Lab Report

Title: Final Project - Prospectus

Notice: Dr. Bryan Runck

Author: Rob Hendrickson

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Project Repository: NA

Google Drive Link: NA

Time Spent: 2.5 hours

Abstract

It is understood that some parts of Minneapolis experience a greater burden of environmental hazard than others. Anecdotally and visually, this can be correlated with areas that were redlined by the Home Owners' Loan Corporation (HOLC) in the 1930's. Ultimately, these disparities can be traced back to the racially-restrictive deeds that were authored in Minnesota from 1910 to 1953 and are an example of how historic racism affects the lives of people today. This project aims to measure that disparity with the intention of spatially correlating it with demographics and restrictive housing practices.

Problem Statement

This project will spatially measure environmental risk in Minneapolis. There are a plethora of factors involved in measuring environmental risk. This project will focus on air quality, however, soil samples from the local initiative, Edible Boulevards, and tree canopy may also be included. Some potential variables involved in determining environmental risk may include: particulate matter 2.5 (PM2.5 – $\frac{micrograms}{meter^3}$), volatile organic compounds (VOCs - $\frac{micrograms}{meter^3}$), SO4, NO, benzene, lead concentration in soil, Annual Average Daily Traffic (AADT), health metrics, and tree coverage.

Once these variables are well understood, through accuracy assessments and modeling, an environmental risk index will be developed. This index could then be modeled across time and analyzed for spatial correlation between the variables: HOLC grade, presence of racially-restrictive deeds, percentage non-white, median income, foreign-born, and other demographics.

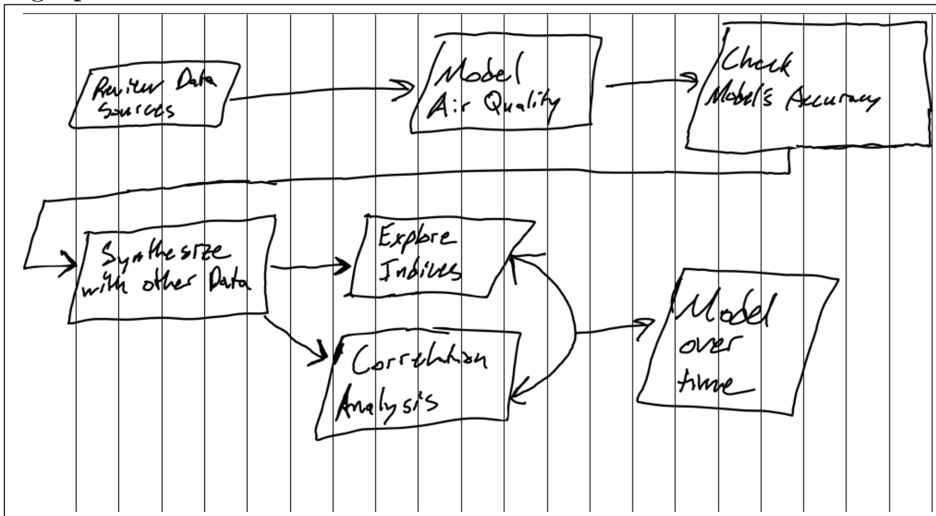


Figure 1: Project Steps

	Requirement	**Defined As**	**(Spatial) Data**	**Attribute Data**	**Dataset**	**Preparation**
1	Model Traffic Emissions Dispersion		MnDoT's Current AADT Segments		MnDOT	
2	Model Industrial Emissions Dispersion		MPCA's Permitted Facility Air Emissions		MPCA	
3	Validate Models	Check model output with Observed data	PurpleAir	Pm2.5, VOCs ($\frac{\mu g}{m^3}$)	PurpleAir	
4	Synthesize Data	Ensure that all environmental risk variables are interoperable	Tree Canopy, Soil Data		http://doi.org/10.13020/D6C016	
5	Experiment with Environmental Risk Indices	Experiment with different weights for variables				
6	Correlation Analysis	Explore how variables/indices correlate	HOLC, Mapping Prejudice, Census		HOLC Mapping Prejudice Census	
7	Spatio-Temporal Modeling					

Table 1: Project Steps

Input Data

	Title	Purpose in Analysis	Link to Source
1	MnDoT's Current AADT Segments [1]	Modeling and Risk Index	https://gisdata.mn.gov/dataset/trans-aadt-traffic-segments
2	MPCA's Permitted Facility Emission [2]	Modeling and Risk Index	https://www.pca.state.mn.us/air/permitted-facility-air-emissions-data
3	PurpleAir Observed Air Quality	Validating Model	https://api.purpleair.com/
4	Tree Canopy [3]	Risk Index	http://doi.org/10.13020/D6C016
5	Soil Quality	Risk Index	
6	HOLC Grades	Correlation	https://gisdata.mn.gov/dataset/us-mn-state-metc-plan-historic-holc-appraisal
7	Restrictive Deeds	Correlation	https://mappingprejudice.umn.edu/racial-covenants/maps-data
8	Demographics [4]	Correlation	https://data2.nhgis.org/main

Table 2: Data Sources

Methods

To be determined... But for modeling air quality I'm considering using resources from both MPCA and Plume Pittsburg. I think the model validation will involve some RMSE, residual, and Pearson Correlation calculations. For the correlation analysis, I was thinking of doing something similar to an earlier project of mine using SLX, SLY, Durbin, and different GWR spatial regressions, but I'm open to suggestions! MPCA also has an air emissions risk assessment that I will explore further when considering the risk index.

Results

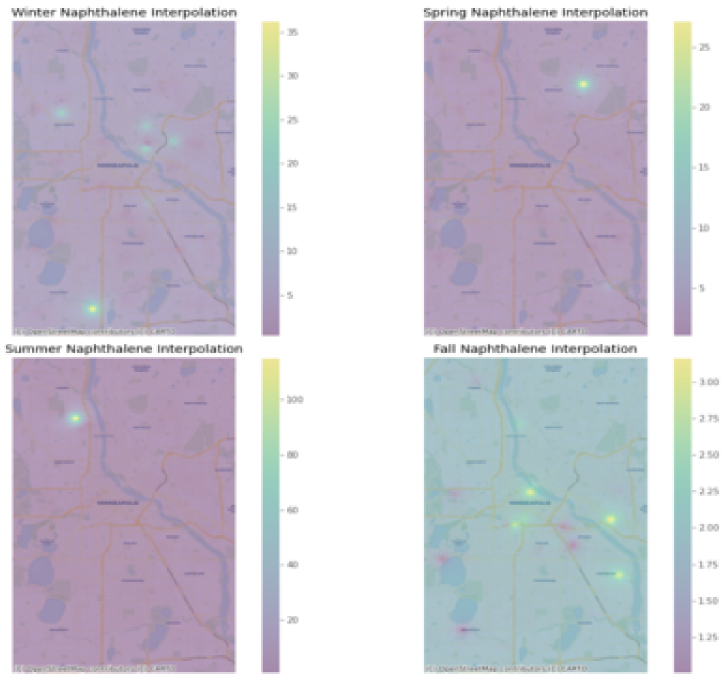


Figure 2: The seasonal interpolations of Naphthalene readings ($\mu g/m^3$).

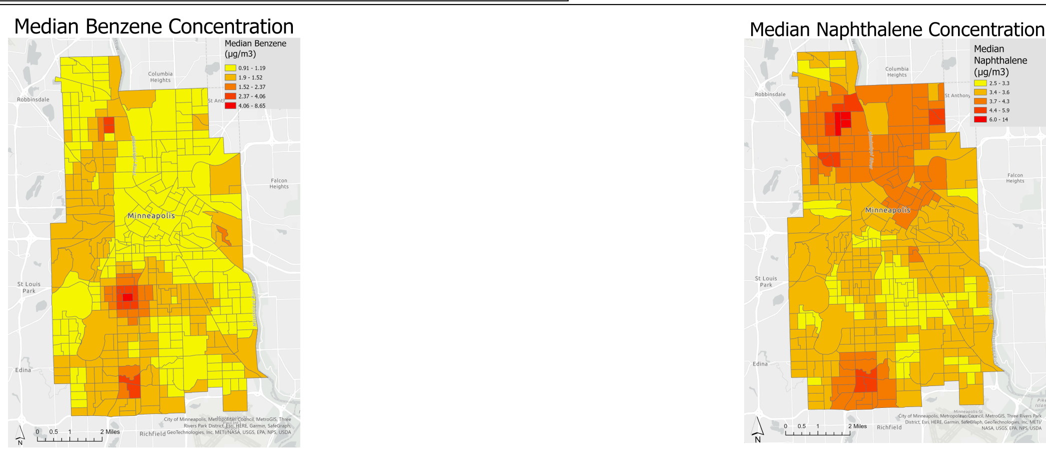
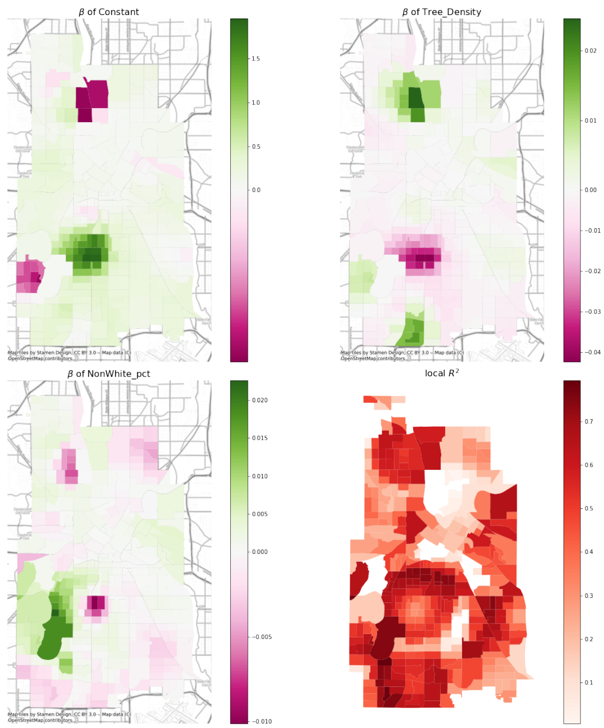
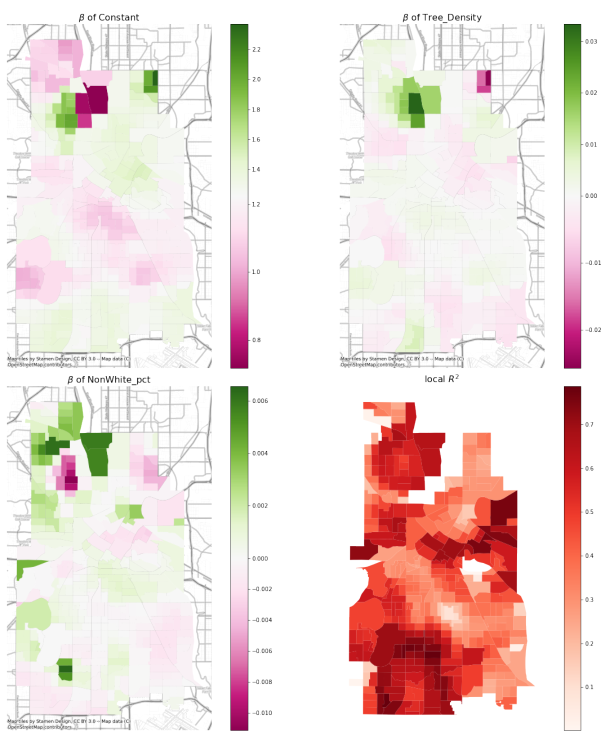


Figure 3: Visualizations of zonal statistics of volatile organice compounds by block group.

Figure 4: Geographically weighted regressions (Air Quality). Fixed 2 kilometer bandwidth.



Regressand: A_B, Regressor: T and R_{NW}.



Regressand: A_N, Regressor: T and R_{NW}.

	R^2	Pearson Coeff	p-value	Residual Morans I	p-value
NonSpatial	0.0888	0.2980	3.7698e-09	0.4336	1.1466e-18
SLX	0.1041	0.3226	1.4926e-10	0.4393	3.5773e-19
SLY	0.2682	0.5179	3.4336e-27	-0.0877	8.9419e-02
Durbin	0.2673	0.5170	4.3190e-27	-0.0774	1.3412e-01
GWR	0.4777	0.6959	9.7322e-56	-0.4243	7.2401e-18

Table 3: Accuracy checks of regressions. Regressand: T, Regressor: R_{NW}.

	CONSTANT	p-value	R_{NW}	p-value	R_{NW}_lag	p-value	T_lag	p-value
NonSpatial	33.44931	1.98079e-135	-0.12088	3.76979e-09	-	-	-	-
SLX	34.99942	8.84001e-115	-0.05236	1.21008e-01	-0.11258	0.01219	-	-
SLY	12.48954	5.28596e-07	-0.05557	3.39681e-03	-	-	0.63771	0.0
Durbin	13.00777	4.13289e-06	-0.04503	1.39290e-01	-0.01866	0.65725	0.62976	0.0

Table 4: Coefficients of regression models. Regressand: T, Regressor: R_{NW}.

Results Verification

The air quality modeling will be verified with the observations from PurpleAir Sensors. Literature will be consulted on how best to construct and refine an index.

Discussion and Conclusion

Environmental justice (EJ) continues to expand and incorporate different conceptions of space, environment, and justice. Contemporary EJ writers often cite a need for more community outreach, education, and inclusive decision-making as well as innovative collaboration between planners, policy-makers, academics, and citizens to achieve profound environmental justice [5, 6, 7]. Pearsall and Pierce [7] emphasize a need for well defined indicators that are spatially focused, not aggregate measures, to gauge a policy's success at implementing environmental justice. This new workflow and index are a couple more tools we can use to collectively reckon with our history, assess our current situation, and work toward reparations.

References

[1] Minnesota Department of Transportation. *Annual Average Daily Traffic Segments in Minnesota*. Periodically Updated. URL: https://gisdata.mn.gov/dataset/trans-aadt-traffic-segments.

[2] *Permitted Facility Air Emissions Data*. Minnesota Pollution Control Agency. 2006-2019. URL: https://www.pca.state.mn.us/air/permitted-facility-air-emissions-data.

[3] Joseph F. Knight, Lian P. Rampi, and Trevor K. Host. *2015 Twin Cities Metropolitan Area Urban Tree Canopy Assessment*. 2017. URL: http://doi.org/10.13020/D6C016.

[4] *2010 Block-level Boundary and Statistical Data*. IPUMS NHGIS. 2010. URL: https://data2.nhgis.org/main.

[5] Gordon Walker. "Beyond Distribution and Proximity: Exploring the Multiple Spatialities of Environmental Justice". In: *Antipode* 41.4 (Aug. 2009), pp. 614–636. DOI: 10.1111/j.1467-8330.2009.00691.x.

[6] Jason Corburn. "Bringing Local Knowledge into Environmental Decision Making: Improving Urban Planning for Communities at Risk". In: *Journal of Planning Education and Research* 22.4 (2003), pp. 420–433. DOI: 10.1177/0739456X03022004008.

[7] Hamil Pearsall and Joseph Pierce. "Urban Sustainability and Environmental Justice: Evaluating the Linkages in Public Planning/Policy Discourse". In: *Local Environment* 15.6 (July 2010), pp. 569–580. DOI: 10.1080/13549839.2010.487528.

Self Score

Category	Description	Points Possible	Score
Structural Elements	All elements of a lab report are included (2 points each): Title, Notice: Dr. Bryan Runck, Author, Project Repository, Date, Abstract, Problem Statement, Input Data w/ tables, Methods w/ Data, Flow Diagrams, Results, Results Verification, Discussion and Conclusion, References in common format, Self-score	28	24
Clarity of Content	Each element above is executed at a professional level so that someone can understand the goal, data, methods, results, and their validity and implications in a 5 minute reading at a cursory-level, and in a 30 minute meeting at a deep level (12 points). There is a clear connection from data to results to discussion and conclusion (12 points).	24	22
Reproducibility	Results are completely reproducible by someone with basic GIS training. There is no ambiguity in data flow or rationale for data operations. Every step is documented and justified.	28	24
Verification	Results are correct in that they have been verified in comparison to some standard. The standard is clearly stated (10 points), the method of comparison is clearly stated (5 points), and the result of verification is clearly stated (5 points).	20	20
		100	90