Assessing Environmental Equity Related to Local Air Pollution in Tampa, FL

Extended Abstract #466

Amy L. Stuart, Michelle Zeager, and Noreen D. Poor
University of South Florida, 13201 Bruce B. Downs Blvd., MDC 56 33612-3805

Sarntharm Mudhasakul and Watanee Sriwatanaponge
King Mongkut's University of Technology Thonburi, Bangkok, Thailand

INTRODUCTION

Despite overall improvements in U.S. air quality in recent decades, there is continued concern that minority and poor population groups may be disproportionately burdened by air pollution and its effects.[1] Particularly concerning are incidences of associated health outcomes, including asthma, that are disproportionately large for some minority groups.[2,3] Lower socioeconomic level may also increase susceptibility to air pollution exposures, due to decreased access to health care and poorer overall health.[4]

Spatial patterns of population segregation and air quality have been found to play important roles in disparities in air pollution-related health outcomes.[5] Previous studies indicate that minorities are more likely than Whites to reside in areas with higher concentrations of criteria air pollutants and closer to toxic air pollution sources.[6-8] However, past work assessing disparities in effects has been limited to lower resolution estimates of spatial concentration patterns (from census tract to metropolitan area resolution). Because concentrations of primary pollutants can vary substantially over much smaller spatial scales, populations living, working, and studying near sources may have greater exposures to air pollution. Significant differences have been found in respiratory and cardiovascular health impacts as a function of roadway proximity, and other indicators of nearby traffic pollution, at scales on the order of 100 meters.[9-11] Here, we investigate potential inequities in air pollution exposures due to small-scale spatial patterns of air quality and population demographics in Tampa, Florida, and surrounding Hillsborough County. We focus on analyzing comparative relationships for racial or ethnic minorities and the population in poverty.

METHODS

Our methods include spatial mapping of air pollution sources, monitors, and population demographics, development and application of a quantitative index of subgroup inequity, air dispersion modeling, and local passive air sampling.

For mapping analyses, we are developing an ArcGIS® geographical database for Hillsborough County, Florida. The database includes population demographics data, air pollution source locations and selected emissions data, and monitor location and measured concentration data for selected pollutants and averaging times. The temporal focus of the database is the decade surrounding the 2000 U.S. census. Population demographics data is from the 2000 U.S. census Summary 3 files at the block group spatial level (block group areas are the smallest spatial scale available in the census data and range in size from hundreds of meters to kilometers in diameter). Using this data, the percentages of people below poverty, Blacks, Hispanics, and Whites residing in each block group area were calculated. Air pollution point source data were derived from the U.S. EPA toxic releases inventory.[12] Data from the years 1996 - 2004 were downloaded and filtered to compile a list of facilities with total air releases greater the 1000 pounds over the period. Major highway source locations are also included in the database, based on mapping files compiled by the Florida Geographic Data Library (FGDL)[13] from the Florida Roadway Characteristics Inventory.[14] Traffic count numbers for 2004 were obtained from the 2004 Florida Traffic Information CD.[15] Comprehensive air quality monitoring location mapping files, with underlying data provided by the Florida Department of Environmental Protection, were obtained from the FGDL. Finally, measured averaging time concentrations for NO_2, SO_2, PM_{10}, and $PM_{2.5}$ were downloaded from the US Air Quality System summary data[16] and included in the geodatabase.

Using this database, block group area subgroup population percentages were qualitatively compared with source and monitoring locations using overlaid map layers. For quantitative comparison, we developed and applied a subgroup inequity index. This index, $F_i = \log (Z_i/T_i)$, is the log transformed ratio of the percentage of population within the influence zone of sources comprised of a specific subgroup (Z_i) over the percentage of that population subgroup in the county (T_i).[17] Positive index values indicate that the population subgroup is disproportionately living within the influences zones of the selected sources, while negative values indicate the subgroup is disproportionately living outside of the influence zones. Population percentages within varying assumed influence radii of sources of different types and monitors were each calculated using the ArcGIS® analysis toolbox.

Since monitoring data for any specific pollutant is not adequately spatially resolved to represent block group level concentrations, we are applying CALPUFF dispersion modeling to assess higher resolution pollution patterns. To date, we have simulated NO_x, PM_{10}, and $PM_{2.5}$ concentrations resulting from 2002 National Emissions Inventory point source emissions for a two-week period in May 2002, using MM5 meteorological data and a 1 km resolution receptor grid. Simulated locations of high concentrations were included in our geodatabase and further used to calculate corresponding subgroup inequity index values.

Finally, we are using passive sampling methods for further determination of local pollutant concentrations and for model evaluation. This has thus far included the initiation of an NO_2 sampling campaign. Seventy five locations near elementary schools in the county have been randomly selected as sampling sites. We are using Ogawa™ passive diffusive samplers with NO_2 elements for sample collection. NO_2 concentrations are being analyzed via a color-producing diazotization reaction and spectrophotometric detection at 540 nm. We are following the sampling and analysis procedures outlined in the Ogawa Protocol,[18] with modification to use Hach Method 8507 powder pillows as the color-producing reagent. Measured concentrations will be compared to school and residential population demographics and roadway proximity.

RESULTS AND DISCUSSION

Figures 1 - 4 shows selected results of our analyses. Figure 1 is an ArcGIS® map of the percentage Blacks in each block group area overlaid on the Toxic Releases Inventory source locations (triangles) and major highway locations (lines). Figure 2 is a contour plot of the maximum 24-hr averaging time NO_x concentrations simulated using CALPUFF. The red crosses are NO_2 regulatory monitor locations. Figure 3 shows the calculated subgroup inequity index values for the simulated NO_x high locations. Figure 4 provides the subgroup inequity index values for simulated PM_{10} high locations.

Figure 1. Sources vs Black population

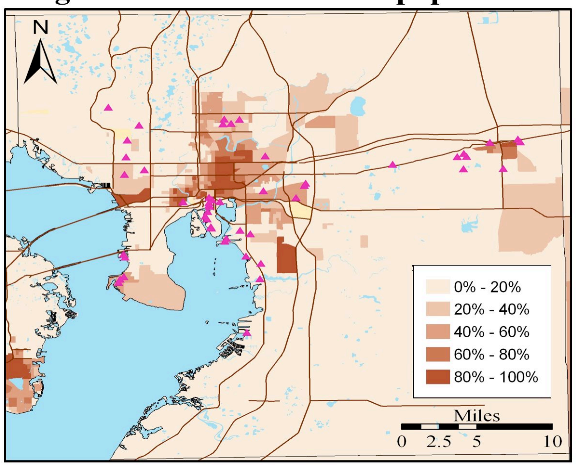


Figure 2. Maximum 24-hr NO_x

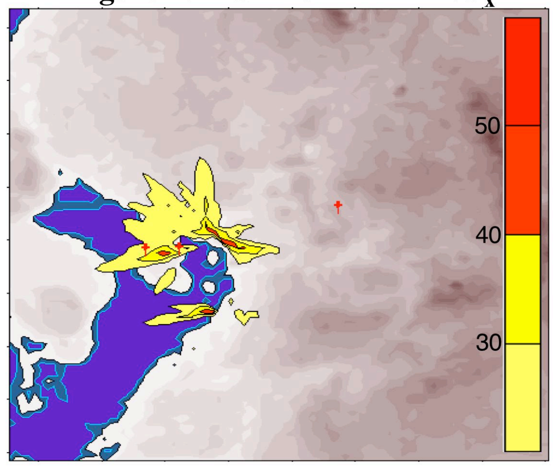


Figure 3. Inequity index for NO_x highs

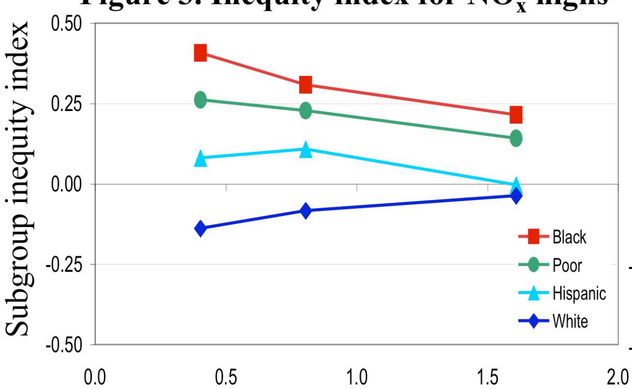
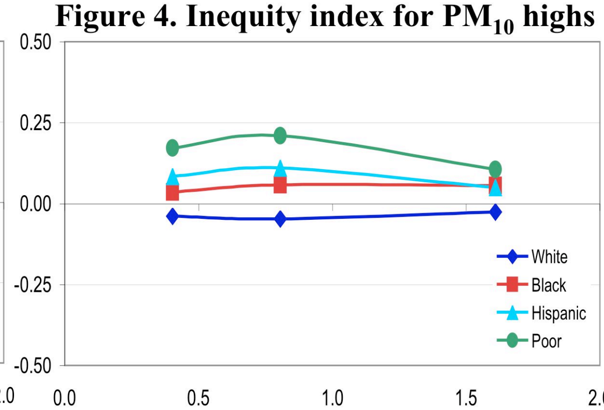


Figure 4. Inequity index for PM_{10} highs



Influence radius(km)

Results suggest that Blacks, Hispanics, and people in poverty in Hillsborough County are living disproportionately close to sources and high concentrations of air pollution. However, they are living disproportionately far from monitors. Whites, conversely, are living disproportionately close to monitors and far from sources and high concentrations.

SUMMARY

Here, we investigate the potential for disparities in exposures to outdoor air pollution between population subgroups in Hillsborough County, Florida. We use spatial mapping of sources and monitors, air pollution dispersion modeling, and passive sampling methods. We find likely higher exposures for studied minority groups and poor people in the county. Implications include the need for better representation of high-resolution pollution patterns in health impacts assessments and in monitoring network design.

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KEY WORDS
environmental justice, exposure assessment, spatial mapping, dispersion modeling, passive sampling