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Satellite-Based Mapping of $PM_{2.5}$ for Bengaluru

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Designed and edited by CSTEP

Contributors: Dr Sreekanth Vakacherla and Dr Padmavati Kulkarni

Editor: Reghu Ram R

Designer: Bhawna Welturkar

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Bengaluru	**Noida**
18, 10th Cross, Mayura Street Papanna Layout, Nagashettyhalli RMV II Stage, Bengaluru 560094 Karnataka (India)	1st Floor, Tower-A Smartworks Corporate Park Sector 125, Noida 201303 Uttar Pradesh (India)

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.

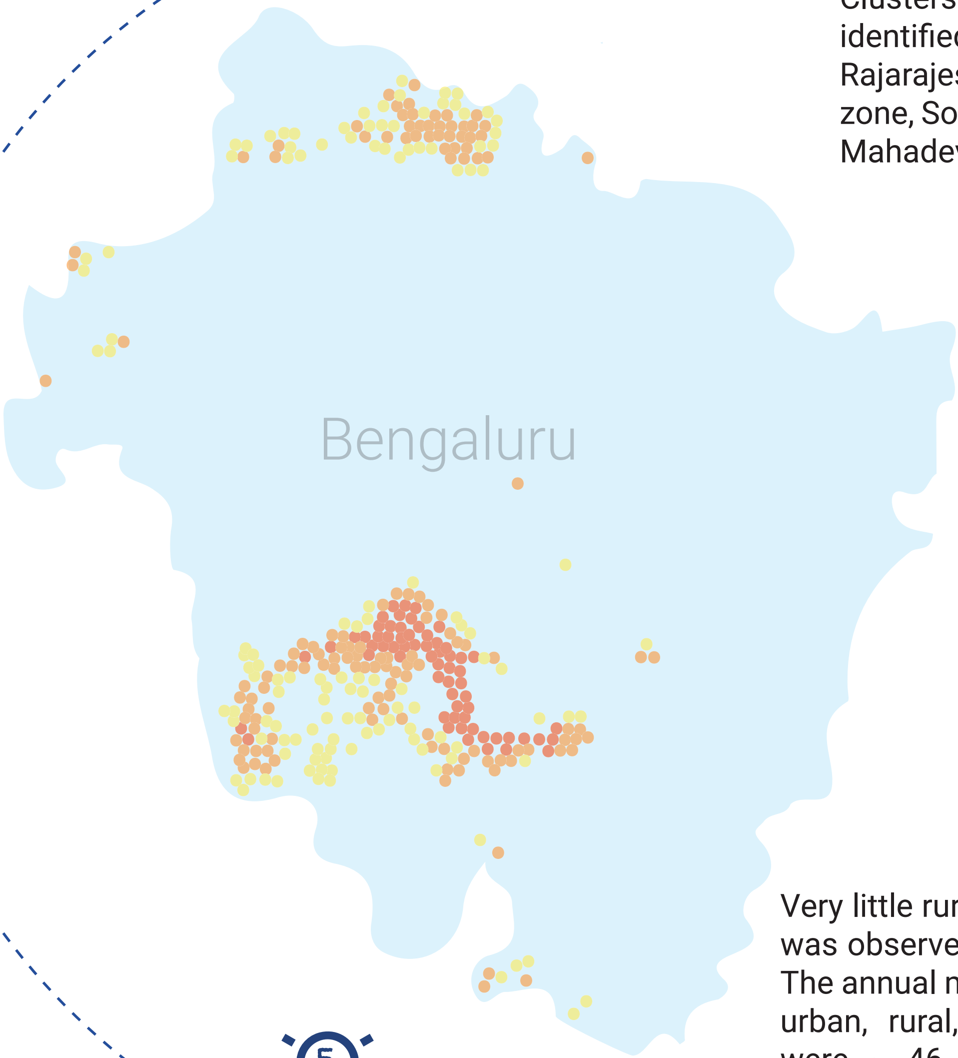
Using satellite-based products to estimate $PM_{2.5}$ can help generate high-resolution gridded spatial maps at a significantly lower cost. These spatial maps can be useful for policymakers, urban planners and developers, and health researchers. They can also be instrumental in guiding clean air action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

Across Bengaluru urban and rural areas, the annual mean $PM_{2.5}$ ranged between 35 and 55 µg m^{-3}. Rajarajeshwari Nagar and South zone recorded the highest $PM_{2.5}$ followed by West zone, Bommanahalli, and Dasarahalli.



2

Clusters of high $PM_{2.5}$ were identified in Dasarahalli, Rajarajeshwari Nagar, West zone, South zone, Bommanahalli, Mahadevapura, and Yelahanka.

3

$PM_{2.5}$ hotspots were also identified in Greater and Rural Bengaluru regions. These coincided with stone crushing units and open biomass burning areas.

4

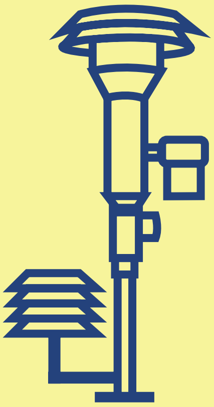
Very little rural-urban contrast in $PM_{2.5}$ was observed, irrespective of season. The annual mean $PM_{2.5}$ for urban, peri-urban, rural, and uninhabited areas were ~ 46, 45, 44, and 44 µg m^{-3}, respectively.

5

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

How it works?

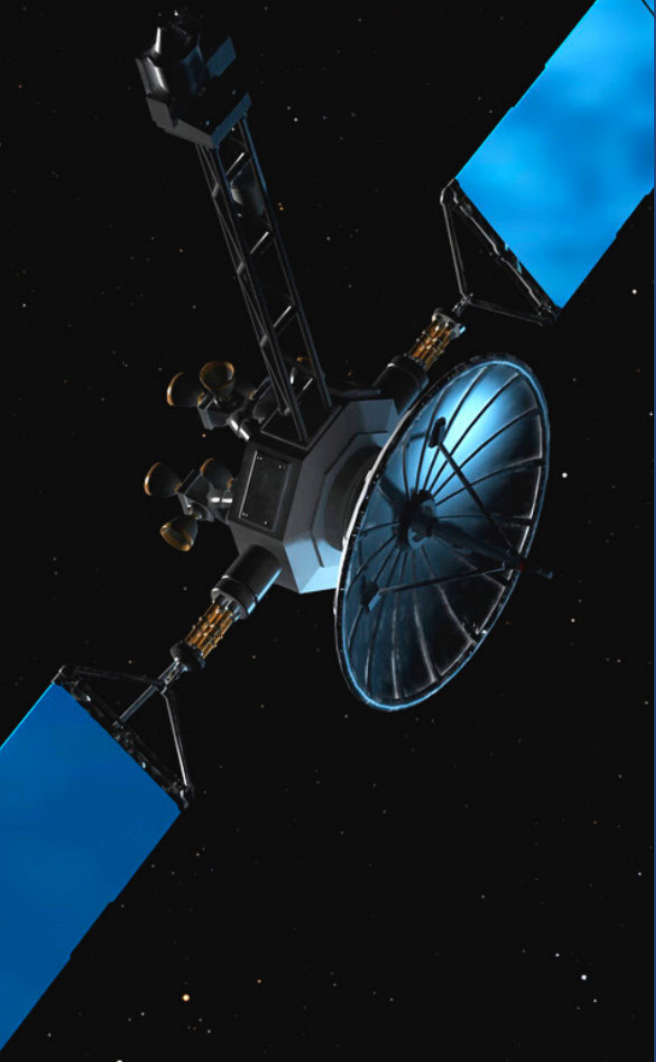
This approach effectively utilises public datasets to build advanced statistical or artificial intelligence models for predicting $PM_{2.5}$ from satellite products.



Representative air pollution monitoring station in non-urban areas of Bengaluru 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 these maps to identify $PM_{2.5}$ hotspots.



Benefits

- Satellite-based maps can help in accurate estimation of population-weighted exposure.
- With most regulatory monitors being confined to urban areas, these maps will be useful in understanding the 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 rural and urban districts of Bengaluru. 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. Major limitations of this approach include the non-availability of satellite aerosol optical depth (AOD, which contains information on the aerosol abundance) during cloudy days and the lack of non-urban $PM_{2.5}$ measurements.

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.

CENTER FOR STUDY OF SCIENCE, TECHNOLOGY & POLICY

Bengaluru
No 18 & 19, 10th Cross, Mayur Street, Papanna Layout,
Nagashettyhalli (RMV II Stage), Bengaluru-560094
Karnataka, India

Noida
1st Floor, Tower-A, Smartworks Corporate Park, Sector-125,
Noida-201303, Uttar Pradesh, India

www.cstep.in

+91-8066902500

cpe@cstep.in

@cstep_India