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GEOG 5229

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Race and Infrastructure: Analyzing the relationship between sociodemographic variables, toxic release sites, and pollution in Ohio

Summary

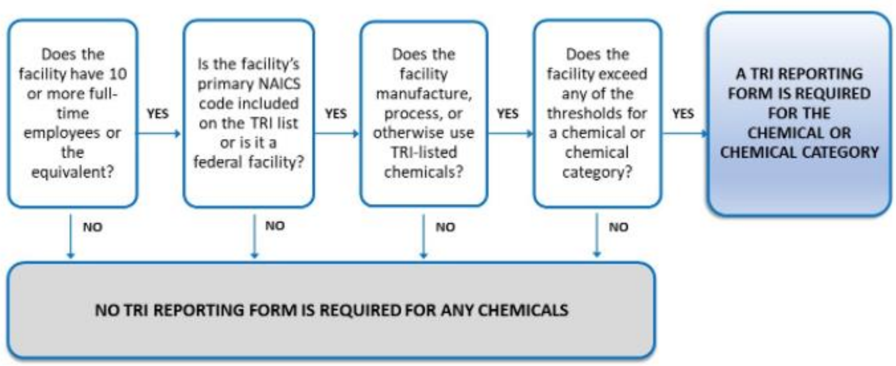
Using data the from the Environmental Protection Agency's Toxics Release Inventory (TRI) Program, the American Community Survey, and the Surface PM 2.5 dataset from Washington University in Saint Louis from the Atmospheric Composition Analysis Group, we conducted an analysis on the intersection of race and exposure to toxic sites and pollution. Highlighting the Census Bureau's racial demographics of White, Black, Asian, and Hispanic as well as median household income, we were able to plot their prevalence in Ohio. The project aims to inform the reader/viewer about the structural racism of infrastructure in the United States, specifically in Ohio. The results of the study provide evidence for a disparity in exposure to pollution. Minorities in the state of Ohio tend to live in areas where toxic release sites are located, according to this analysis.

Introduction

Racial discrimination has increasingly been brought to light in recent years and permeates society in numerous ways. We considered some of these issues through analysis of sociodemographic variables and toxic release sites in Ohio. We were motivated to discover if there was a relationship between racial minority prevalence, toxic release sites, and pollution. After reading Vann R. Newkirk's "Trump's EPA Concludes Environmental Racism Is Real" where it was found "that people of color are much more likely to live near polluters and breathe polluted air, we wanted to take a look at our home state and see how environmental racism impacts our friends and family in Ohio (Newkirk). We predicted that there would be a positive correlation between the presence of minorities and the presence of toxic release sites and pollution given prior anecdotal conversations and after reading the article. That being said, we were unsure which racial minorities would be more impacted and if potentially some racial minorities would be less impacted than whites by toxic release sites. Our prediction was that Hispanics and Blacks would be more impacted by toxic release sites and pollution than whites and that Asians would be less impacted than whites. All of this is based on prior understandings of sociodemographics, therefore we used correlations to prove whether this holds, at least in Ohio. This is important because "according to the EPA, chemicals covered by TRI typically cause cancer or other chronic health conditions, significant adverse acute health effects, or significant adverse environmental effects" ("What is TRI," n.d.). Tracking this is crucial because while we predict that racial minorities are going to be more adversely impacted by toxic release sites and pollution, we also know (from Assignment 5) that minorities in Ohio generally have lower access to healthcare as well. We considered looking at Ohio given the relatively high population, pollution, as well as our own familiarity with the state. Additionally, through a narrower scope, we looked at data at the zip code level. For each zip code, we considered the prevalence of minorities, pollution, and toxic release sites to answer if there is a correlation between race and exposure to toxicity. The zip code level is a better scope to look at as the county level would generalize data, especially in cities.

Data

The Toxics Release Inventory (TRI) dataset is provided by the U.S. Environmental Protection Agency on an annual basis since 1987. The 2020 dataset was used in this analysis, it contains the 100 most requested data fields from the TRI forms. This includes facility names and locations, industry sector, name of the chemical, total releases, and more. TRI is a mandatory program for qualifying facilities. The infographic below details the process of determining whether a facility must report its release information. A "release" is defined as a chemical that is emitted into the air, water, or some type of land disposal ("What is TRI," n.d.).



Infographic Provided by EPA

Sociodemographic data was gathered from the American Community Survey 5-year estimates from 2019. Variables extracted were at the zip code level for Ohio and included population that is Black, Hispanic, White, and Asian. Median income was also gathered. Finally, surface PM 2.5 data was gathered from Washington University in Saint Louis from the Atmospheric Composition Analysis Group. The 2019-10 dataset was used. PM 2.5 is an air pollutant that can pose risks to human health at high levels. PM stands for particulate matter and 2.5 is in reference to the size of the particles, just 2.5 microns or less. The small size is what makes this pollutant dangerous as it can travel deep into the lungs ("Fine Particles Questions and Answers," n.d.).

Methods

Multiple approaches were used to estimate the following three questions:

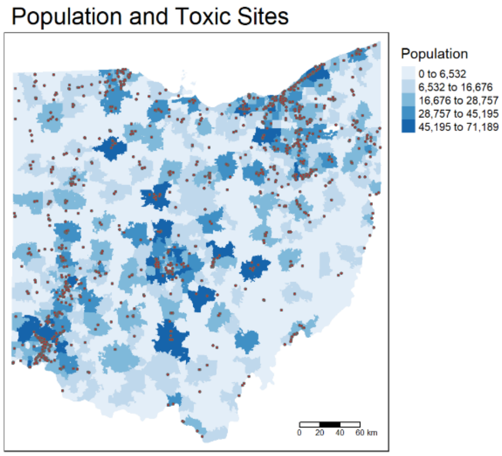
1. What is the distribution of toxic release sites in Ohio?
2. How do the locations of toxic waste sites correlate with demographic variables?
3. Is there a relationship between the incidence of toxic waste release and air pollution?

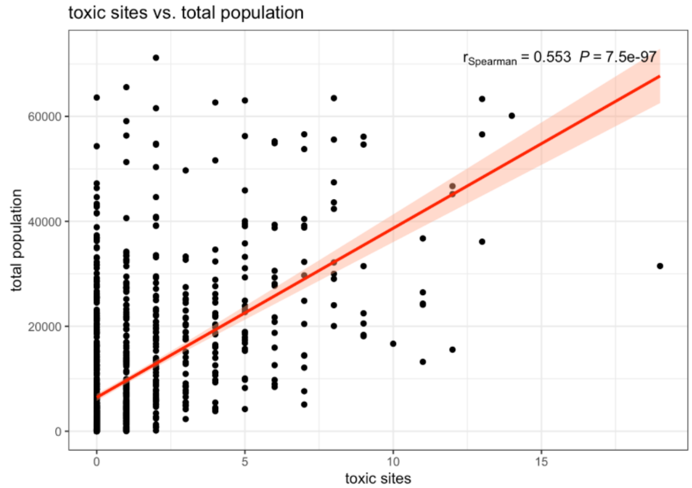
To explore the distribution of toxic sites, a map of their locations was made for the state. In order to create this map, it was necessary to adjust the TRI dataset to drop all duplicates. The TRI dataset includes an entry for each chemical that a facility has released. For the purposes of this analysis, the location of sites was the only thing considered, so duplicates were eliminated. Toxic site locations were aggregated to the zip code level to calculate the number of sites per zip code. The choice to aggregate to the zip code level was due to the number of toxic sites throughout the state. Approximately 1233 toxic sites are located in Ohio, compared to 1197 zip codes. Although zip codes are larger in area and therefore less precise than a measure like census tracks, of which there are 2952 in Ohio, zip codes are more precise than a unit like counties or congressional districts.

Next correlations were calculated between sociodemographic variables of each zip code and the number of toxic site locations in that zip code. These variables were mapped to draw conclusions visually. The relationships of particular interest to this analysis were between number of toxic sites per zip code and population, percent of zip code population that is Black, Hispanic, Asian, and White, and median income. These relationships were visualized on a scatterplot where the line of best fit, the strength, and the significance of the relationship was found. The correlation between air pollution and the number of toxic sites was calculated for each zip code as well to determine whether there may be a confounding effect from these pollutants on certain communities. As another measure, the distance between each zip code center and the nearest toxic site was calculated and correlated with select sociodemographic variables.

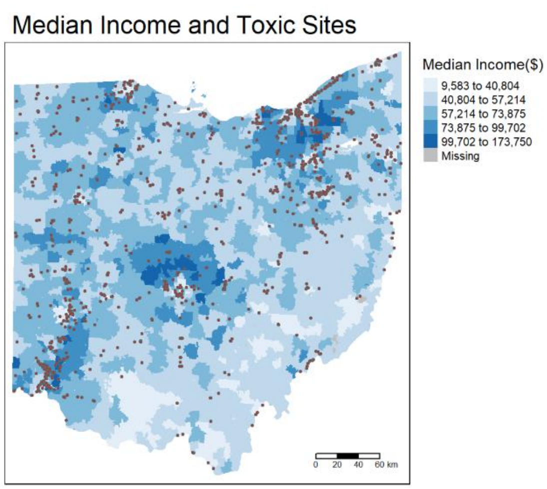
Results

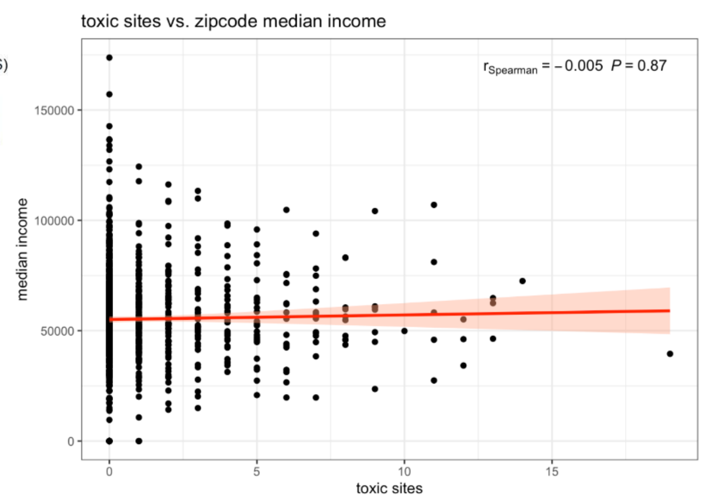
In this study, we examined many variables and their relationship to toxic sites in all Ohio zip codes. We mapped toxic sites in relation to population, median income, White populations, Black populations, Asian populations, Hispanic populations, and air quality. We did this in order to visualize the relationships between each variable and toxic sites in Ohio. Along with mapping these variables, we also ran correlations between each variable and toxic sites to quantify their relationships. The map titled *Population and Toxic Sites* shows us the distribution of total population in comparison to toxic sites in Ohio. Visually, this map shows us that the majority of toxic sites are found in areas of high population density. From the correlation plot, *Toxic Sites vs. Total Population,* we can see that as the population increases, so does the number of toxic sites. With an extremely low P-value, we can be 99% confident that there is a strong, positive correlation between toxic sites and total population, but we cannot assume that there is a causal relationship between these two variables because there are so many other factors to consider with this data.



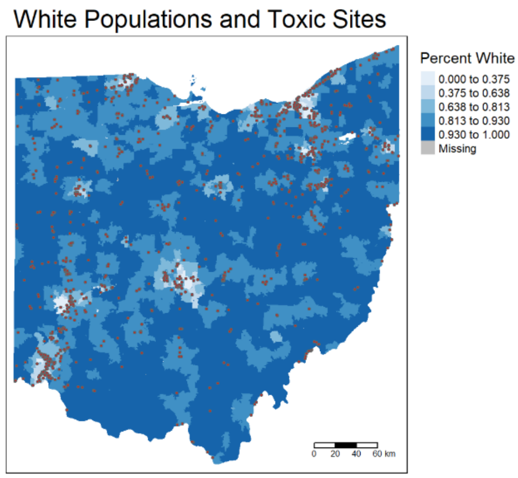


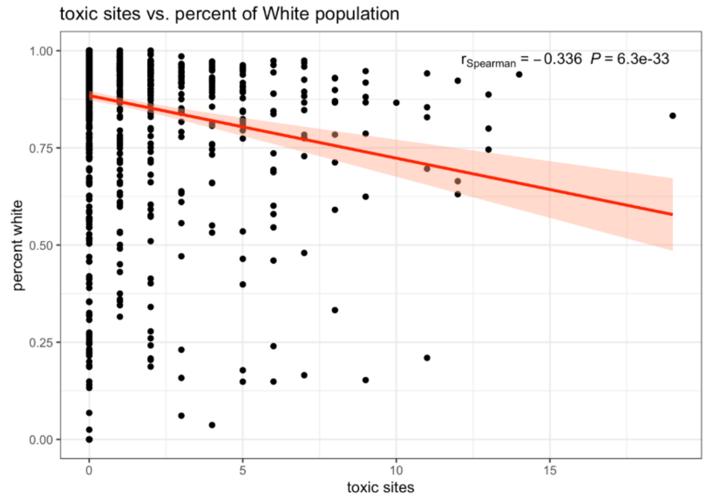
From the map titled *Median Income and Toxic Sites,* we can see that median income is the highest around big cities in Ohio, such as Columbus, Cleveland, and Cincinnati. The number of toxic sites appear to also be more dense near these cities. From this, we would assume that there is a positive correlation between median income and toxic sites, but the correlation plot, *Toxic Sites vs. Zipcode Median Income,* shows otherwise. With a P-value of 0.87, the plot shows no strong evidence for a correlation between median income and toxic sites. Although toxic sites and median income are heavily concentrated around large cities, each large city encompasses the richest and poorest populations, and the toxic sites are distributed quite evenly among these income levels.



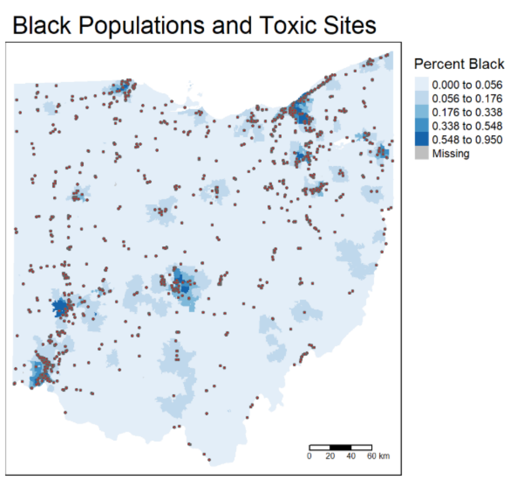


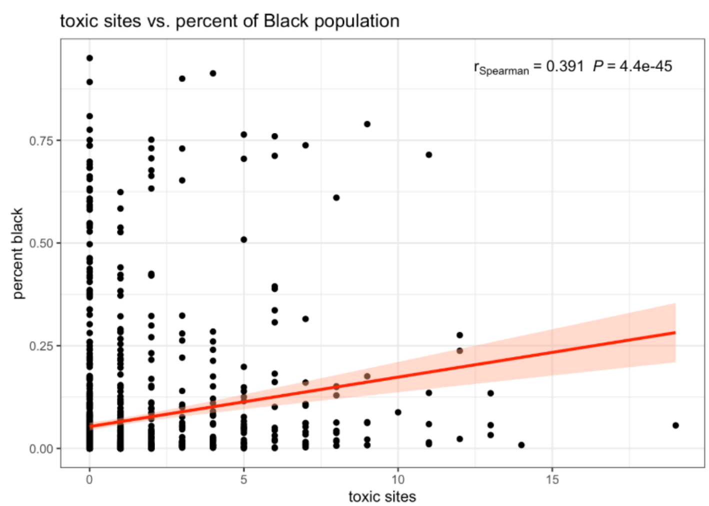
From the map *White Populations and Toxic Sites,* it is clear that the majority of people in almost all of Ohio's zip codes are White. Here, toxic sites seem to be clustered in areas with the least White populations. From our correlation plot, the negative r-value and extremely low P-value allows us to be 99% confident that there is a strong, negative correlation between White populations and toxic sites. That being said, there should be a strong, positive correlation between minority groups and toxic sites in Ohio.



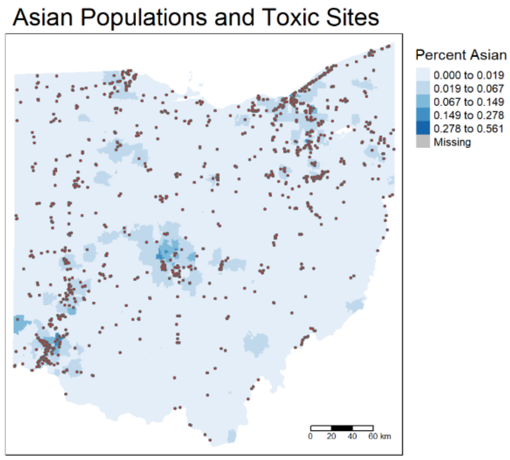


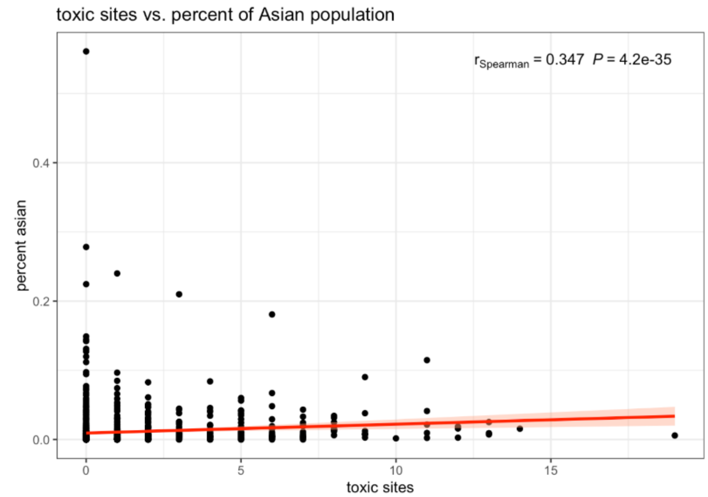
The map titled *Black Populations and Toxic Sites* shows us that the highest percent of Black populations are found in Ohio's biggest cities. Toxic sites also are found heavily clustered near these cities. Our correlation plot shows a very low P-value, which tells us that we can be 99% confident that there is a strong, positive correlation between the percent of Black population in Ohio and toxic sites.



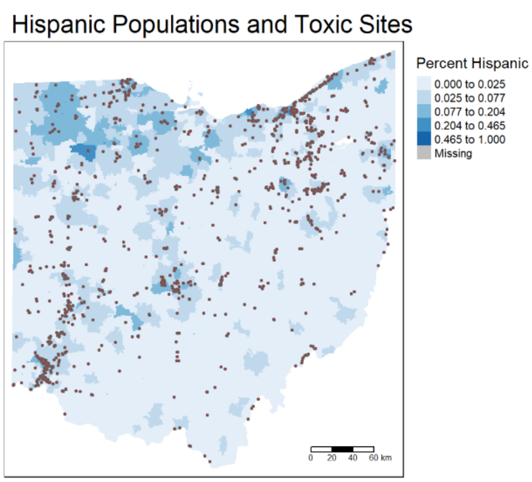


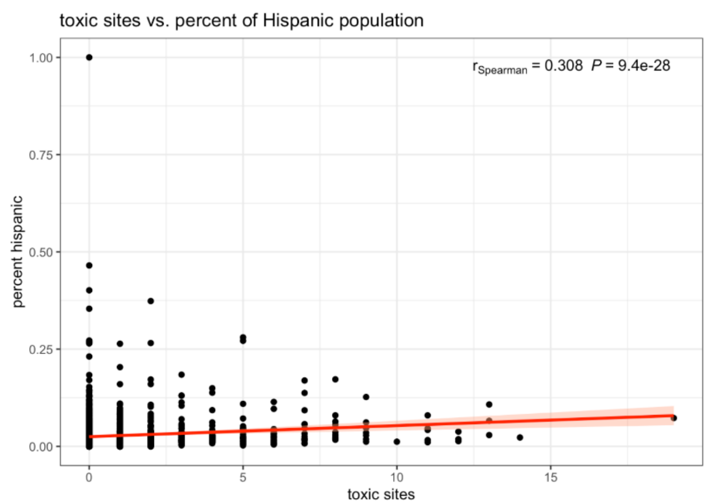
From the map titled *Asian Populations and Toxic Sites,* we can see that the largest cities in Ohio also are home to the largest percent of the Asian population and toxic sites. Our correlation plot gives us a very small P-value, therefore we can be 99% confident that there is evidence for a strong, positive correlation between toxic sites and the percent of Asian people living in Ohio zip codes.



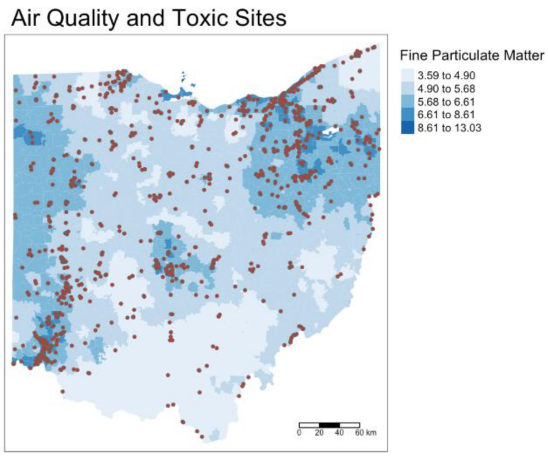


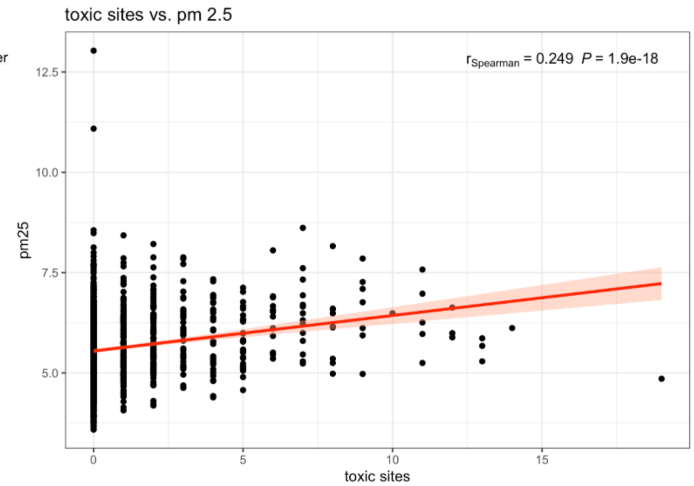
he map titled *Hispanic Populations and Toxic Sites* shows us that the percent of Hispanic populations and toxic sites are also heavily located in the biggest cities in Ohio. The correlation plot gives us a very low P-value, so we can be 99% confident that there is a strong, positive correlation between the percent of Hispanic populations and toxic sites in Ohio.





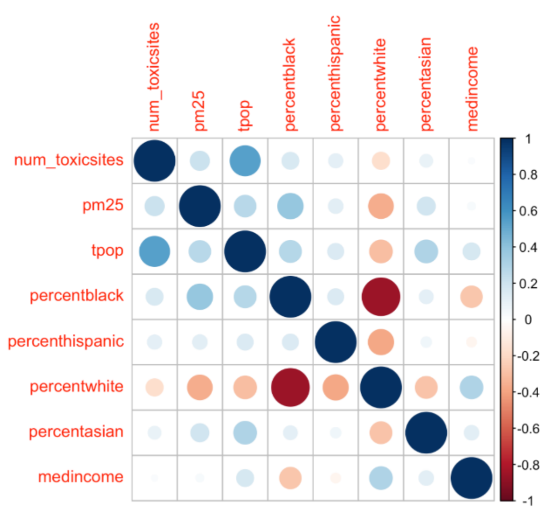
From the map titled *Air Quality and Toxic Sites,* we can see that there are large areas in Ohio where there is more fine particulate matter in the air, and therefore worse air quality. Ohio's largest cities show the worst air quality, and the Western border of Ohio also shows high levels of fine particulate matter. From our correlation plot, we found a low P-value and can be 99% confident that there is evidence of a strong, positive correlation between toxic sites and air quality in Ohio.

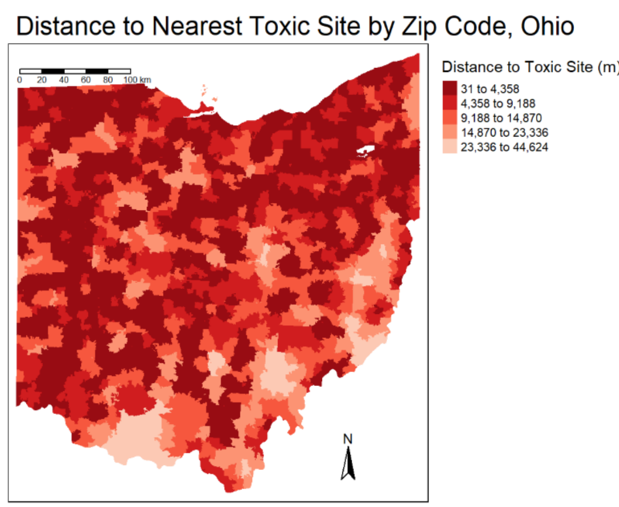




As the correlation matrix shows, for number of toxic release sites, there is a strong positive correlation between total population and number of toxic release sites. Meanwhile, there is a weak positive correlation between number of toxic release sites and pm 2.5, percent of Black population, and percent of Asian population. and a weak correlation between the percentage of white population and number of toxic sites. Finally, the median income level shows no correlation with the number of toxic release sites.

Our map titled *Distance to Nearest Toxic Site by Zip Code, Ohio* was used to measure the distance to each toxic site within any given zip code to see of some zip codes were closer to toxic sites. To determine the distance for each zip code, centroids for each zip were used. This technique would not be problematic if racial groups were evenly distributed across each zip code area. This is likely not the case and has affected our results, and no conclusions can be drawn from this procedure.





Conclusions

The goal of our study was to analyze the relationships between race, income, air quality, and toxic sites in Ohio. We expected to find a strong correlation between toxic sites and both racial minority groups and air pollution. Although we found strong correlations between most of our variables and toxic sites in Ohio, we cannot conclude that these relationships are causal. There are too many factors that play a role in the distribution of these toxic sites and the spread of our socio-demographic variables and air quality to make such claims.

Possible error in our study could stem from the fact that the majority of racial minorities live in heavily populated cities. There has been some debate on whether the location of these sites caused minorities to move into these areas. This becomes important in policy considerations. In a widely cited 2001 paper, Paster et al. found that in a 30-year period in Los Angeles, the location of polluting facilities was based primarily on the unequal siting of these facilities in existing minority communities. Considering that this case may apply to other geographies including the case in Ohio, this would mean more attention to the planning of the facilities and permitting will be necessary. More oversight into the company's decision-making could be necessary as well if they are not considering environmental justice concerns.

It is clear that there are greater issues at play here, and that companies creating toxic waste are most likely not targeting certain demographic groups when choosing where their sites should be located. There is a need for reform in zoning laws. Further, more consideration of environmental justice should be given in the locations of these sites. The real estate market is fundamentally racist, with real estate in areas with more minority groups costing much less than in other areas. Target relief in the form of monetary compensation, government programs, or other support for toxic pollution and its adverse effects should be directed towards minority communities.

In the future, further analysis could be done with this data and similar datasets. We could integrate real estate data at both the industrial and residential levels. From this, we could analyze the relationships between race, housing, and toxic sites, and may find stronger correlations than we did in this study.

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