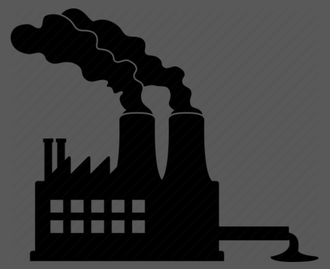


SACRIFICE ZONES: Are some ZIP Codes *too toxic* to live in?

Visualizing the Environmental Justice Impacts of Industrial Pollution in Texas

Introduction

Sacrifice zones are based on the environmental justice concept that there are ZIP Codes across the United States that are so polluted that they are not safe to live in. According to the Center for Health, Environment and Justice, (CHEJ), these zones essentially must be "sacrificed", as they have suffered irreversible environmental damage. In Texas, due to the high concentration of toxic industries like petroleum and fracking, there's a high likelihood some of its most polluted ZIP Codes are sacrifice zones. These zones create an extreme public health risk for those living in those ZIP Codes. According to environmental justice theories, people who live in toxic regions are more likely to be low income and/or People of Color (POC). However, does this correlation apply to sacrifice zones as well?

Currently, there is no specific criteria that determines what makes a zone a sacrifice zone rather than highly polluted. In this study, we attempt to remedy this knowledge gap by creating "potential sacrifice zone regions", or regions where industrial pollution is so high that the ZIP Codes should be considered sacrifice zones. We also investigate the environmental justice implications of sacrifice zones by determining whether POC and people with low income status are more likely to live in these toxic ZIP Codes.

Methodology

For the purposes of this project, we defined ZCTA regions to be ZIP Codes.

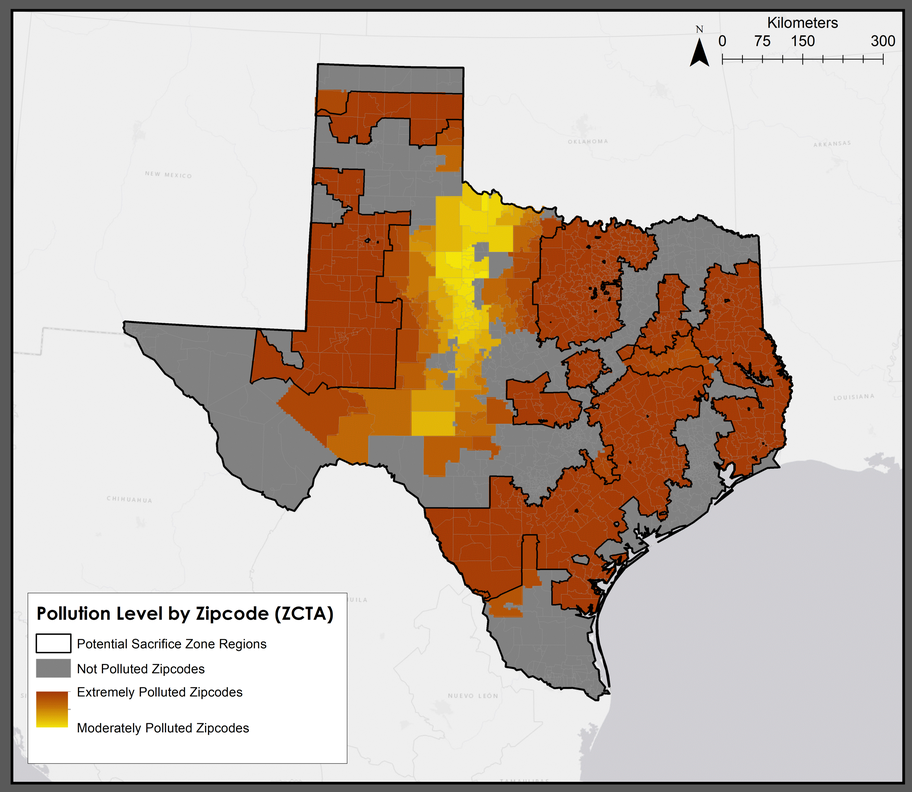
Interpolation: Water Pollution, Air Pollution (stack air & fugitive air) and Underground Pollution (discharge from Class I, Class IV injection wells and landfills) rasters were created through interpolating TRI data, using Ordinary Kriging.

Risk Factors Analysis: All factors were fuzzified in a model using large fuzzy membership, except for Distance to Superfund Sites which was fuzzified using small fuzzy membership. Fuzzy overlay was used to perform the risk factors analysis. Zonal statistics were used to find the levels of pollution for each ZCTA. We define an "extremely polluted ZIP Code" as a potential sacrifice zone region.

Risk Factors: Underground Pollution, Air Pollution, Water Pollution, Distance from Superfund Sites (calculated using Euclidean Distance), Density of Fracking Wells (calculated using Kernel Density)

Spatial Statistics: Next, spatial autocorrelation was calculated using Global Moran's I for polluted ZIP Codes. Correlations between race, low income status and levels of pollution were calculated using Ordinary Least Squares Regression. Correlations were calculated for polluted ZIP Codes only.

Potential Sacrifice Zone Regions



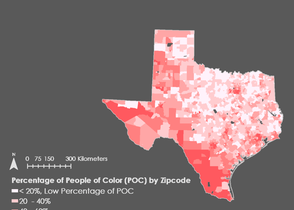
Conclusions

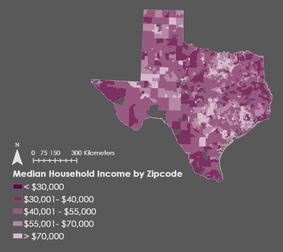
ZIP Codes with extreme levels of industrial pollution were considered to be potential sacrifice zone regions. There are 661 ZCTA regions in Texas that could be sacrifice zones based on their extremely high levels of industrial pollution. Significant portions of Texas are exposed to extreme industrial pollution, especially those surrounding urban areas like Houston and Dallas. Eastern Houston counties like Jefferson country are considered to be extremely polluted according to our model. According to the National Resource Defense Council, Jefferson county has some of the highest rates of toxic chemical releases in the country.

There is a high positive correlation between level of pollution and race in Texas, which makes sense: according to the NAACP, race is the #1 indicator of toxic facility placement throughout the country. Our results also indicated a high positive correlation between median income, which does not make sense according to existing literature on environmental justice. It's possible that these results were skewed as they were just calculated for polluted ZCTAs rather than for the whole state. Given the low r^2 value for income correlation, it is more likely that median income is not a good indicator for pollution level in Texas. Different socioeconomic status variables are likely better indicators of the correlation between industrial pollution and socioeconomic status.

Future research should incorporate further pinpoint sacrifice zone locations by analyzing public health data for the most polluted ZIP Codes.

Demographic Maps





Correlation Statistics

Global Moran's I (Moran's Index) = .954

Z Score = 43.97, < 1 % likelihood that clustered pattern is random chance

Factor	Regression Coefficient	r^2	Interpretation
Race and Pollution	.877	.0293	As pollution increases, percentage of POC also increases
Income and Pollution	.854	.0235	As pollution increases, median household income also increases

Sources and Acknowledgements

Kenia French

Projection: WGS 1984 UTM Zone 14N

Sources: US EPA, ACS 2013-2017

Course: UEP 235, Advanced GIS

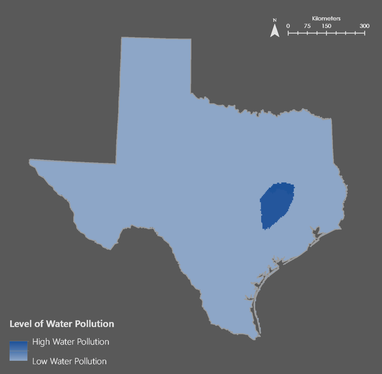
Header: Webstock, Creative Commons

Special thanks Sumeeta Srinivasan for her endless guidance!

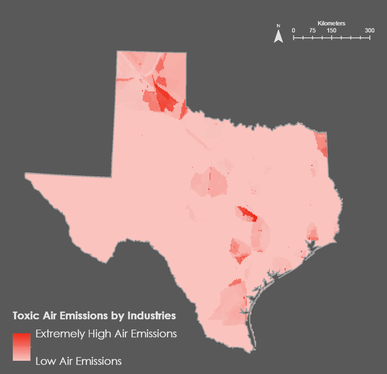
Tufts

Pollution Indicator Maps (Fuzzified)

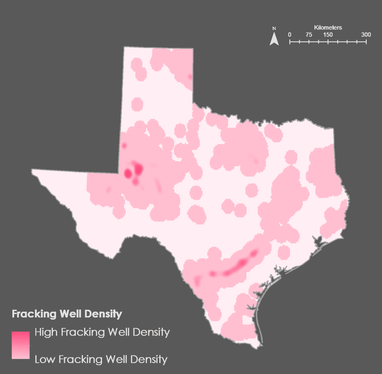
Water Pollution



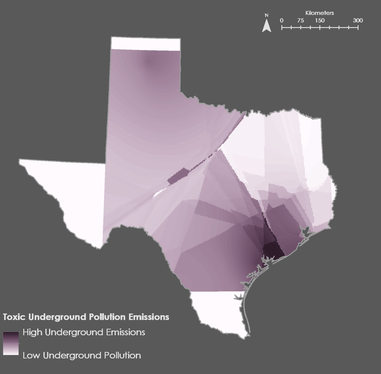
Air Pollution



Fracking Well Density



Underground Pollution



Distance to Superfund Sites