



Exposure to Air Pollution in Chicago: A Continuing Social and Environmental Justice Concern!



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Introduction

Effective public policy and governance of air quality is a major concern for policymakers, environmental justice advocates, and researchers alike. Billions of people worldwide are exposed to unhealthy levels of air pollution (WHO, 2023) despite being acknowledged as a fundamental human right (UN General Assembly, 2024). Moreover, historically disadvantaged and vulnerable communities and marginalized groups are burdened with poor air quality, raising concerns about social, racial, and environmental justice issues (Jbaily et al., 2022). Studies suggest a racial and ethnic disparity in exposure to air pollution, particularly in the energy and industry sectors, and an income disparity across all sources of air pollution from all sectors (Nunez et al., 2024). Chicago, a city ranked among the worst 10 hotspots for fine particle air pollution in the US (McCormick, 2024), is also the 10th most diverse city in the US (Ramos, 2020). This juxtaposition of high pollution levels and diverse communities, including a significant proportion of low-income and communities of color, presents a compelling case for examination. Many researchers are concerned about disparities of exposure to air pollution in South Chicago and hence suggest and develop data that help to improve air quality and address environmental justice outcomes, focusing on PM2.5 (Illegner and Lad, 2022). Hence, it's worth exploring the social and environmental justice implications of air pollution disparities in Cook County, Chicago.

Research Question

This research project uses spatial analysis based on the EPA's environmental justice index to assess air pollution levels associated with socio-economic factors. It explores the relationship between these factors and air pollution exposure.

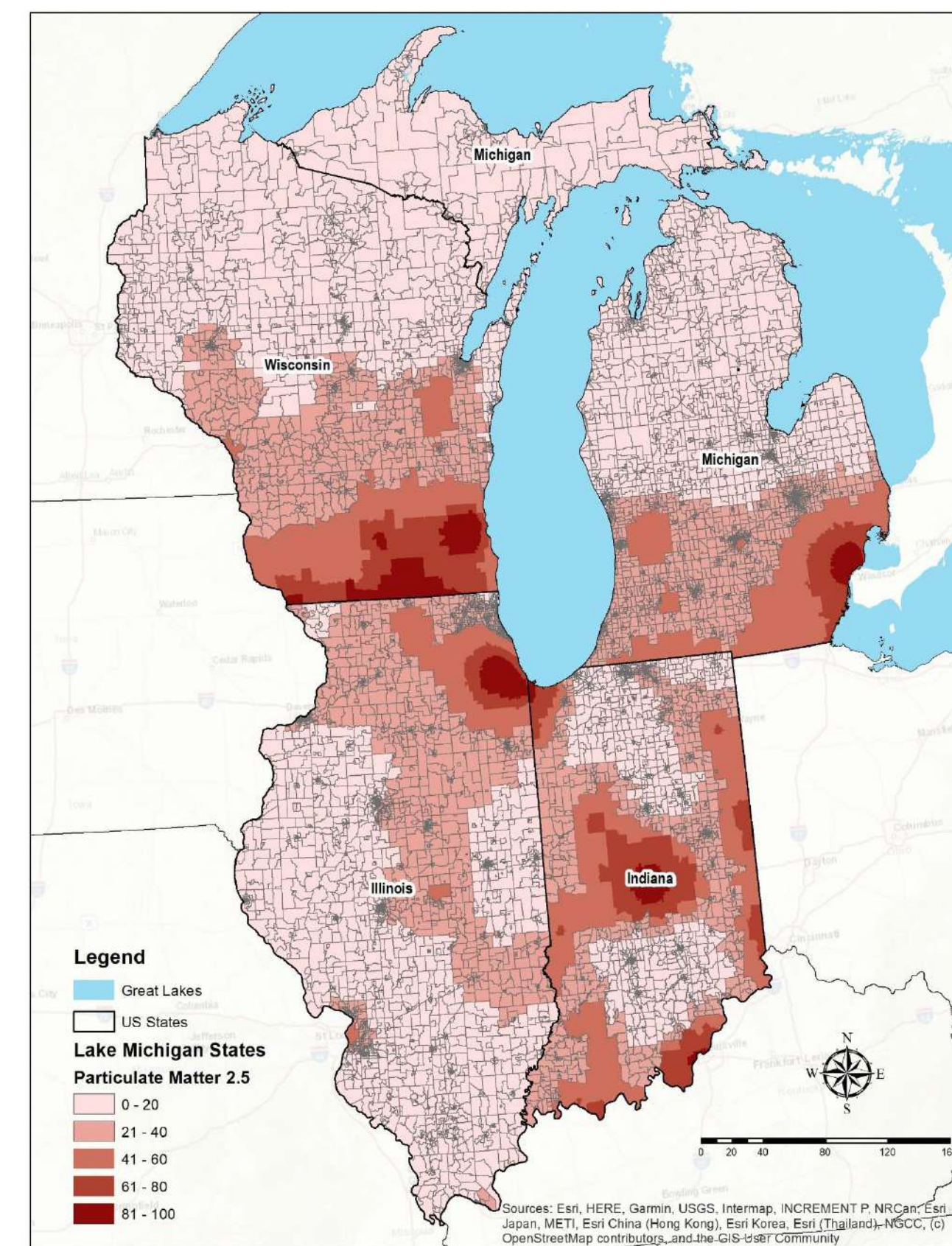
Data and Methodology

The spatial analysis assessed air quality, vulnerability, and environmental justice on the group block level using publicly available data from the US EPA agency, specifically, the Environmental Justice Screening and Mapping Tool (EJ Screen). EJ Screen provides comprehensive CVS and geodatabase data, including various environmental justice indexes, socio-economic indicators, demographic indexes, and air pollution data.

- This project started by providing an overview of air pollution distribution in the lake region of Michigan, which includes the four states of Wisconsin, Illinois, Indiana, and Michigan.
- It shifted focus to Cook County and the Chicago area to assess the environmental justice index based on three different risk indexes of air pollution, including air toxic cancer risk, air toxic respiratory hazard index, and particulate matter 2.5 (PM 2.5).
- It used the environmental justice and supplement indexes to perform a cold and hot spots analysis of Particulate Matter 2.5.

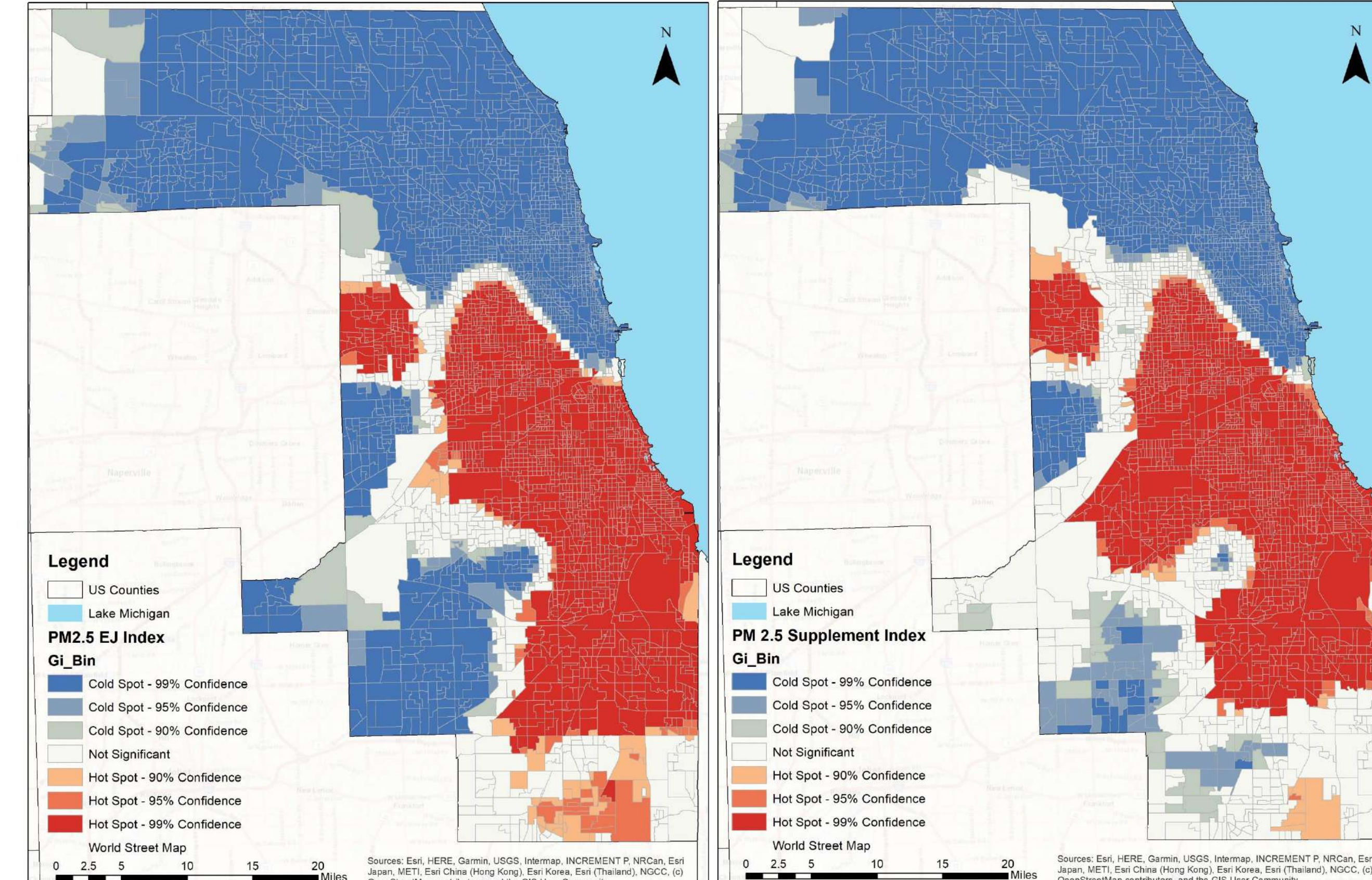
The EPA's Environmental Justice indexes utilize Office of Air and Radiation data on PM 2.5 and the Air Toxics Respiratory Hazard Index. The EPA's Air Toxics Screening Assessment focuses on toxic cancer risk. All air pollution data sources are current as of 2019. Demographic indicators come from the Census Bureau's ACS summary, covering 2017-2021 5 years (ACS 2021), while socioeconomic data is from the 2020 US Census.

Findings and Results

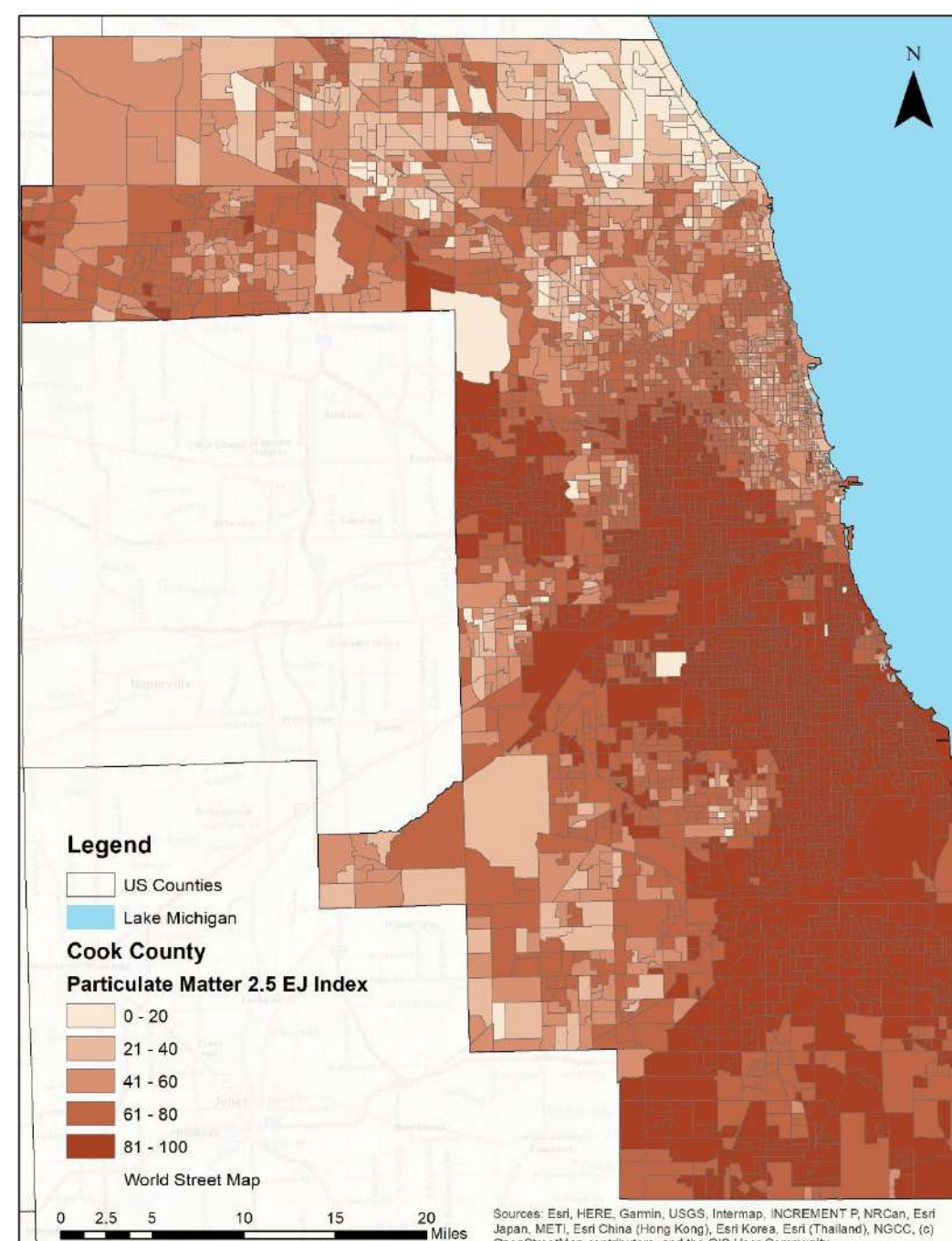


Map (1) on the left shows the levels of PM 2.5 in the air in the Lake region, covering Wisconsin, Illinois, Indiana, and Michigan states. The spatial distribution shows that higher PM 2.5 levels are observed around cities with larger populations. The map indicates that some areas are more affected by poor air quality than others. The following maps (2 a-c) will zoom in on Chicago's Cook County, analyzing air pollution at the Block Group level of analysis.

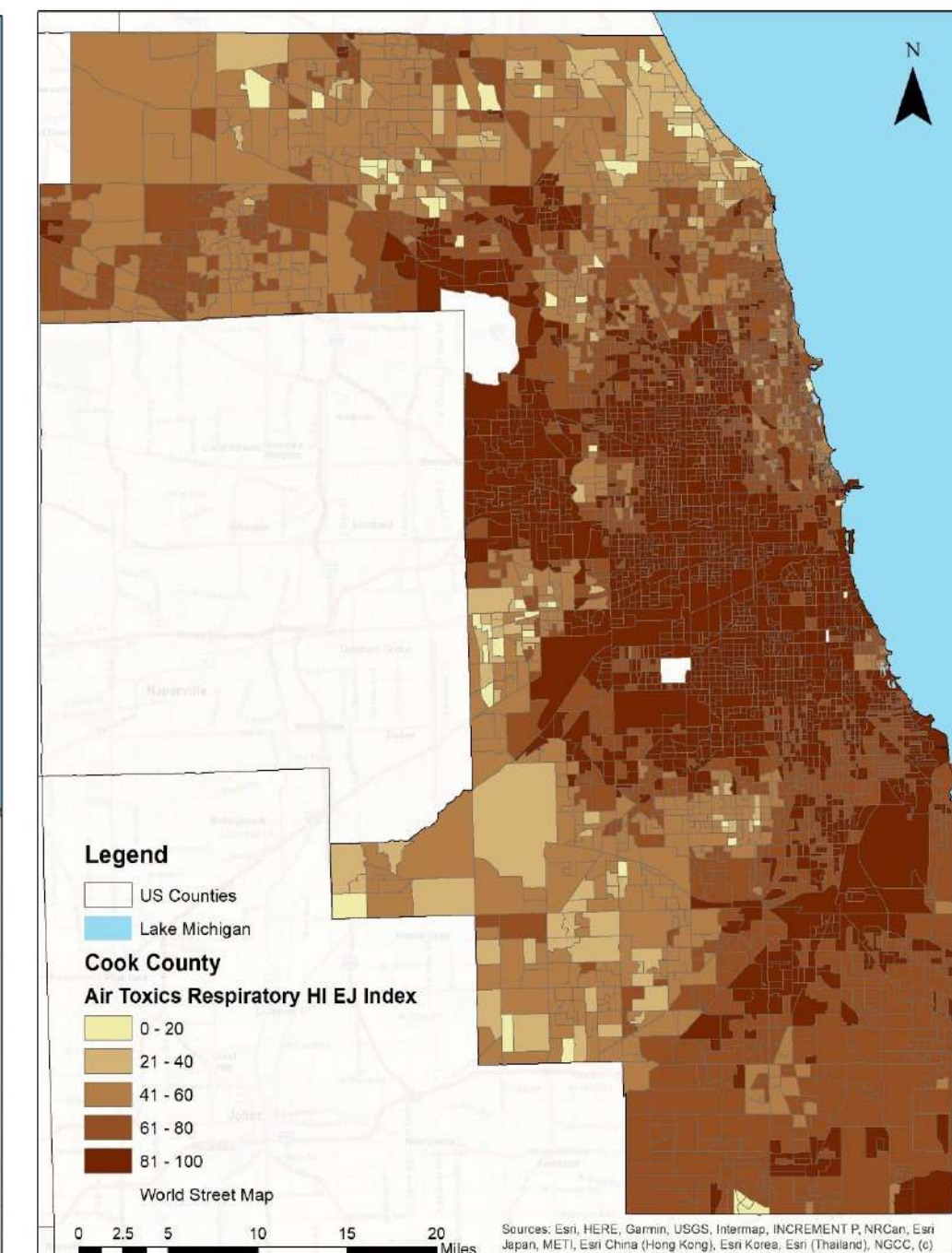
Maps 3-a and b on the right report hot spot analysis of PM 2.5 for two indexes: the Environmental Justice Index (Map.3-a), which incorporates the percentages of low-income and people of color, and the Environmental Justice Supplement Index (Map. 3-b), which substitute people of color data with information on the percentages of people with limited English-speaking, low life expectancy, less than high school education, and unemployment. To capture different forms of vulnerability.



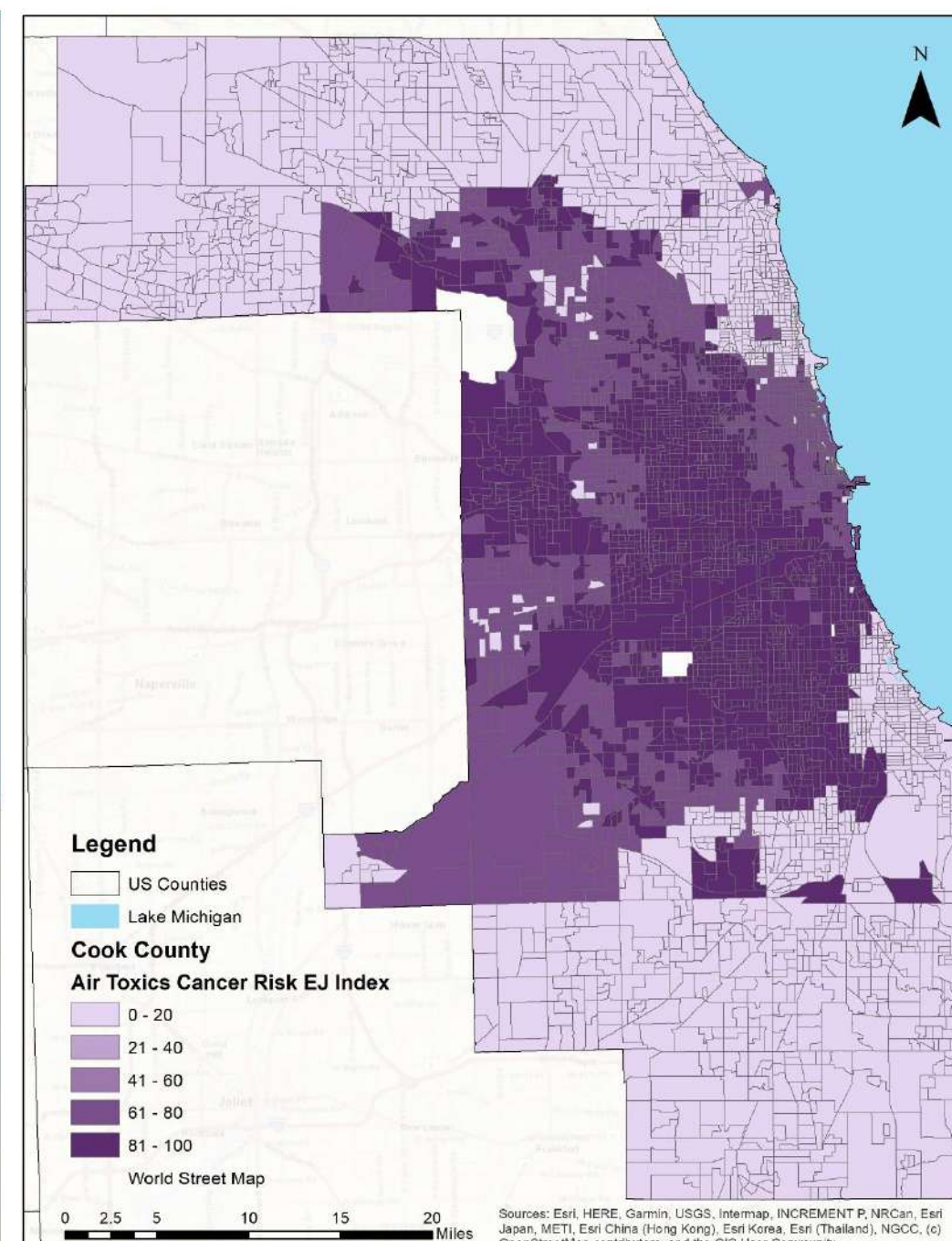
Maps 2-a, b, and c below display the Environmental Justice (EJ) Index for Cook County, highlighting three different air pollution-associated risks: a) PM 2.5 levels in the air, b) Air Toxics Respiratory Hazard Index, and c) Air Toxics Cancer Risk. According to maps, the south and west sides of Chicago, particularly the southeast and southwest areas, display higher values in the environmental justice index. This is associated with a darker distribution of colors, with slight variations based on risks of air pollution and their health effects.



Map 2-a: Cook County PM2.5 EJ Index



Map 2-b: Cook County Air Toxics Respiratory Hazard EJ Index



Map 2-c: Cook County Air Toxics Cancer Risk EJ Index

Based on the hot spot analysis of both the environmental index and supplement index, the cold spots are concentrated in the northern part of Chicago, and hot spots are clustered in the southern parts of the city (Southeast and Southwest). Cold spots of PM 2.5 in northern areas of Chicago tend to be nonsensitive, adding more socio-economic variables. However, analyzing hotspots in the southern part of Chicago, it was found that the added socioeconomic factors in the supplement index caused a slight difference in distribution compared to the Environmental Justice Index. The spatial analysis suggests that exposure to PM 2.5 is acutely sensitive and responsive to the added socioeconomic factors in the supplement index, demonstrating a clear association between air pollution exposure and the population's socioeconomic status.

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Conclusion

Spatial analysis reveals that certain groups, such as people of color, minorities, and those with low socioeconomic status, are exposed to higher levels of air pollution and suffer the most from environmental inequities. This disparity depends on the risks associated with the source of pollution, but it remains true regardless, and imbalances persist. The findings shed light on the environmental injustices marginalized communities face and can help inform policy decisions to address these issues. Local policies can be more effectively implemented by pinpointing the areas most affected. The study also emphasizes the importance of having data available at the local level, which can be instrumental in guiding policymakers as they develop strategies to address these issues at community levels.

Implications and Future Research

Results show a spatial association between air pollution and socioeconomic indicators. However, it is worth investigating whether reducing emissions and pollution is also associated with racial and ethnic disparities. It is also critical to apply an environmental justice lens when targeting pollution reduction, not only when targeting communities with support. Conducting a regression analysis in future research may help better understand racial and ethnic disparities in exposure to air pollution. It is worth exploring how the Environmental Protection Agency (EPA) will use the environmental justice index to ensure enforcement and compliance with regulations to reduce air pollution. This could provide valuable insights into how to address the issue of unequal exposure to air pollution and promote environmental justice.