Winds of Change in the City of Destiny:
Modeling Air Pollution Exposure Risk in Urban Environments

Neal Langeberg, Matthew Kelley

Introduction

In 2016, the world health organization estimated the death toll of outdoor air-pollution to be 4.2 million worldwide (WHO 2022). Identifying areas of concern where exposure risks are higher can work to mitigate the harm that may be done. One of the more cost effective ways to identify poor air quality exposure risk is modeling. By focusing on the factors that contribute to poor urban air quality, theorized hot spots were identified. These predictions were then tested against interpolated observed data to find the amount of correlation between the two models.

Methods

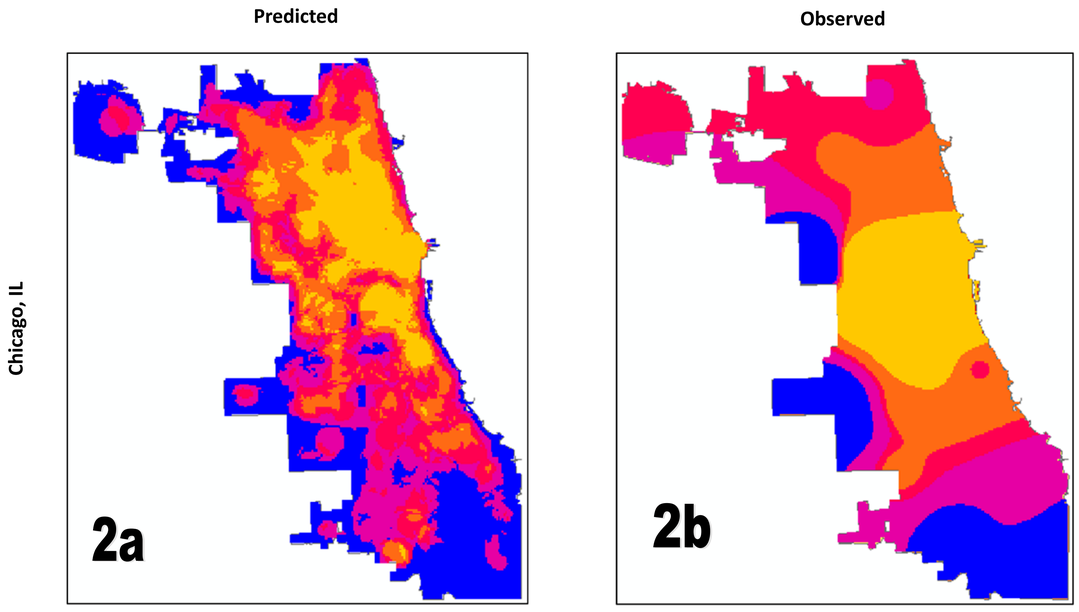
This study focused on data from two cities: Chicago, IL and Tacoma, WA.

Four metrics were identified as being the most correlated with poor urban air quality:

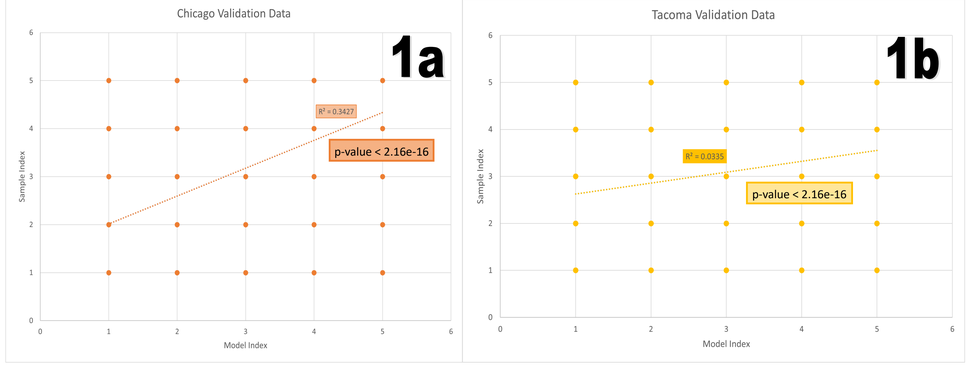
- Population Density
- Road Density
- Active Construction Density
- Proximity to EPA SuperFund Sites

Validation was conducted by analyzing covariance

- In Chicago, real-time AQI and PM 2.5 data was collected through the Project Eclipse web portal. Tacoma data was collected in the field.
- Excel was used to find the R^2 of the two models
- Using R-Studio, a linear regression model was used to test the statistical significance of the model against the mean.



In the maps above (figures 2a-2d) high risk areas are the lighter colored yellow and low risk is shown in dark blue.



The indexed scores for the model and interpolated sample data were graphed to display variation between the two. R^2 values remained low (Chicago = 0.3427, Tacoma = 0.0335). While the p-values were extremely low for both cites (p-value < 2.16e-16), indicating high statistical significance. However, this could be due to the relatively low expected amount of variation between model and sample.

For a more in depth tutorial on how to make your own exposure risk model, scan the QR code.

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Results

- The Chicago model often over predicted an area's risk factor, with 40.8% of risk categories overestimated by one category and 34.9% with accurately predicted risk factors. The model accurately predicted areas of poor air quality 34% of the time.
- On the other hand, the Tacoma model successfully predicted risk factors 33% of the time when compared to the observed dataset, while it underpredicted risk factors by 1 category 55.9% of the time.

Conclusion

- This study proposed a solution in the form of a low commitment semi-universal localized air quality model that could offer a GIS solution to smaller communities.
- Every tool has its limitations. While this model often predicted high risk areas within the two cities of Chicago and Tacoma, the combination of field data was indispensable in determining the effective range and scope of the study.
- In future iterations of this model, it is suggested that focus should be placed on high risk areas alone. It was found that when the data were interpolated to the edges of a cities extent, the model failed to predict low risk areas effectively.

Land Acknowledgement

Many of the cities within North America are built on the colonized lands of Indigenous cultures. Pre-Columbian culture was vibrant and diverse across the continent. However, after colonization many of these cultures lost their voice in the discourse of the time, and often till this day.

Works Cited & Attributions

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[WHO] World Health Organization. 2022. Ambient (outdoor) air pollution. Geneva, Switzerland: WHO. [accessed 2022 Feb 15]. https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

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