Role of air pollution in the Covid-19 outbreak: A Ward Level Spatial analysis in Mumbai

Aparajita Chattopadhyay and Subhojit Shaw

International Institute for Population Sciences, Mumbai

(www.iipsindia.ac.in)

July 12, 2020

IIPS Analytical Series on COVID-19:

Paper: 19 Role of air pollution in the Covid-19 outbreak: A Ward Level Spatial analysis in Mumbai

(This work has not been peer-reviewed. If you find any errors or have clarifications, please

For research and updates on Covid-19,

visit: https://www.iipsindia.ac.in/content/covid-19-information

Role of air pollution in the Covid-19 outbreak: A Ward Level Spatial analysis in Mumbai

Aparajita Chattopadhyay and Subhojit Shaw
aparajita@iips.net; subhojitshaw93@gmail.com

Abstract:

The analytical paper looks into the role of selected air pollutants in determining cases of Covid-19 in Mumbai. We could find significant relation of Covid-19 cases with three pollutants, i.e. NO2, SO2 and PM_{10}. Sspatial clustering hot spots are observed in the following wards of Mumbai i.e L, HE, GN, GS, FS, E, FN, N and ME located mainly in the central and south parts. Pollution may favour coronavirus spreading in Mumbai. Air pollution should be considered in epidemics prevention because higher exposure to pollutants leads to increased risk of respiratory infections.

Key Words: Pollution, Covid 19, Mumbai, Hot spot

Introduction:

Pollution levels depend upon a number of factors like topography, building density/ pattern and road density, weather conditions etc. Pollutions often build up in low lying areas - i.e. valleys, between hills etc. We are all aware of the fact that the lockdown has a silver lining in terms of reduction of air pollutants. Almost every big city in India experienced a better air quality during lockdown. Particulate matter (PM) has reduced and oxides of nitrogen and sulphur that are mainly generated through combustion, sharply declined, helping the city population to breath better air. However, these changes are short term. We will be back to the pre lockdown pollution level once normal activities start again. The question here is that do we see any association between the usual pollution levels and Covid-19 positive cases spatially? That is, does pollution favour Covid 19 spread? We looked into the air quality of Mumbai through *NO2, SO2* and PM_{10} (particulate matter lesser 10 microns) and analysed these pollutants in context of Covid 19 cases. Few interesting studies published recently in international Journals (Fattorini and Regoli 2020; Zhu et.al 2020) expressed that 78% of deaths had occurred in just five regions in northern Italy and Spain that have the highest concentrations of nitrogen dioxide (*NO2*); further, a small increase in long-term exposure to air pollution could have a significant effect on the severity of COVID-19 in the US. The papers based on Italy and Spain argues that Lombardy region in the Po Valley and Madrid administrative region which are ringed by mountains hence experiencing the downward air pressure that are worst hit region of these two countries. Does it connote a similar situation for Mumbai in India- a place with

plenty of low lying areas surrounded by the Western Ghats? Release of Mumbai's recent ward wise data helped us to look into the aspect of Covid19 and pollution's spatial relation.

Methods:

The datasets used for the study was derived from different ancillary sources: Central Control Room for Air Quality Management - All India and MCGm web page The summary distribution of Covid-19 cases as of June 22 has been given in (fig. 1a). To empirically check the association of the atmospheric pollutant and the increasing positive cases, we have used the bivariate local indicator of spatial autocorrelation *(LISA)* maps with the level of *NO2, SO2* and PM_{10} to access the spatial autocorrelation and clustering. Here, Covid 19 is the dependent variable in spatial regression. We could not find any association for O_3 and $PM_{2.5}$ and thus not mentioned in detail in this note. A *Moran's I* statistic ranges between - 1 and 1. Positive spatial autocorrelation signifies cluster pattern, whereas negative value has spatial dissimilarity with associated regions. In the present study, Bivariate local Moran's I statistic was computed which measures the spatial autocorrelation between two matrices using a randomization test on a Z-score with 9999 permutations as follows:

$$\text{Bivariate Moran's I} \quad = \frac{n}{S_0} \times \frac{\sum_i \sum_j W_{ij}(x_i - \bar{X})(y_j - \bar{Y})}{\sum i \, (y_i - \bar{Y})^2}$$

Results:

In the present study we have investigated whether the patterning of Covid-19 occurrences follows an organized spatial configuration with air pollutants or not.

The highest level of Covid-19 infection has been recorded across the central part of Mumbai, in the wards of L (Kurla), KW (Andheri West), KE (Andheri East), GN (Dadar) and PN (Malad). While, the lowest cases were recorded in B (Sanhurst Road) and C (Marine Lines) wards. The concentration of major three pollutants, *NO2, SO2* and PM_{10} were high across the central wards of Mumbai. Mumbai wards shows a distinct association in the level of air pollutants and Covid-19. LISA maps show a compelling evidence of association between Covid-19 cases with the key pollutants in this study. The ward wise scenario can be visualised as:

- *Hot Spot:* (red colour) High-presence of air pollutant and High-presence of Covid-19.
- *Cold Spot:* (blue colour) High-presence of air pollutant and Low-presence of Covid-19.
- *Spatial Outliers*: (light-blue colour) Low-presence of air pollutant and High-presence of Covid-19.
- *Spatial Outliers*: (Pink colour) Low-presence of air pollutant and Low-presence of Covid-19.

The High-High spatial clustering can be found across L (Kurla), HE (Khar/Santacruz), GN (Dadar/Plaza) and FN (Matunga) wards, where higher frequencies of *NO2* pollutants corresponds with high Covis-19 cases. Whereas, Low-Low clustering is found RC (Borivali West), RS (Kandivalli) and T (Mulund) wards in the northern zone of Mumbai (Fig1. b). The spatial lagged Moran's I is (0.321) with 5% significance level.

Furthermore, the High-High clustering of SO2 and Covid-19 can be observed across the wards of ME (Chembur East), FN (Matunga) and N (Ghatkopar). While, Low-Low clusters can be found in RC (Borivali West), RS (Kandivalli), T (Mulund) and PS (Goregaon) wards (fig1. c). The Bivariate lagged Moran's I of SO2 and Covid-19 was (0.228) at 5% significance level.

Interestingly, High-High clustering of PM_{10} concentration and Covid-19 in the low lying areas of Mumbai might be due to sand particles along the coastal wards or high pollution in GN (Dadar/Plaza), FN (Matunga), GS (Elphinstone) and FS (Parel). All these places are low lying regions, and thus may have higher levels of PM_{10} that is related to higher number of cases (fig1. d). The Low-Low clustering is found in the Northern wards of Mumbai. Although the bivariate cluster of PM10 and Covid-19 is not statically significant, we cannot ignore the spatial distribution of pollutant areas. Overall the Spatial-Outliers are found across the wards of PN (Malad) and S (Bhandup).

Discussion:

To prevent the outbreak and transmission of Covid-19, India had adopted country wide lockdown on 25th March 2020. The restriction of transportation, mobility and industrial production has proved to improve the ambient air quality (Mahato et al. 2020; Kumari and Toshniwal 2020). A handful of studies across the globe has measured reduction in the pollution while, in our knowledge no study has been conducted to relate Covid-19 cases (number, rate etc) with air quality in India. It is well known that the long term exposure to pollution leads to various ARI, heart diseases, cardiac problems and breathlessness. Thereby, chronic exposure

to the Covis-19 pandemic is indeed a subject to be explored. The current paper is a step ahead of univariate analysis where we applied LISA model to reveal spatial relation of air pollutants with Covid-19 cases.

This paper adds value as compared to other published papers/news reports published on similar lines in India thus far due to the following reasons-

First, the current paper is a step ahead of univariate analysis of pollution level. Here we applied LISA model to reveal spatial relation of pollution and with Covid-19 cases. Our study, first time in India, are relating Covid-19 total cases in wards of Mumbai with pollution. Till date there are few published papers in the world on this issue where significant association is being found on these two parameters.

Second, Mumbai Municipality has recently published the Covid 19 data ward wise that helped us to do the spatial regression. Such detailed data either for Covid-19 or on pollution level for other cities are not available.

Third, some empirical studies conducted in Europe and the US found strong association with pollution exposure and susceptibility of respiratory diseases. Indian experts, however, has made arbitrary comments (positive or negative association) on pollution and Covid-19 when detail data for this analysis was not available.

Our study reveals that the Covid-19 outbreak in Mumbai has a clear regional pattern and spatial association with pollutants in Mumbai wards. Chronic atmospheric pollution (*NO2, SO2* and PM_{10}) favor spreading of infections. The wards that reveal hot spots of Covid 19 and pollution (mainly located in the eastern and central zone of Mumbai) need immediate attention. Thus our analysis proves that air pollution should be considered in Covid 19 epidemics prevention because higher exposure may increase risk of respiratory infection. The study provides indication that atmospheric contamination may represent a favourable context for the spread of the virus in certain parts of the city and thus environmental pollution should be considered as measure of an integrated approach for sustainable development, human health protection and prevention of epidemic spreads.

Highlights

Covid-19 outbreak in Mumbai is revealing a clear spatial relation with pollutants.

Atmospheric pollution (NO2, SO2) may favor coronavirus spreading in Mumbai.

Central and eastern Mumbai Wards indicate high association of Codiv 19 cases with air pollution, while northern wards are better positioned in this regards.

Hot spot locations in this association could be due to presence of low lying areas, higher population density, traffic congestion and presence of more industrial units in the central and eastern part of Mumbai that needs further research.

Environmental pollution should be considered in epidemics prevention.

References:

Daniele Fattorini and Francesco Regoli (2020) Role of the chronic air pollution levels in the Covid-19 outbreak risk in Italy. **Environmental Pollution,** Volume 264, September 2020, 114732

Kumari, P., & Toshniwal, D. (2020). Impact of lockdown measures during COVID-19 on air quality–A case study of India. **International Journal of Environmental Health Research**, 1-8.

Mahato, S., Pal, S., & Ghosh, K. G. (2020). Effect of lockdown amid COVID-19 pandemic on air quality of the megacity Delhi, India. **Science of the Total Environment**, 139086.

Zhu, Y., Xie, J., Huang, F., Cao, L., 2020. Association between short-term exposure pollution and COVID-19 infection: evidence from China. Sci. **Total Environ.**727, 138704.https://doi.org/10.1016/j.scitotenv.2020.138704.

Fig 1: LISA cluster maps showing the spatial clustering of *NO2, SO2* and PM_{10} with COVID-19 positive cases as on 22nd June 2020 across Mumbai.

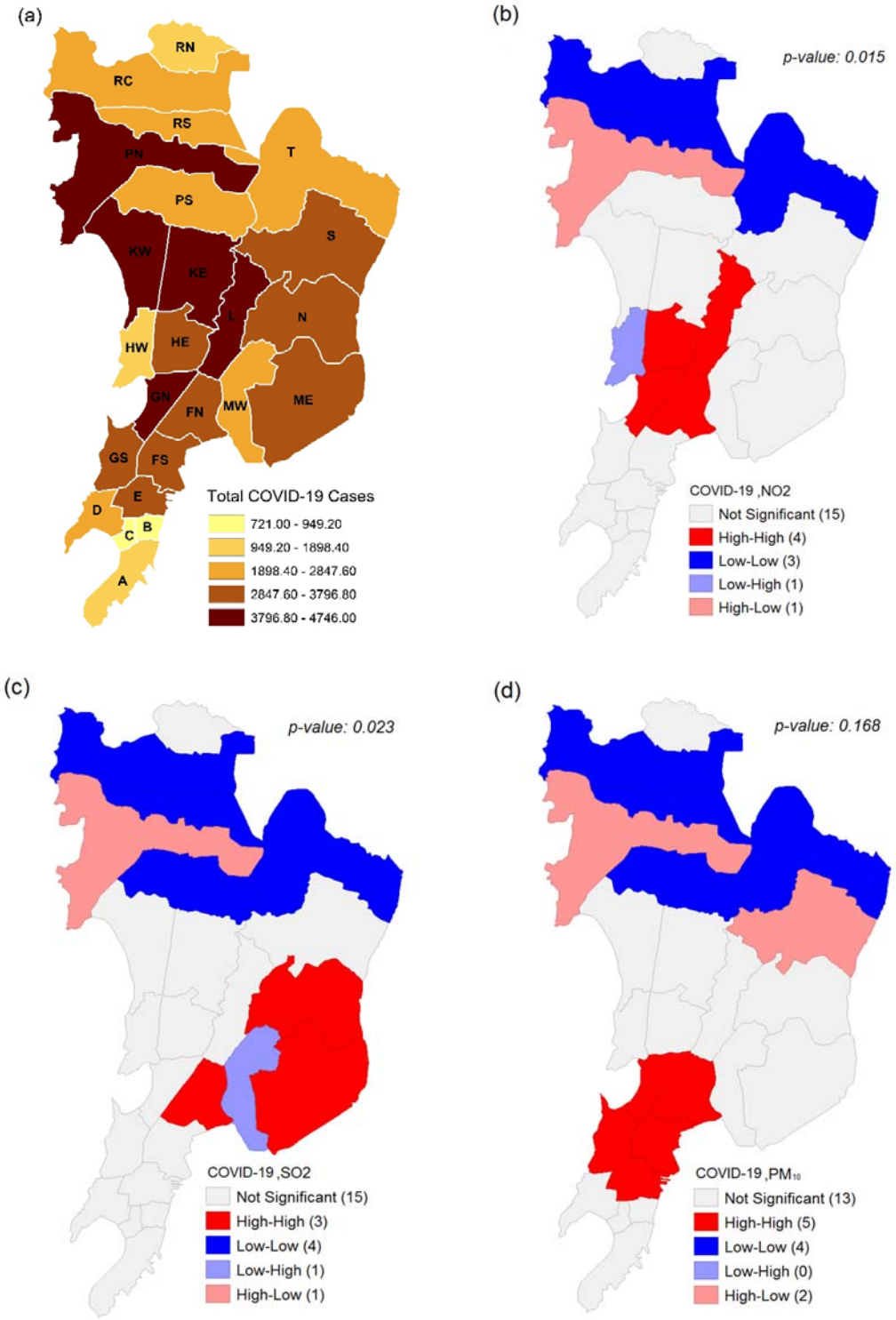

Fig 2: Bivariate *Moran's I* showing the spatial clustering of *NO2, SO2* and PM_{10} with COVID-19 positive cases as on 22nd June 2020 across Mumbai.