In a new collaborative project, the Science Museum of Virginia, the University of Richmond and VCU is collecting and analyzing data on the spatial and temporal variability in air quality data for the City of Richmond. This work builds on earlier research that mapped the urban heat island effect in the city which studied and identified specific neighborhoods and communities that are highly vulnerable to heat stress and related health concerns. This follow-up study examines whether similar patterns exist for air quality in the city.

Pollution and poor air quality have detrimental effects on human and environmental well-being, and they are often tied to complex societal factors. For example, multiple studies have already documented the correlation between air pollution and COVID-19 infection and mortality rates. Our analysis aims to identify connections between social, demographic, and economic variables and spatial patterns of pollution in Richmond, Virginia.

Background

Following principles of citizen-science, 15 PurpleAir air quality sensors are being hosted at homes and businesses in the RVA. These sensors measure temperature and humidity and use laser particle counters to quantify the concentration of suspended particles of varying sizes. We focused on the measurements of atmospheric particulate matter of fewer than 2.5 micrometers (μg) in size (PM2.5) since these particles have been shown to severely impact human health. The higher the PM2.5 level, the worse the air quality. The lungs usually block coarser particles like PM10, and finer particles like PM2.5 have not been studied enough to be considered a threat to human health.

When the temperature rises, air quality tends to worsen since the convection of cool and warm air creates an atmospheric lid that traps air pollutants thus increasing their concentration. An increase in temperature results in increased PM2.5 readings. So, throughout a typical spring event, the correlation between air pollution and COVID-19 infection and mortality rates. Our analysis aims to identify connections between social, demographic, and economic variables and spatial patterns of pollution in Richmond, Virginia.

Results

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Discussion

The results indicate that, on average, PM2.5 levels slowly rose throughout March, dropped suddenly between March and April, then rose again throughout the summer. The sudden drop in PM2.5 can be attributed to Virginia Executive Order 55, which was effective March 20, 2020. This stay-at-home order substantially decreased the amount of traffic in the city. Nationwide, vehicle mileage bottomed out on April 9th, recovering to about 90% of pre-pandemic levels by mid June.

The PM2.5 concentrations measured at Scott’s Addition, an area of the city identified by the urban heat island analysis as likely to have elevated pollution levels, were significantly lower during the month of April following the executive order (7.6 μg/m³) than for March, before the executive order went into effect (9.8 μg/m³, p < 0.05). For the entire sensor network, the mean PM2.5 concentrations in April (7.7 μg/m³) were also significantly lower than for March (9.4 μg/m³, p < 0.05).

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