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Satellite-Based Mapping of $PM_{2.5}$ for Delhi-NCR

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Disclaimer

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Regulatory air pollution monitoring in India is mostly limited to urban areas. Without a dense network of monitors, it is difficult to capture the fine spatial variations of $PM_{2.5}$, one of the major pollutants with severe implications for human health.

Using satellite-based products to estimate $PM_{2.5}$ can help generate high-resolution gridded spatial maps at a significantly lower cost. These spatial maps can be useful for policymakers, urban planners and developers, and health researchers. They can also be instrumental in guiding clean air action plan for the city.

A study by the Center for Study of Science, Technology and Policy (CSTEP) mapped high-resolution daily $PM_{2.5}$ for the calendar year 2019 over the Delhi-NCR region. The study, which used satellite data and ground data collected from monitoring stations, also identified $PM_{2.5}$ hotspots and examined the rural-urban contrast in $PM_{2.5}$.

Key insights

1

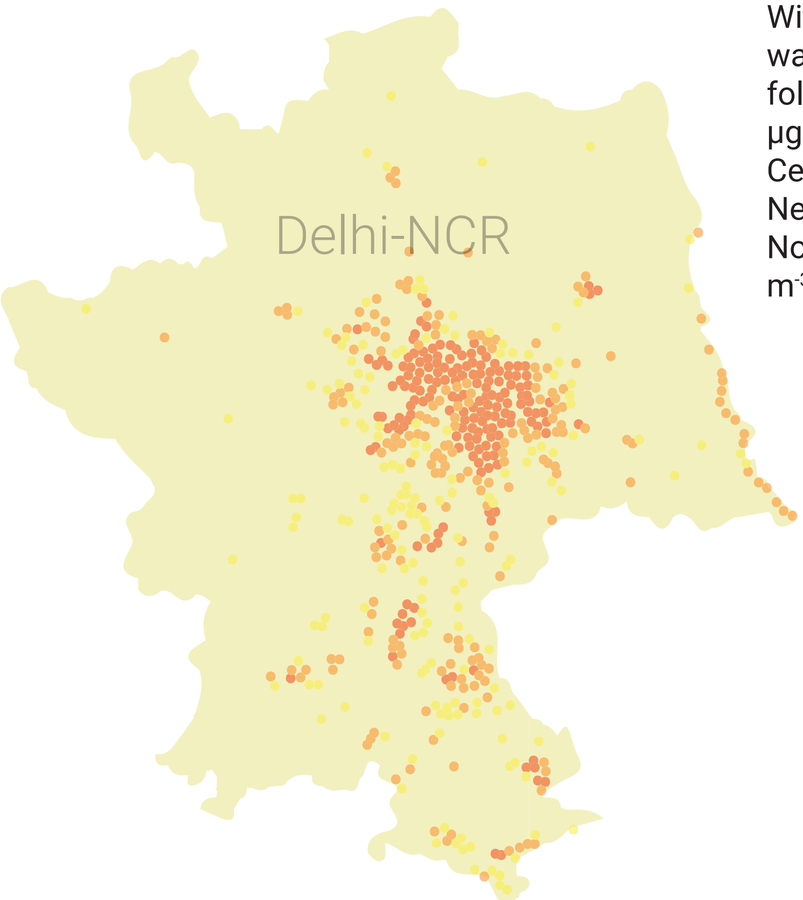
The annual mean $PM_{2.5}$ over all of rural, peri-urban, and urban Delhi-NCR exceeded the national annual standard (40 µg m^{-3}).

2

The annual mean $PM_{2.5}$ value for Delhi-NCR region ranged between 80 and 130 µg m^{-3} with highest values observed over the national capital territory (NCT).

3

Within the NCT, the highest annual mean $PM_{2.5}$ was observed for Shahdara (~126 µg m^{-3}) followed by the East (~124 µg m^{-3}), West (~122 µg m^{-3}), South East (~120 µg m^{-3}), North East and Central (~119 µg m^{-3}), North West (~118 µg m^{-3}), New Delhi (~116 µg m^{-3}), South (~115 µg m^{-3}), North (~114 µg m^{-3}), and South West (~113 µg m^{-3}) revenue districts.



4

Seasonally, winter recorded the highest $PM_{2.5}$ (134 µg m^{-3}) followed by post-monsoon (131 µg m^{-3}), summer (79 µg m^{-3}), and monsoon (57 µg m^{-3}).

5

Most of the NCT and its surrounding areas were identified as $PM_{2.5}$ hotspots, while scattered hotspots were also observed in the districts of Nuh, Bharatpur, Meerut, and Sonipat.

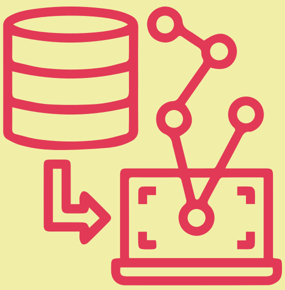
6

Annually, the urban areas were characterised by the highest mean $PM_{2.5}$ (109 µg m^{-3}), followed by peri-urban (102 µg m^{-3}), rural (101 µg m^{-3}), and uninhabited (100 µg m^{-3}) areas.

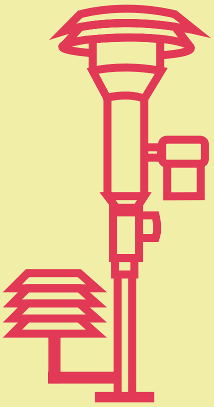
7

Representative regulatory measurements in non-urban areas of Delhi-NCR will help to understand the pollution dynamics and sources better.

How it works?



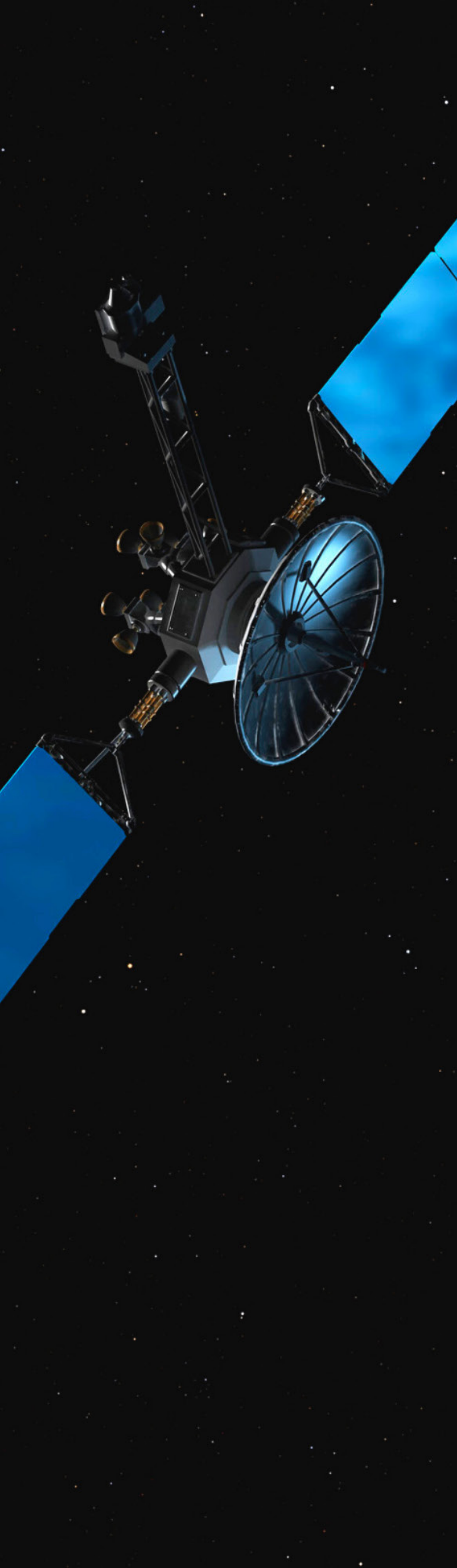
This approach effectively utilises public datasets to build advanced statistical or artificial intelligence models for predicting $PM_{2.5}$ from satellite products.



Representative air pollution monitoring station in non-urban areas of Delhi-NCR will provide accurate local data useful for model building and validation.

As satellite provides daily near global data, spatial $PM_{2.5}$ also can be estimated at daily scale.

Statistical tools can be applied on spatial maps to identify $PM_{2.5}$ hotspots in Delhi-NCR.



Benefits

- Satellite-based maps can help in accurate estimation of population-weighted exposure.
- These maps will be useful in understanding the urban, peri-urban, and rural air-pollution levels.
- For policymakers, these maps can be useful in strategising region/season-specific mitigation measures instead of umbrella activities.
- Pollution maps can be helpful in identifying the locations for future regulatory monitoring stations and hybrid (a combination of high-end and low-cost sensors) monitoring networks.

Barriers

- Infrastructural demands (such as uninterrupted power supply, building, etc.) for pollution monitoring set up could be a challenge in the non-urban areas.
- Availability of skilled manpower in non-urban areas to manage the monitoring equipment.

Annexure

We trained a linear mixed effects model using the continuous ambient air quality monitoring $PM_{2.5}$, satellite aerosol optical depth, reanalysis meteorological parameters, and land use proxies. Spatial (at 1 km x 1 km resolution) daily mean $PM_{2.5}$ were predicted using the trained model over the Delhi-NCR region. The model is extensively validated using 10-fold and leave-one-out cross validation exercises. $PM_{2.5}$ hotspots were identified based on Gi* index. The rural, peri-urban, urban, and uninhabited settlements pixels were identified using Global Human Settlement Layer data.

Season classification is as follows: January and February months constituted Winter; March, April, and May constituted Summer; June, July, August, and September constituted Monsoon; October, November, and December constituted Post-monsoon.

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