SPATIAL DISTRIBUTION AND DETERMINANTS OF PCB CONTAMINATION IN RESIDENTIAL SOIL IN ANNISTON, ALABAMA

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Introduction:
Polychlorinated biphenyls (PCBs) were produced at two facilities in the U.S., one located in Anniston, Al, and the other located in Sauget, IL. Although PCBs were produced in Anniston from 1929 until 1971, it was not until the mid 1990s that the extent of environmental and human exposure to PCBs began to be investigated in this community of about 24,000 inhabitants. In 2003, the US EPA started the large scale remediation of PCB contaminated residential soil in Anniston. As part of a comprehensive exposure assessment, GIS analysis was used to map the spatial distribution of PCBs remaining in the soil for 35 or more years following the ban on production. Spatial regression analysis was also used to describe the effects of physical and environmental variables on the concentration of PCBs in soil.

Methods:
The US EPA provided a database containing total PCB levels in about 7,109 residential soil samples in Anniston with multiple measurements taken from the upper 3 inches of soil in each location measured in ppm (parts per million or mg/kg). Information on the associated address and geographic coordinates is also contained in the database. Regression models were used to identify predictors of soil PCB levels. To examine the magnitude of the effect of the explanatory variables, we calculated coefficients of each predictor using an ordinary linear regression, with levels of PCBs in soils taken as the dependent variable and physical factors as independent variables.

Results and Discussion:
PCB levels in soil ranged from non detectable to 690 ppm. Approximately 163 residential soil samples had PCB levels > 10 ppm (time critical removal) and 1,028 had levels ranging from > 1.0 to <10 ppm (standard removal). In the physical and environmental model, two variables, distance to plant landfills and distance to main hydrology were particularly important in explaining soil PCB levels within the study area, with concentrations declining as distance increases. Subsequently, geographically weighted regression (GWR) was performed to correct problems of spatial nonstationarity in ordinary least square (OLS) regression. It produced results that considered the spatial variation in the associations between explanatory and dependent variables in comparison to ordinary regression, which generates only a single regression equation to yield global associations between variables. The GWR increased R^2 values and reduced errors of model-fit, in comparison to the OLS estimates.

PCB concentrations of soil samples vary markedly in the vicinity of the plant. The vicinity of the main hydrology explains a significant amount of the geographical variance in PCB soil concentrations in Anniston, Alabama. These associations were observed after taking other environmental/ physical variables into account. Furthermore, GWR modeling, correcting for regional variations in the relationships between explanatory and dependent variables allow for better identification of significant risk factors. Unlike ordinary regression, GWR provides a different measurement of associations between dependent and explanatory variables from location to location.

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