Hazardous Waste Exposure Analysis in the Commonwealth of Massachusetts

Background

Are hazardous waste facilities disproportionately concentrated in low-income areas? Which households will experience the most severe human health and environmental impacts from the toxins released from each of the hazardous waste facilities? The following set of maps model the relationship between income level by census block group and the minimum extent of toxic release from waste sites using income data from the U.S. Census Bureau and registered hazardous waste facilities maintained by the Massachusetts Department of Environmental Protection. These types of waste sites include any facility that manages hazardous waste such as pharmaceutical waste dumps, gas stations etc., all of which are controlled under the Bureau of Air and Waste (BWP). Data is mapped for the Commonwealth of Massachusetts in order to determine the extent to which hazardous waste sites may be placed near low-income areas. Using spatial analyst tools that join census feature blocks to buffers that show how far toxins can travel from hazardous waste sites, the model will demonstrate where waste site toxic exposure affect populations in relation to income. Disproportionate distribution of hazardous waste sites is a policy problem related to environmental justice, a concept defined by the EPA as the, "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies." This environmental justice related model idea is based from a landmark environmental justice study done by Faber and Krieg of Northeastern University in 2002 in the Commonwealth of Massachusetts. The study was done using 2000 census data and looked at the relationship between race and income in relation to a multitude of ecological hazards including landfill sites, industrial sites and hazardous waste facilities across the state. The study revealed a disproportionate placement of these types of ecologically hazardous facilities by geographic location to lower income communities and communities of color in Massachusetts. This model looks at just one type of environmental hazard in particular; hazardous waste facilities in relation to distribution across income classes. This model also uses updated census data from 2010 and models toxic exposure. Therefore, this model will account for less environmental factors than Faber and Krieg's study but will look at more updated census data and waste facilities to see if these types of disproportionate placements still exist.

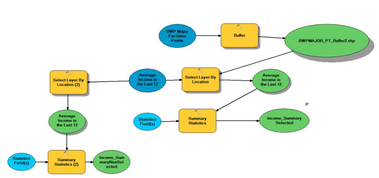
Locator Map of Massachusetts

Hazardous waste is defined by the EPA as any substance that is either ignitable (e.g. waste oils, solvents), corrosive (e.g. battery acid), reactive (e.g. explosives) and/or toxic (e.g. mercury, lead). These types of toxins can remain in the ground for long periods of time, leach into groundwater and destroy drinking water supplies, contaminate soil and pollute the air in the atmosphere and in homes by leaking gaseous particles from the facility or from leaking gaseous molecules in contaminated soil. Furthermore, toxins present in hazardous waste site facilities such as Volatile Organic Compounds (VOCs) and polychlorinated biphenyl (PCBs) tend to bioaccumulate in the environment and in human bodies over time, meaning the toxin itself becomes more concentrated and therefore the level of toxicity increases over time. This phenomena can be difficult to model since it depends on certain factors such as soil composition and how well the facility seals its waste to determine the extent and severity to which a toxin can impact the surrounding environment and human population. The following model will look at just one travel method: leaking of toxins as gaseous molecules through the ground and air. It has been observed, as cited by the Agency for Toxics Disease and Registry of Atlanta, that gases have travelled 1,500 and more from hazardous waste facilities. Therefore we can assume that this 1,500 foot distance represents a minimum potential exposure to toxic gases present in what is characteristic of hazardous waste.

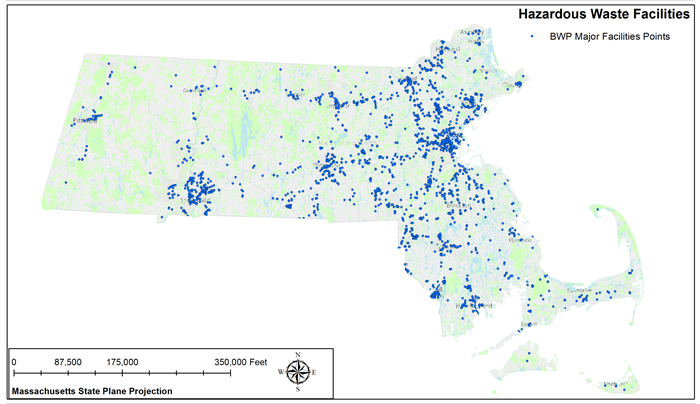
Methodology

Modeling was done using the buffer tool and summary statistics. A 1,500 foot buffer was created around each hazardous waste facility used to represent the minimum potential exposure distance to the adverse human health and environmental effects of gaseous toxins. Then, block groups were selected that intersect with the buffers using the select layer by location tool to represent how many block groups have the potential to be exposed to these adverse effects. While parts of the population within block groups will be affected by the gaseous toxins differently, the focus will be to consider these block groups 'near' the waste sites. Summary statistics was used to calculate the sum of how many households that make each income level. This data originates from the census data present in all of the selected block groups. These sums were reclassified into three income classes using the adding function in Microsoft excel to create the following chart displaying the number of households that make 'low income,' 'middle income,' and 'high income'. The selection was reversed and summary statistics calculated the same income distributions for the non-selected block groups. The results of the model revealed that of the 4,979 block groups in the state of Massachusetts, 2,780 were selected and 2,199 remained unselected. Therefore we can consider the 2,780 selected block groups as 'near' a hazardous waste facility and 2,199 as 'not near.' After calculating summary statistics for the 'near' and 'not near' block groups, the following charts were created to display the number of households in each income level. In other words, the chart compares the block groups that are 'near' and 'not near' the potential exposure risk to hazardous waste facilities in terms of household income levels for the classification scheme created in excel.

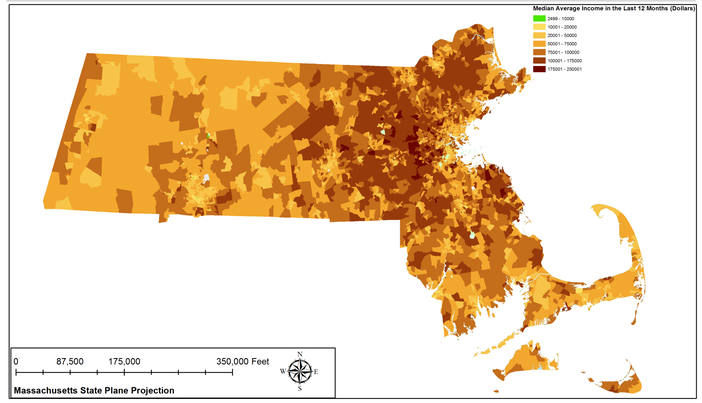
Geo-processing Model



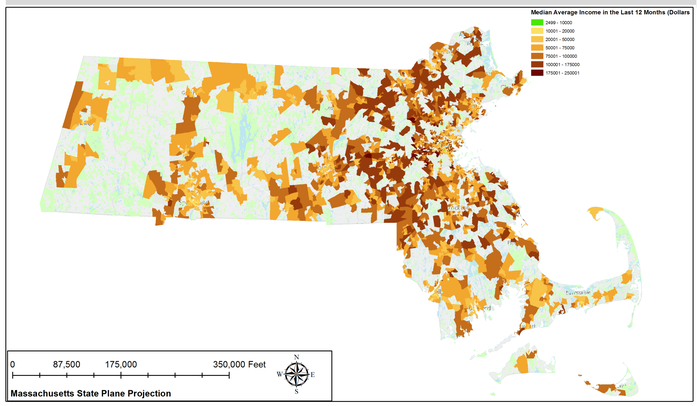
BWP Hazardous Waste Facilities



Median Average Income

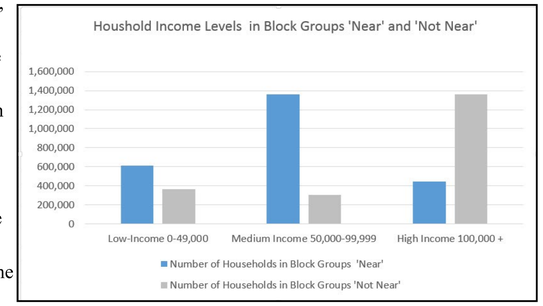


Selected Block Groups 'Near' Hazardous Waste Facilities



Results

By beginning to compare the block groups that are 'near' and 'not near' hazardous waste facilities in relation to income levels by households in each block group, we can see if there is a correlation between these two entities. This first set of summary statistics counts the number of households that make particular income levels for the selected block groups and the unselected block groups. The summary statistics calculated the sum of households that make 'low income' (between $0 and $49,000 per year), 'medium income' (between $50,000 and $99,000 per year), and 'high income' ($100,000 or more per year). From these results, the data reveals that there is a large number of high income households in the 'not near' block groups compared to those that are 'near.' This could be interpreted to mean that in areas with many high income households, there are less hazardous waste facilities. Furthermore, there are more low-income and middle income households in the 'near' block groups than in the 'not near' block groups, based on quantity of households exposed and not exposed. Generally, the data reveals that as a household makes a higher income, the more likely it will be in a block group that is considered 'not near' by the results of this model.



Conclusions and Limitations

In terms of whether or not there is a disproportionate placement of waste sites near low and medium income groups, the data reveals that there is an unequal number of households in the 'not near' groups as compared to the 'near' groups. However, it does not consider this placement as a consequence of other factors such as population density or the difference between urban and rural areas. As such, it may be difficult in determining whether these results reveal a biased or disproportionate placement of hazardous waste sites in the context of environmental justice without the incorporation of these factors. The model does reveal, however, that there is more money by household in the block groups considered 'not near' than those that are considered 'near.' It is also important to note that of the block groups that are considered 'near' a buffer, these block groups most likely represent a minimum potential toxin exposure since toxins from hazardous waste facilities may continue to spread and cause more damage over time due to bioaccumulation. Therefore, certain block groups or populations within the block groups may experience more negative effects than others at different times based on how long the waste facility remains operating or may experience more extreme effects the closer they are to the hazardous waste facility itself, regardless of the distance from the buffer. Since this model only considers the travel path of gaseous toxins, populations in block groups that are 'not near' may also experience adverse effects over time as well due to exposure from toxins present in water and soil that are not in gas form. Once again, the extent to which an intersecting block group may experience adverse effects depends on other factors including soil composition and facility management policies. In other words, this model is limited in demonstrating the relation of income by block group to placement of the waste sites considering just the 1,500 foot minimum potential impact from gaseous toxins. It may also be helpful in the future to consider the density of poverty around each of the hazardous waste sites to more accurately model if there is a biased placement.

Sources

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