Spatial Variation of fine particulate matter levels in Nairobi before and during the COVID-19 curfew: Implications for Environmental Justice

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Air Quality Data reported by countries

HUGE GAPS!

http://openaq.org/
Air Quality Monitors: high cost to low cost

Reference Air Quality Monitoring Station

- High accuracy
- High cost ($150,000-$200,000)

Low Cost Air Quality Monitor

- Low accuracy
- Low(er) cost (~< $2,500 as defined by USEPA Air Toolbox)

https://archive.epa.gov/pesticides/region4/sesd/pm25/web/html/p2.html

deSouza, P., Nthusi, V., Klopp, J.M., Shaw, B.E., Ho, W.O., Saffell, J., Jones, R. and Ratti, C., 2017. A Nairobi experiment in using low cost air quality monitors. Clean Air Journal, 27(2), pp.12-42.

http://senseable.mit.edu/cleanair-nairobi/
What are the spatial variations in air pollution in Nairobi? How have COVID-19 policies affected these patterns (with University of Nairobi Fablab + open-seneca)

8 Sensirion SPS-30 devices were used between March 17 - May 5/ 1,316,558 measurements over 39 unique days (Curfew started March 25)
Data Pre-Processing

1) We divided our measurements into two time periods: before and during COVID-19
2) For each time period we estimated background pollution using a minimum-of-splines approach
3) We then performed a background correction or standardization

\[
PM_{2.5c,i} = PM_{2.5,OPC,i} - PM_{2.5, bkg,i} + PM_{2.5, bkg,median} \quad \text{.................(1)}
\]

4) We then dividing Nairobi into grid cells of 100 m x 100 m (3,151 before and 4,209 during the curfew)
5) We selected the median background-corrected \( PM_{2.5} \) levels for each grid cell as the ‘generalizable’ \( PM_{2.5} \) concentration
Generalizable PM$_{2.5}$ levels before and during COVID-19
Predicting $\text{PM}_{2.5}$ surface for all of Nairobi

Land use covariates:

1) Population density
2) Multidimensional poverty index
3) Length of different road types
4) Average travel friction/accessibility of an area
5) Number of matatu stops
6) Number of matatu trips
7) Land use
8) Different neighborhoods

In buffers of 100 m, 200 m, 300 m

Model used: Random Forest Model (10 - fold CV)

Robustness check: Used Universal Kriging, Only used grid cells with stable generalizable $\text{PM}_{2.5}$ concentrations
We used a Random-Forest (RF) model to predict PM$_{2.5}$ before and during the COVID-19 curfew over the entire city of Nairobi:

R$^2$ before: 0.95, after: 0.93
Sensitivity Analysis: We ran the RF model on all segments with a stable median PM$_{2.5}$ value (std error in median < 20%)
Sensitivity Analysis: Universal Kriging
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Paper can be found here:

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