 7: (%) less than high school grad, DFW (2015)

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