Group Project Final Paper
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TRAP and Race in Seattle, WA

Abstract:

Research indicates that minorities experience disproportionate exposure to air pollution caused by transportation. To achieve equity, we must acknowledge that differential air pollution exposure can cause vulnerable communities to have an increased risk of health problems. Disparities in air pollution are also significant since they exacerbate comorbidities, increasing the risk of COVID. For this study, we examined Transportation-Related Air Pollution, or, TRAP. We hypothesized that BIPOC communities in Seattle, Washington experience greater exposure to TRAP because of segregation and redlining. We used Diesel PM levels to represent TRAP, and percent people of color population to indicate the racial composition of census tracts. Additionally, I-5 was used as a transect because it runs centrally through Seattle, however, TRAP concentrations were measured from various roadways and were not specific to highway pollution. Based on the data, there is no correlation between percent POC population and Diesel PM concentrations, meaning our hypothesis was rejected. Although our hypothesis was rejected, it is important to conduct research like this so environmental injustices are addressed. Furthermore, since we only looked at Diesel PM, minorities may be disproportionately exposed to other forms of air pollution, especially if they live near industrial centers.

Introduction:

Air pollution has long been noted as an environmental crisis impacting human health (Jakubiak-Lasocka et al., 2014). However, it must be noted that although air pollution adversely impacts everyone, not all people are impacted by air pollution equally. Some studies have indicated that there is a correlation between racial minorities and the increased exposure to transportation-related air pollution or abbreviated as TRAP (Woo et al., 2018). TRAP can be defined as "The mixture of vehicle exhausts, secondary pollutants formed in the atmosphere, evaporative emissions from vehicles, and non-combustion emissions (e.g., road dust, tire wear)" (Matz et al., 2019). Exposure to these pollutants has been linked to an increased risk of respiratory diseases, asthma, allergies, heart attack, adverse birth outcomes, dementia, etc (Połednik et al., 2021). Additionally, air pollution is also important to keep in mind due to the current COVID-19 pandemic. Having comorbidities such as the diseases previously mentioned increases one's risk for developing serious complications that may arise from contracting COVID-19 (Marshall, 2020). Residents in urban areas, especially those who live on busy streets are more likely to be exposed and inhale TRAP. According to the EPA, the distribution of TRAP or pollutant concentration is affected by traffic activity, wind speed, and direction- so certain activities such as congestion, stop-and-go movement, or high-speed operations can increase the concentration of TRAP. Concentrations of TRAP typically decrease with distance away from traffic, though this distance can vary (EPA, 2014).

Clark et al. (2017) found that "Racial minorities and low-income households are disproportionately likely to live near a major road, where TRAP concentrations are typically the

highest". Racial groups are highly segregated in Seattle for a variety of reasons, reflecting historical and ongoing racism that continues to push minorities into more hazardous environments than White populations (Thomas and Gabriel., 2015). For example, redlining, which was the practice of restricting non-White racial and ethnic minorities to hazardous areas by denying home loans to non-White homeowners has been abolished. But, communities in Seattle are still seeing the impacts of these policies today with racial minorities being more exposed to environmental hazards. Additionally, other studies have revealed that people of color experience increased exposure to TRAP because minorities are more likely to reside in census tracts with higher traffic density in comparison to their White counterparts (Tian et al., 2012). The association between race and distance from major roads is important to look at because it can reveal racial inequalities in housing and lack of accessibility to a clean environment. This is even more relevant now than ever before, during a pandemic where those with underlying health conditions are likely to experience a higher mortality rate. Given all of these facts, it is highly likely that minorities in Seattle have disproportionately high exposure to pollutants and other environmental hazards.

We investigated the following question: How does transportation-related air pollution (TRAP) as indicated by Diesel PM levels vary by census tract racial composition in Seattle? We are testing the hypothesis that BIPOC communities are more vulnerable to TRAP exposure. We are using three transects and systematically selecting census tracts along these transects to compare 2017 Diesel PM concentrations to the percent of people of color in that tract.

Methods:

We hypothesized that BIPOC communities in Seattle experience greater exposure to TRAP because of the historical effects of segregation. Based on this hypothesis, we predict that census tracts with more BIPOC individuals will have higher levels of transportation-related air pollution (TRAP) as indicated by elevated 2017 Diesel PM levels (Figure 1). We came to this prediction because we believe racial segregation would have forced BIPOC individuals to live in less desirable areas.

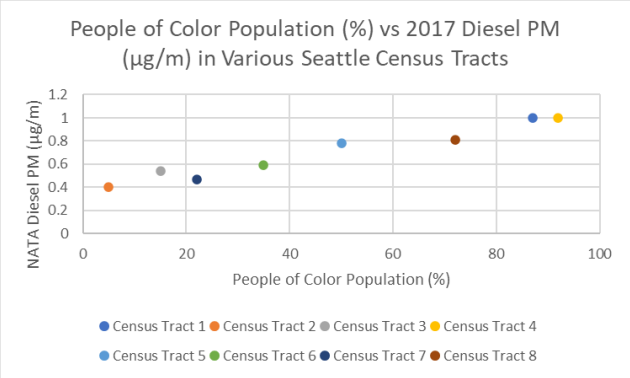

Figure 1: Mock Scatterplot that Supports the Hypothesis

We measured racial composition as our independent variable and the concentrations of TRAP as our dependent variable. Racial composition is measured by looking directly at the percent of people of color within given census tracts. The EPA considers any individuals who don't identify as White alone, including Hispanic, Latino, and multiracial individuals as people of color (Environmental Protection Agency, n.d.). While the concentration of TRAP is measured by micrograms per cubic meter (ug/m3) of 2017 Diesel PM pollutants. PM is short for particulate

matter, which are particles typically smaller than 2.5 microns, however, the size is not explicitly stated in our data source.

The data for this paper was collected by data mining from an online mapping tool. The mapping tool utilized in this study is EJSCREEN, the EPA's Environmental Justice Screening and Mapping Tool. This tool was used in our study to determine the percent of people of color in each given census tract. EJSCREEN was also used to determine the concentration of 2017 Diesel PM (μg/m) in each census tract. It is important to note that we set the tool to show percentiles relative to the state of Washington, not the entire country.

We chose to use I-5 as a transect as it runs centrally through the entire north and south boundaries we created for Seattle, which tend to have a variance in racial composition with North Seattle being predominantly White and South Seattle having more diverse demographics. While we used I-5 as a transect, we were measuring TRAP concentrations in general among all roadways including I-5, but not specific to highway pollution. We were aware that diesel concentrations may be higher near a major roadway, however, we were looking for a correlation between traffic-related air pollution and percent people of color in a census tract regardless of proximity to major roadways.

Starting from the northern boundary, NE 145th Street, we used the measuring tool on the EJSCREEN program to measure the length of our I-5 transect within our determined boundaries. The measurement of our transect was approximately 14 miles, so we then decided to create points 1 mile apart moving southbound. We chose this scale of measurement because we wanted to collect data from systematic points along the transect without having an overlap of census tracts, in addition to collecting an adequate yet manageable sample size given the limited time frame of our study. If the points fell within the same census tract as one previously recorded, we simply skipped that data point to avoid pseudoreplication which could potentially lead to a false conclusion. Next, we measured out 1 mile horizontally to both the east and west of each point along the I-5 transect and created two more transects. The purpose of adding the additional transects was to achieve a sufficient sample size. There were exactly 14 collection points (census tracts) for each transect, due to one overlapping census tract between the 12th and 13th point which we skipped over, for a total sample size of 42 (Figure 2). At this point, we used the split-screen function from EJSCREEN to record the 2017 Diesel PM and the percent people of color data for the corresponding census tract that I-5 runs through (Figure 3). We repeated these same steps for the entire length of each transect until we met the South boundary, S Frontenac Street. There are approximately 131 complete census tracts within the boundaries of Seattle, so the sample size was sufficient and large enough to account for the margin of error.

We used an Excel spreadsheet to input our data collection using a separate page for each transect and then a cumulative page that contained all data sets from the three transects. To find the range that determines lower and higher Diesel PM concentrations, the Diesel PM data that was collected from all three transects were first sorted in chronological order from smallest to largest on Excel. Then, since there were 42 census tracts in total, the 21 lowest concentrations were classified as “Lower Diesel PM Concentrations (0.548 - 0.701 ug/m3)”, while the 21 highest concentrations were classified as “Higher Diesel PM Concentrations (0.703 - 0.957 ug/m3)” (Figure 4). After all of the data was collected we created a scatter plot for each transect. We then combined the cumulative data into one scatter plot to see if there was a correlation between the percent people of color population and the 2017 Diesel PM within various census tracts.

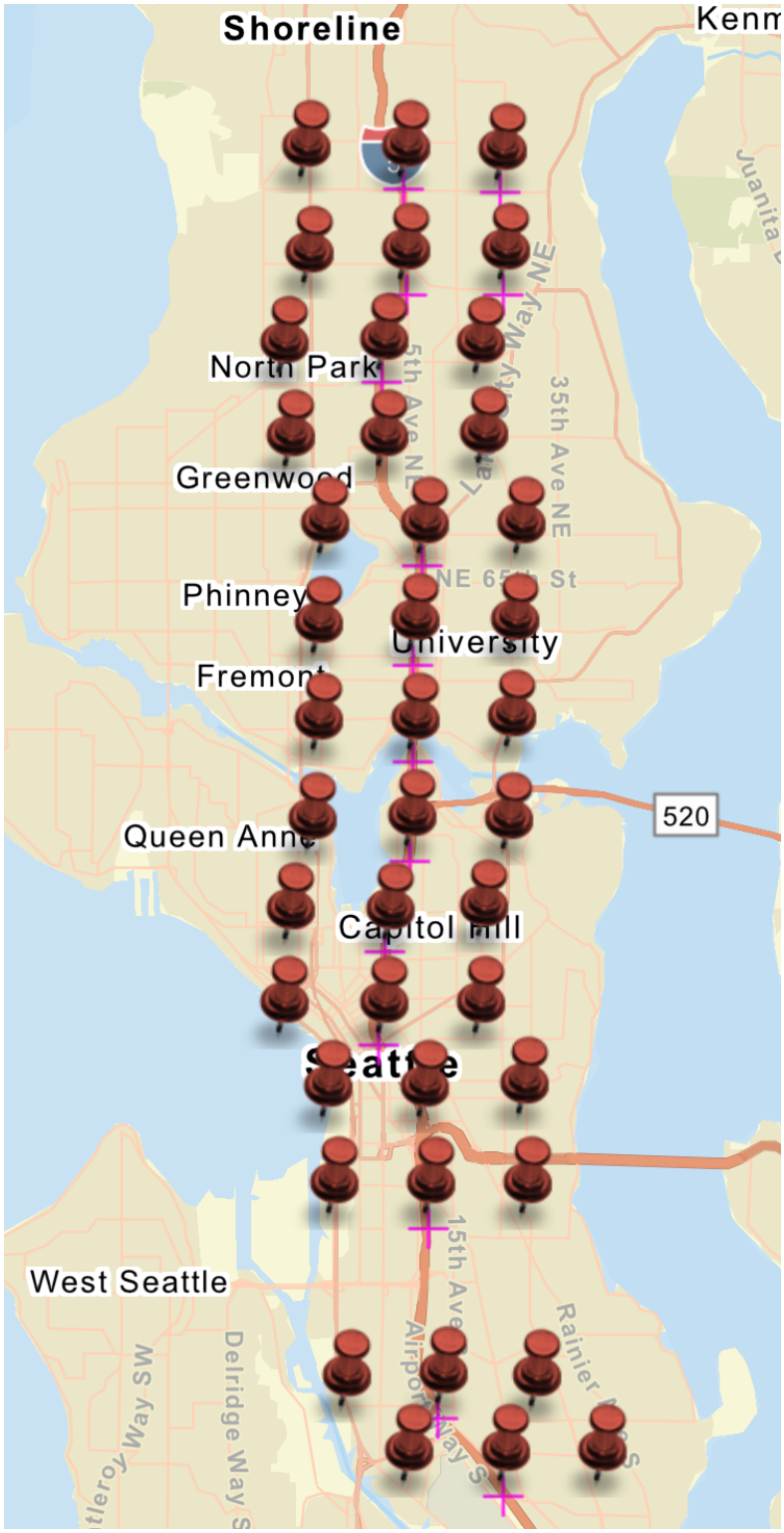

Figure 2: Map of all 42 points (census tracts) along the 3 transects used for data collection-the gap between the 12th and 13th points is due to overlapping census tracts

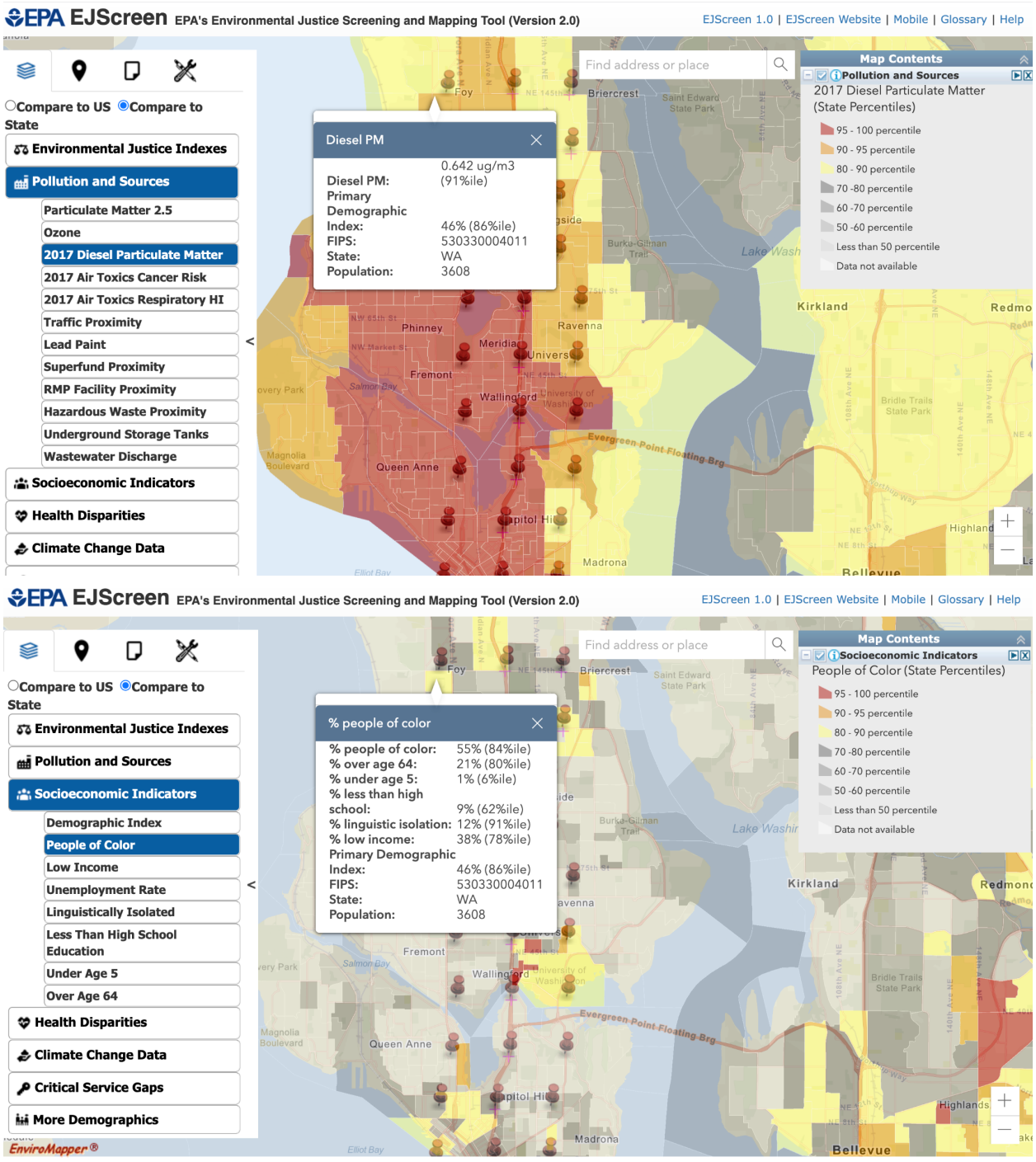

Figure 3: The split-screen option on EJScreen used to apply filters to the map and collect data on 2017 Diesel PM concentrations and percent people of color demographics

Results:

There are 42 census tracts, in which 32 of these tracts were predominantly White tracts (<50% POC Population), while the 10 remaining census tracts were predominantly POC tracts (>50% POC population)(Figure 4). For both lower and higher Diesel PM concentrations, there was a higher number of predominantly White tracts than predominantly POC tracts (Figure 4). From the data we collected, there were more predominantly White tracts with higher Diesel PM concentrations (18 tracts), in comparison to predominantly White Tracts with lower Diesel PM concentrations (14 tracts)(Figure 4). Conversely, of the 10 predominantly POC tracts, more tracts have lower Diesel PM concentrations, given there are 7 of these tracts, whereas only 3 predominantly POC tracts have higher Diesel PM concentrations (Figure 4).

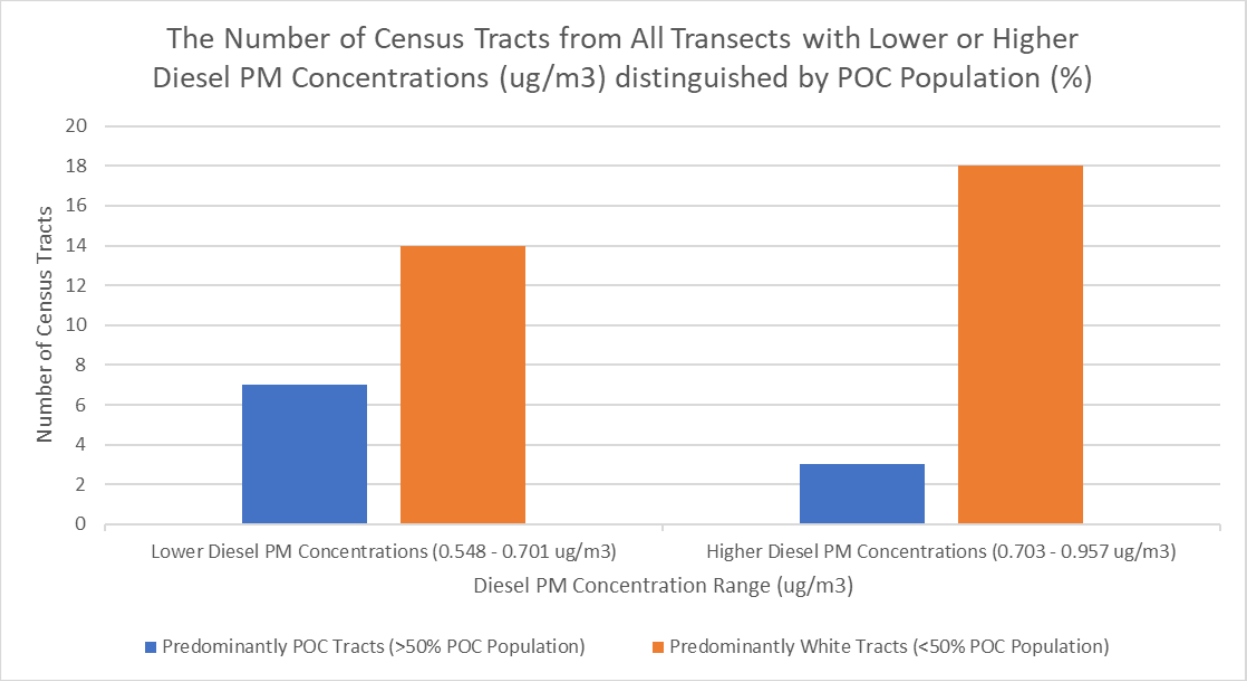

Figure 4: Bar chart comparing the Number of Census Tracts from All Transects with Lower or Higher Diesel PM Concentrations

When examining the data from all three transects combined, the overall Diesel PM concentration range is 0.548 to 0.957 ug/m3 (Figure 5). The I-5 transect has the medium Diesel PM concentration range, which is from 0.642 to 0.908 ug/m3, while the transect East of I-5 has the smallest Diesel pm concentration range at 0.548 to 0.709 ug/m3 (Figures 6 and 7). To add on, the transect West of I-5 has the largest concentration range at 0.642 to 0.957 ug/m3 (Figure 8).

Additionally, the combined data from all transects displays that the overall POC Population percent range is 11% to 89%, with much of the data clustered between 22% to 49% (Figure 5). The I-5 transect has the medium POC population percent range at 15% to 89%, while on the contrary, the transect East of I-5 has the largest POC population percent range at 11% to 87% (Figure 6 and 7). Similar to where much of the data is clustered, the transect West of I-5 encapsulates the smallest POC population percent range at 22% to 49% (Figure 8).

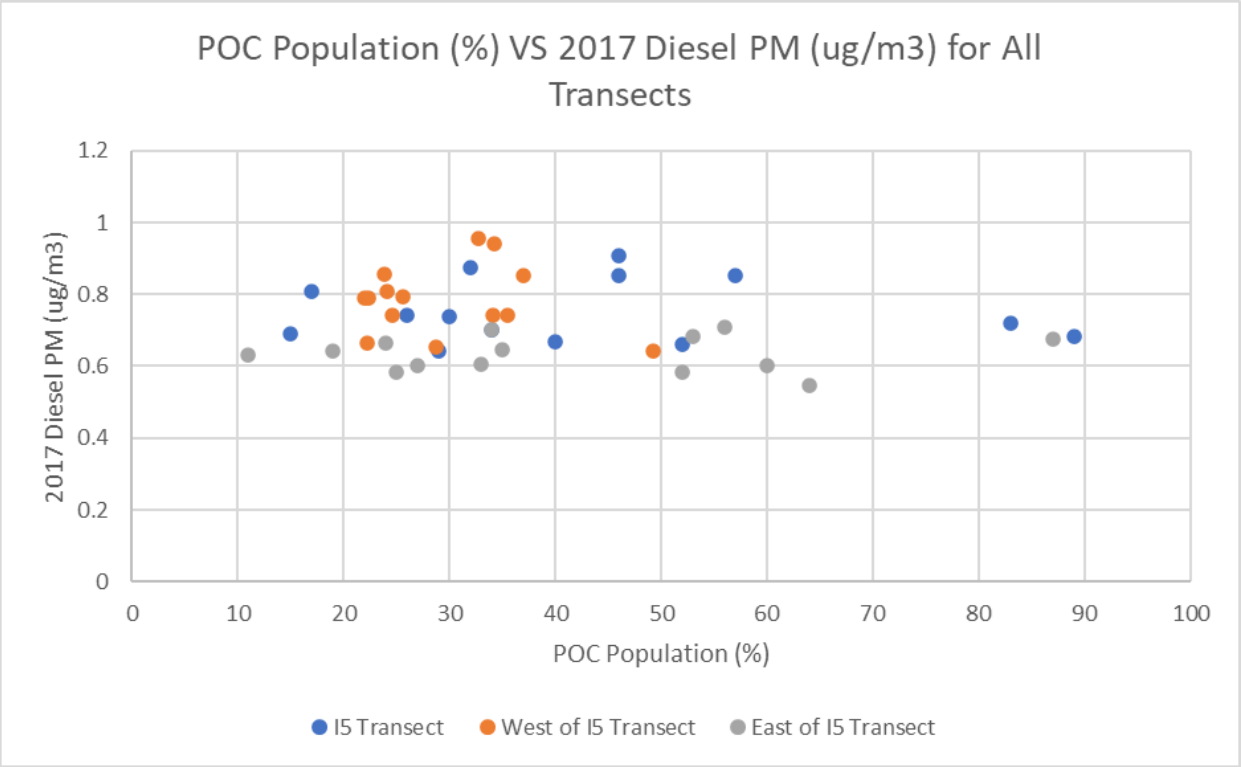

Figure 5: Scatterplot comparing POC Population and 2017 Diesel PM in All Transects

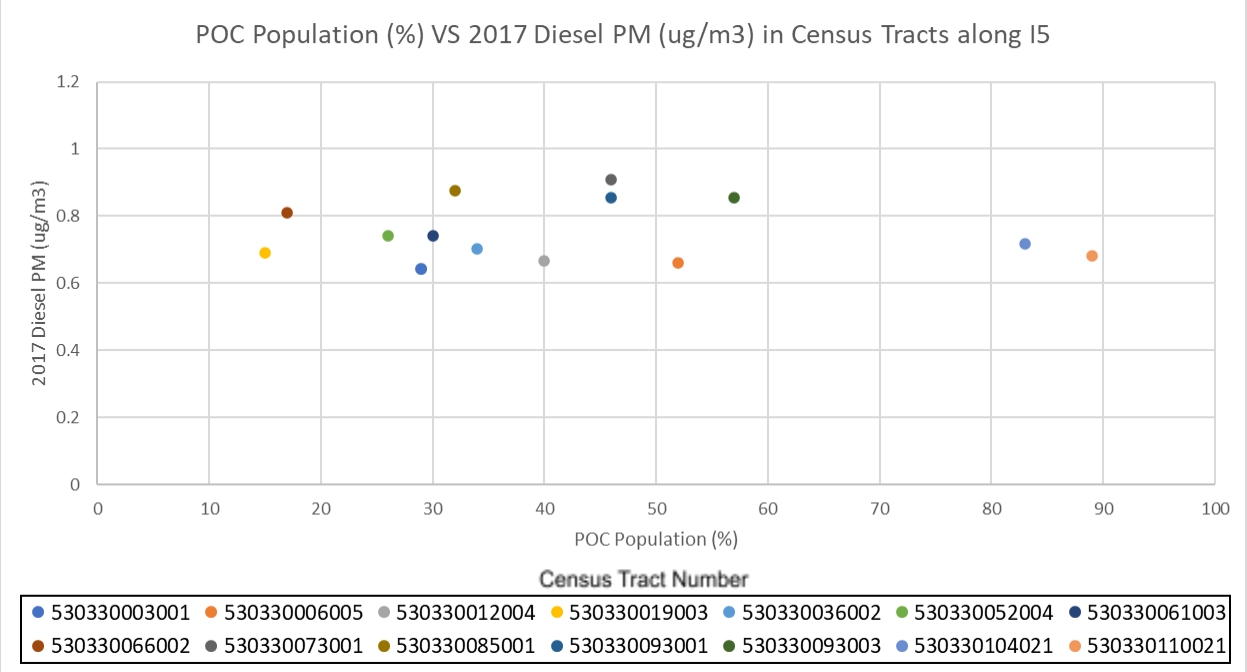

Figure 6: POC Population and 2017 Diesel PM in Census Tracts along I-5

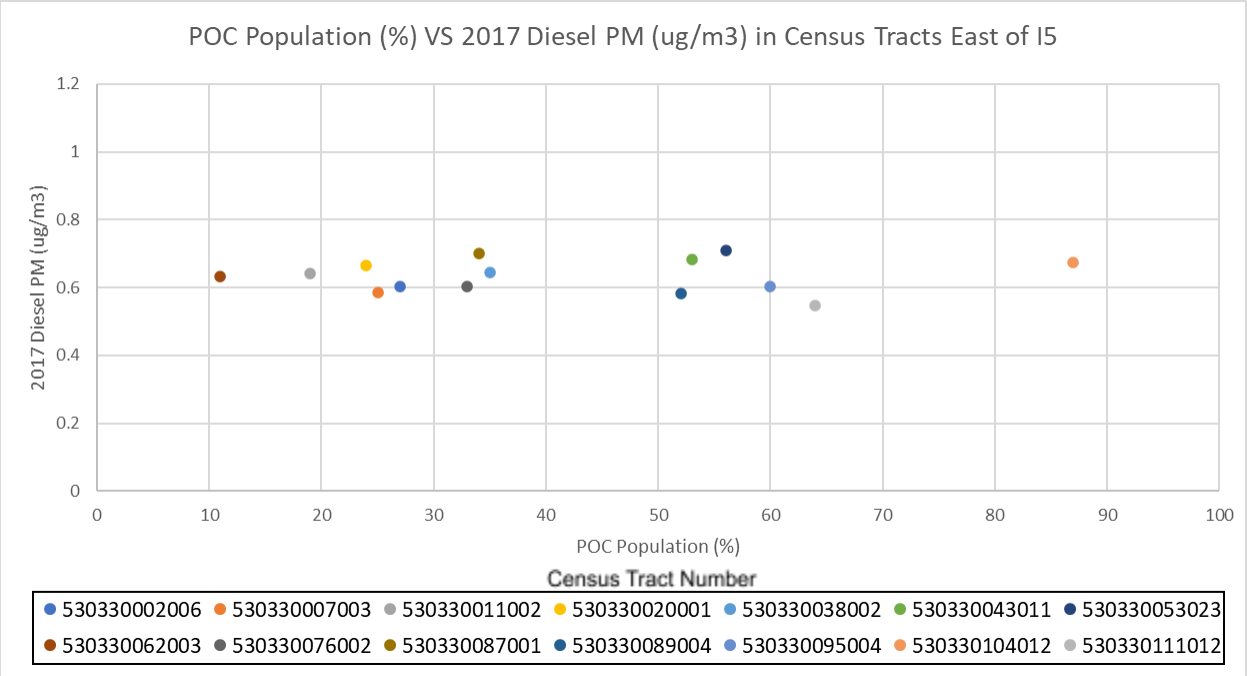

Figure 7: POC Population and 2017 Diesel PM in Census Tracts East of I-5

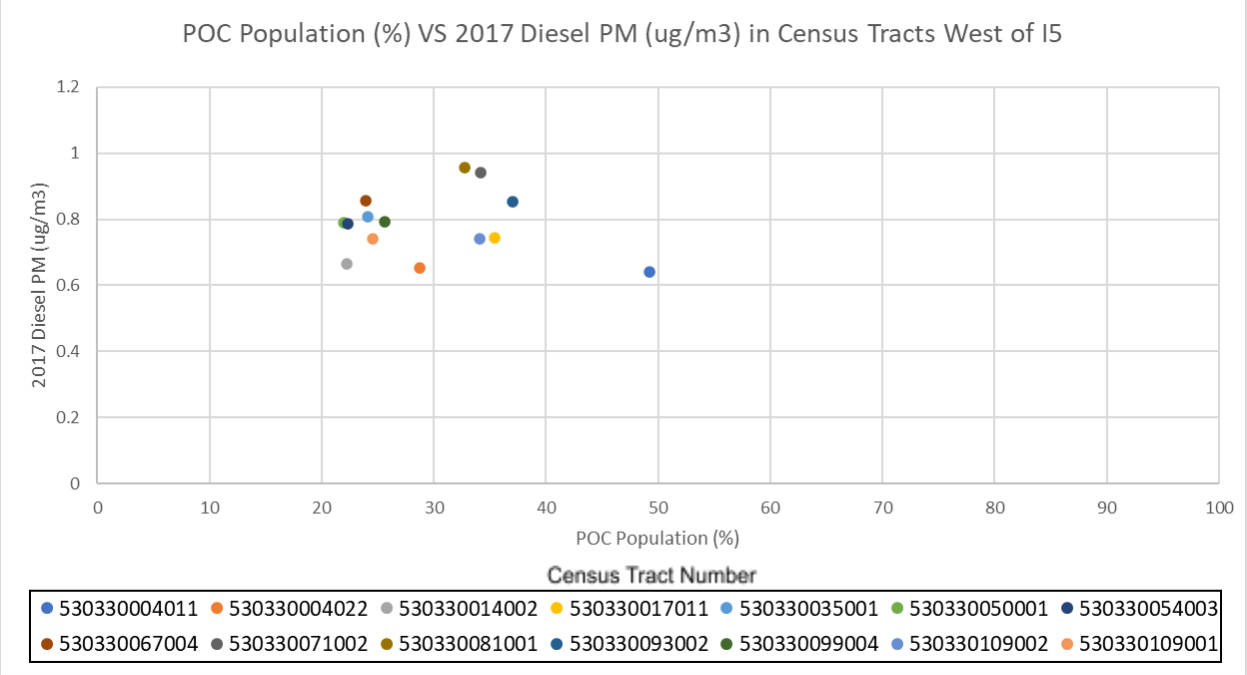

Figure 8: POC Population and 2017 Diesel PM in Census Tracts West of I-5

Discussion:

We hypothesized that BIPOC communities in Seattle experience greater exposure to TRAP because of the effects of historical segregation and ongoing effects of racism that disproportionately force minorities into hazardous spaces. Our results consistently showed that

there is no direct correlation between the percent people of color population and Diesel PM concentrations related to TRAP, therefore our hypothesis was not supported. Our results did not reflect the conclusions presented in the academic articles that inspired this study such as Woo et al., 2018 and Clark et al., 2017, although that does not mean the results are invalid. It is important to understand why our study did not show a correlation between TRAP and populations of color so that future studies can effectively measure the effects of environmental injustice.

There were certain limitations to our project that should be addressed and can potentially aid in future studies. For example, one limitation that could restrict the outcome of our results would be that the data we analyzed was specifically from the year 2017. This leads to the potential for error and the inability to make long-term conclusions because that year could have been a fluke, although we have no indication that it was. In order to come to a long-term conclusion, it would be necessary to analyze data over a longer time period to see if there is a difference in results based on time.

Another limitation within our project is that we collected data from the census level and not more in-depth such as block level. Census tracts can vary in population and size, ranging from multiple blocks to multiple miles in scale which means there can be a variation in both TRAP and percent people of color clusters within census tracts. This can overlook smaller concentrations of people of color that are situated closer to high-use roads and have higher levels of pollution than White individuals within that same census tract (Thomas and Gabriel., 2015). Also, the data mining site we used did not specify how many sensor devices were placed within each census tract and where within that census tract they are located. This could have caused overgeneralizations about TRAP and we recommend that future studies utilize another source in addition to EJScreen that provides fine-scale data down to the block level to ensure accurate conclusions.

In addition, we only collected data on Diesel Particulate Matter as a proxy for TRAP, however, other variables such as PM 2.5 and Nitrogen Oxide (NO_2) can also be used to measure traffic-related air pollution. To achieve a holistic understanding of TRAP, it could be effective to collect data on multiple indicators of transportation-related air pollution in order to reach a conclusion that accounts for multiple factors.

It is also important to take into account that Seattle is one of the Whitest large cities in the United States with a population of 67.3% White (United States Census Bureau, 2021). This could have impacted our results because we considered census tracts composed predominantly by people of color to be greater than 50% people of color, however, compared to the demographics of the entire city, any census tract that has a people of color percentage greater than 32.7% would be above average. If this study was conducted in other major cities in the U.S. such as Los Angeles, California, or Detroit, Michigan the results would likely be different as both cities have a majority people of color population, Hispanic and Black respectively. We would also like to acknowledge that the majority of Seattle's people of color populations reside in South Seattle and bordering the city limits which may mean that the highest percent people of color population census tracts were not included in this study. We believe that this is a result of gentrification where wealthier White individuals are moving into previously majority people of color occupied census tracts and increasing home value.

Environmental factors could have also had a significant influence on the results of our study, such as wind direction redistributing TRAP. In Seattle, the wind blows from southwest to the northeast which could explain why the census tracts on the west I-5 transect near the Port of

Seattle did not have any significant increase in TRAP concentrations outside of the range of the other transects. The 5 census tracts in the Port of Seattle area of the West of I-5 transect were among the highest diesel PM concentrations that we observed, which can be attributed to the industrial centers in this area. However, contrary to our hypothesis, these census tracts had some of the lowest percentages of people of color relative to all other census tracts we analyzed. Along these lines, as we noted in our methods, we recognized that the census tracts along I-5 had the potential for higher Diesel PM concentration than census tracts a mile away due to it being a high-use road. However, in our data collection, none of the census tracts along I-5 indicated any overwhelming effects of the highway traffic. It is interesting to note that the Diesel PM concentrations within each of those census tracts varied despite the constant pollution output of I-5. This has the potential to be caused by other factors such as congestion and stop-and-go movement as mentioned in the introduction.

There is also the probability that the instruments used for collecting Diesel Particulate Matter concentrations were not always functioning correctly or were not sensitive enough to small changes in concentrations for the undefined duration that data was collected. We have no evidence that this occurred but would like to acknowledge the potential for error. We collected data from 42 different census tracts, so it is likely that a couple of these measurements were inaccurate, which may have impacted our results.

In the interest of not looking at too many variables, our group decided to not look at the average income or percent poverty rate of census tracts, however, this could be an interesting variable to include as it would be interesting to see if income has any significant impact on exposure to TRAP and how that varies or is similar to percent people of color population.

Overall, it is clear that for future studies more precise data must be acquired to gain an accurate depiction of the correlation between BIPOC communities and TRAP concentrations. We recommend using a source that allows for fine-scale data collections among census blocks and clearly located where the data is coming from. Knowing the location of sensors and how Diesel PM concentrations are being determined based on the distribution of sensors is key to determining which communities are most impacted.

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