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# SOURCE APPORTIONMENT OF LEAD AND CADMIUM BY CHEMICAL CHARACTERIZATION OF PM2.5

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**ABSTRACT**

Particulate matter below 2.5 micron (PM2.5) and its existence in atmosphere is observed in most of major cities in India and abroad. Health impacts of such pollutant on human being leading asthma and chronic bronchitis in India in last decade. Pune city in Maharashtra state of India is rapidly emerging as mega city in India due to its urbanization and modernization. Particulate matter and trace elements in it are causing severe effects on people of Pune. In present study, trace elements like lead (Pb) and cadmium (Cd) in PM2.5 at Pune city in Maharashtra, India were measured with the help of PM2.5 sampler and chemical characterization of Pb and Cd was done to determine the concentrations in the ambient air. The source apportionment of Pb and Cd was done by applying US EPA positive matrix factorization model to identify the sources and quantitative distribution of these elements at receptor location of Katraj in Pune city. The main objective was to identify and determine health impacts of Pb and Cd as well as PM2.5. The results of the study shall help urban planners, air quality planners and people of medicine to initiate urban air pollution management in Pune city.

## INTRODUCTION

The higher concentration on Pb and Cd in major cities are now growing concern for society as well as city planners. The evidences show that these trace elements with higher concentrations show the health impacts which are severe in infants and old age people. The source of Pb and Cd is of much reason but still automobiles and paint booths are major sources for such elements.

More recently, greater interest has been taken with regard to the specific role of these trace elements. Pollution due to toxic trace metals is considered to be of great importance for population at large due to their non-biodegradable nature and long biological half-lives (Raghunath, *et al.*, 1999). They get accumulated in different compartments of environment as well as in human body due to their accumulative nature. They are toxic at very low concentrations and can cause profound biochemical changes in the body, even at trace levels (Akhilesh, *et al.,* 2015).

In this study, an attempt is made to estimate and analyze chemically trace metals like Pb and Cd in PM2.5 at Pune city which constitutes a long term threat to the health of general population. The source apportionment was done and sources of Pb and Cd is found. Pune city is a one of the major industrial and commercial city in the western Maharashtra which governs highest per capita income group city. As city experiences high concentrations of PM2.5 particularly when the concentrations are in the exceedance of an air quality standard, it is important to identify the contributing emissions sources (Gupta, *et al.,* 2007). Rapid urbanization, higher vehicular density and use of diesel vehicles, and the industrialization are the major reasons for the increased air pollution in Pune.

## MATERIALS AND METHODS

Sampling site like urban/commercial area was selected at Katraj chowk on south side of Pune city. PM2.5 sampler was used to monitor and collect PM2.5 and was operated for 24 hrs during 2nd October 2014 to 4th June 2015. Chemical characterization of Pb and

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Cd was done by acid digestion and concentration of Pb and Cd was measured with the help of atomic absorption spectrophotometer. Concentrations of Pb and Cd were given as input to US EPA positive matrix factorization model for predicting concentrations of Pb and Cd with uncertainty conditions. Identification and quantitative estimation of sources of Pb and Cd were found out using factor analysis. Model validation was done with onsite monitoring and observations of PM2.5 and Pb and Cd with respect to source identified by model.

## RESULTS AND DISCUSSIONS

It is observed from Table 1 that the presence of trace elements like Pb, Cd in Pune city. Their existence in the atmosphere of Pune city should not be ignored. The following figures show that the predicted concentrations of trace elements Pb and Cd are also high which is given by US EPA PMF model. It is observed from Table 2 that concentrations of Pb and Cd are coming from mostly the oil and coal burning, soil and road dust and transportation sector which is high in the city of Pune. It is observed from Table 2, Figs. 1 and 2 that other sources are also contributing to Pb and Cd concentrations which are found out with the help of the model.

## CONCLUSION

Concentration of Cd may be originated from metallurgical processes, smelters, plastics, pigments, fossil fuels, electroplating, industries and power stations in Pune. But Pb is identified from road dusts by wear and tear of tire. This may be due to accumulation of Pb in road side dust over the years.

**Table 1.** Observed and predicted concentrations of trace elements Pb and Cd in microgram per cubic meter

| Date of Sampling | Observed Concentrations of Pb | Predicted Concentrations of Pb | Observed Concentrations of Cd | Predicted Concentrations of Cd |
|---|---|---|---|---|
| 2-Oct-14 | 3.0480 | 2.9000 | 1.2670 | 1.2500 |
| 9-Oct-14 | 3.0500 | 2.8500 | 1.2660 | 1.2500 |
| 16-Oct-14 | 3.0510 | 2.6000 | 1.2700 | 1.2000 |
| 23-Oct-14 | 3.0550 | 2.9500 | 1.2600 | 1.2500 |
| 30-Oct-14 | 3.0560 | 3.0000 | 1.2700 | 1.3500 |
| 6-Nov-14 | 3.0550 | 2.9500 | 1.2400 | 1.3500 |
| 13-Nov-14 | 3.0550 | 2.9000 | 1.3000 | 1.4000 |
| 20-Nov-14 | 3.0640 | 3.0000 | 1.3400 | 1.3200 |
| 27-Nov-14 | 3.0650 | 3.3000 | 1.3500 | 1.4000 |
| 4-Dec-14 | 3.0620 | 2.8000 | 1.3500 | 1.3000 |
| 11-Dec-14 | 3.0520 | 3.3000 | 1.3900 | 1.5000 |
| 18-Dec-14 | 3.0700 | 3.2000 | 1.3500 | 1.4300 |
| 25-Dec-14 | 3.0660 | 3.6000 | 1.3400 | 1.7000 |
| 1-Jan-15 | 3.0650 | 3.5000 | 1.3600 | 1.5000 |
| 8-Jan-15 | 3.0550 | 2.9500 | 1.3800 | 1.3500 |
| 15-Jan-15 | 3.0600 | 3.0000 | 1.3400 | 1.2800 |
| 22-Jan-15 | 3.0610 | 2.9500 | 1.3400 | 1.4000 |
| 29-Jan-15 | 3.0680 | 3.4000 | 1.3900 | 1.5000 |
| 5-Feb-15 | 3.0640 | 3.2500 | 1.4000 | 1.4800 |
| 12-Feb-15 | 3.0700 | 3.0000 | 1.4500 | 1.4000 |
| 19-Feb-15 | 3.0740 | 3.0000 | 1.4700 | 1.3500 |
| 26-Feb-15 | 3.0450 | 2.7500 | 1.4800 | 1.3200 |
| 5-Mar-15 | 3.0400 | 3.0500 | 1.4900 | 1.3500 |
| 12-Mar-15 | 3.0450 | 2.9000 | 1.5000 | 1.3800 |
| 19-Mar-15 | 3.0660 | 3.5000 | 1.5500 | 1.6500 |
| 26-Mar-15 | 3.0650 | 2.8000 | 1.5500 | 1.3000 |
| 2-Apr-15 | 3.0550 | 2.9000 | 1.5000 | 1.3000 |
| 9-Apr-15 | 3.0600 | 3.2000 | 1.5200 | 1.6000 |
| 16-Apr-15 | 3.0610 | 3.1500 | 1.5400 | 1.5800 |
| 24-Apr-15 | 3.0680 | 3.4000 | 1.5400 | 1.6200 |
| 7-May-15 | 3.0640 | 3.3000 | 1.5600 | 1.6000 |
| 14-May-15 | 3.0700 | 3.0500 | 1.6000 | 1.4000 |
| 21-May-15 | 3.0740 | 3.3000 | 1.6500 | 1.5800 |
| 28-May-15 | 3.0450 | 2.8000 | 1.4000 | 1.3800 |
| 4-Jun-15 | 3.0400 | 2.4000 | 1.3400 | 1.1500 |

**Table 2.** Source apportionments of Pb and Cd

| Factor | Source | Pb | Cd |
|---|---|---|---|
| 1 | Soil and Road Dust | 16.1 | 14.6 |
| 2 | Oil and Coal Burning | 23.6 | 22.6 |
| 3 | Iron and Steel Industries | 19.1 | 14.3 |
| 4 | Non-ferrous Metal Industries | 08.1 | 09.8 |
| 5 | Refuse Incineration | 13.6 | 17.0 |
| 6 | Transportation | 19.5 | 21.8 |

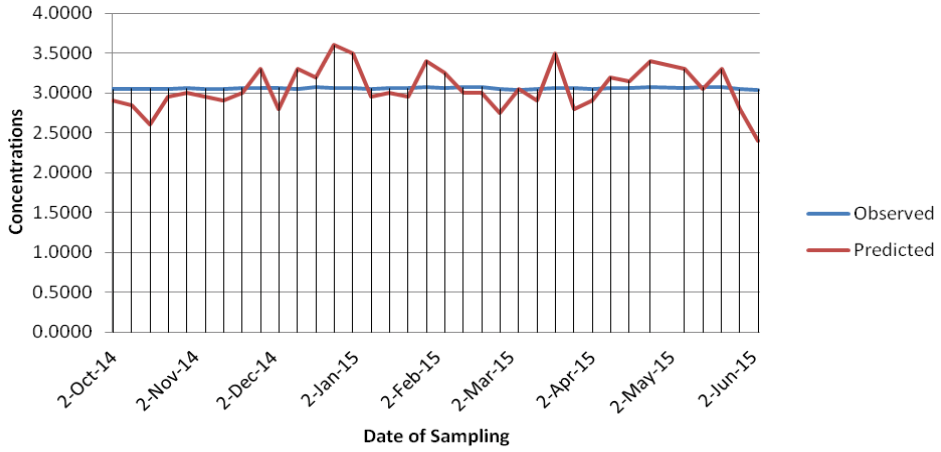


**Fig. 1** Predicted concentration and observed concentrations of trace element Pb.

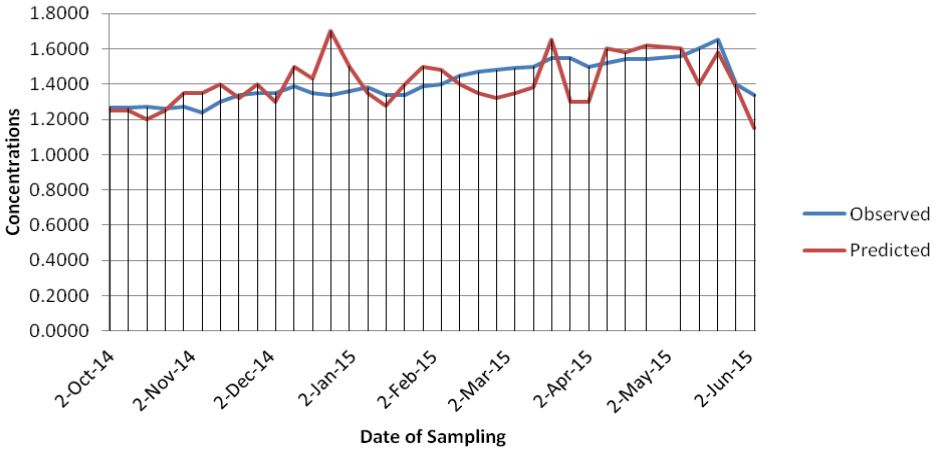


**Fig. 2** Predicted concentration and observed concentrations of trace element Cd.

Concentrations of Pb and Cd may be confirmed as main trace elements due to transportation and traffic pollution. Results of this study show that there is significant increase in concentrations of Pb in soil nearby roads. It may be concluded that concentrations of Pb and Cd in soil and road dust are higher at Katraj chowk in Pune city.

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## REFERENCES

Raghunath, R., Tripathi, R.M., Kumar, A.V., Sathe, A.P., Khandekar, R.N. and Nambi, K.S. 1999. Assessment of Pb, Cd, Cu, and Zn Exposures of 6 to 10-Year-Old Children in Mumbai. *Environ. Res.* 80 : 215-221.

Yadav, A.K, Sunil, S., Vinod, A., Jay, S.D., Pradyumna, L., Vidya, D. and Raj, M. 2015. Chemical Characterization and Variations of Particulate Matter in a Coastal Residential Area Proximate to a Beach Sand Mine in the Ganjam District of Odisha. India: Impact of Mining on Air Quality. *Environ. Qual. Manage.*

Gupta, A.K., Karar, K., Srivastava, A. 2007. Chemical mass balance source apportionment of PM"1"0 and TSP in residential and industrial sites of an urban region of Kolkata. India. *J. Hazard. Mater.* 142 : 279-287.