Air Pollution - Emissions and damages reconceived

Martin Sweeney, GEOG 320, Fall 2011

Motivation & Questions

Air pollution has a variety of sources: power plants, automobiles, businesses, agriculture, and even households. Different pollutants are generated by different activities; the quantity of emissions can depend on both industry mix and individual behavior in an area.

How does air pollution vary spatially? Is it dependent upon population? What counties are responsible for generating the largest air pollution damages? Are racial minorities or poorer individuals harmed disproportionately?

Emissions

The map below suggests that annual CO₂ emissions are driven largely by large power plants. The counties with the highest gross emissions generally contain at least one power plant and are generally not the most populous.

Notes about the model

Professor Nick Muller is the creator of the Air Pollution Emission Experiments and Policy model, a computer model that estimates annual damages from air pollutant emissions in the contiguous United States at the county level. Though the model does not incorporate GIS software, it does represent spatial concepts through the use geographic coordinates and mathematical functions, like the dispersal of air pollutants from one county to another counties. It converts emissions to concentrations to damages using dose-response functions.

Emissions from non-point and point sources are allotted to the centroids of counties. Point sources are differentiated by stack height, for the height effects the dispersal of pollutants. The tallest smokestacks (effective stack heights of over 90m) are essentially point sources, for they are modeled individually in the model. Many of these tall stacks are found at power plants that generate an overwhelming share of the nation’s emissions.

Race

We’ve seen thus far the emissions and damages vary spatially. One remaining concern is that minorities may suffer disproportionately from the harmful effects of air pollution. The heights of the dark bars on the map above correspond to the percentage of non-whites in the census tracts that lie within a quarter-mile of a large power plant. The height of the base map represents the national average of the percentage of non-whites in census tracts.

While the national census tract average is 31.9 percent non-white, the average for the tracts of interest is 21.4 percent non-white. Since non-whites disproportionately live in urban areas, this phenomenon could likely be explained by the siting of plants in more rural or lower-density areas, as previous graphs have suggested. Plants in rural areas are likelier to avoid large gross pollution damages and comply with air pollution regulations. Alternatively, energy providers may be reluctant to operate a plant in a non-white neighborhood out of fear of being accused of environmental racism.

Income

A related concern is that poorer individuals may suffer disproportionately from air pollution. The map below depicts income data from the census tracts within a quarter-mile of a large power plant. Red circles represent tracts with a median household income that is lower than the national average, and blue circles represent tracts that report a higher median household income than the national average. The size of the circles corresponds to the magnitude of the difference from the national average.

Whereas the national average for median household income by census tract is $43,453, the average in the tracts of interest is $38,6/7, or 12 percent lower. The result suggests that poorer individuals may indeed suffer disproportionately from air pollution. This could potentially be due to the intentional siting of power plants in poorer neighborhoods, or the inability of poorer individuals to find more affordable housing in other less polluted areas.