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Observational study of Delhi pollution: A brief review

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Abstract
Air pollution is responsible for many health problems in the urban areas. Of late, the air pollution status in Delhi has undergone many changes in terms of the levels of pollutants and the control measures taken to reduce them. The urban air database released by the World Health Organization in September 2011 reported that Delhi has exceeded the maximum PM10 limit by almost 10-times at 198 µg/m3. Vehicular emissions and industrial activities were found to be associated with indoor as well as outdoor air pollution in Delhi. Studies on air pollution and mortality from Delhi found that all-natural-cause mortality and morbidity increased with increased air pollution. Delhi has taken several steps to reduce the level of air pollution in the city during the last 10 years. However, more still needs to be done to further reduce the levels of air pollution.
Pollution refers to the contamination of the earth's environment with materials that interfere with human health, quality of life or the natural functioning of the ecosystems.
Of late, the air pollution status in Delhi has undergone many changes in terms of the levels of pollutants and the control measures taken to reduce them. This paper provides an evidence-based insight into the status of air pollution in Delhi and its effects on health and control measures instituted.

Keywords: air pollution in Delhi, health problems, stubble burning, crop residue

Introduction

Air pollution in (urban and rural) India is a growing public concern, and city of Delhi (its capital) is one of the most studied cities with a disproportionate share of media attention. Yet, we do not seem to have decisive answers to simple questions like how polluted is the city, what are the main sources, and where to start to control pollution in the city. An earlier post focused on a "call for open air pollution data" in Delhi and other Indian cities.

The ground level sources like vehicle exhaust, re-suspended dust, open waste burning, residential cooking and heating, are commonly referred to as diffused sources, tend to influence the immediate vicinity and then they diffuse and disperse into the neighborhoods. And the others like industries and power plants with high stacks, their emissions have the tendency to move farther distances (depending on local meteorological conditions) and end up as pollution not only where they are sourced, but also away.

So, in numbers, if we are looking at an emissions inventory for a city; it is possible the city may have only the diffused sources in its administrative boundary. For example, in case of Delhi, all the coal-fired thermal power plants are outside Delhi (within 20-30 km), all the brick kilns are outside Delhi, a majority of the industries are outside Delhi, which means an emissions inventory drawn from within the administrative boundary of the city, will miss the sources that are likely to contribute to the ambient air pollution. Another example, every November, we point fingers at crop residue burning in Punjab and Haryana and its immediate impact of Delhi's urban air quality, which is not part of a regular emissions inventory for Delhi. However, it is part of the ambient pollution, because of long range transport.

There is a certain percentage of gases present in the atmosphere. An increase or decrease in the composition of these gases is harmful to survival. This imbalance in the gaseous composition has resulted in an increase in earth's temperature, which is known as global warming. And in this global warming, a Union Territory that is home to India's capital, New Delhi, is among the world's urban agglomerations with the most toxic air. The magnitude of air pollution is massive. It causes devastating impacts on people's health, the city's environment, and economic well-being.

Twenty-one of the world's 30 cities with the worst levels of air pollution are in India, according to data compiled in IQAir Air Visual's 2019 World Air Quality Report; six Indian cities are in the top ten Among all the cities in India, some of the worst levels of air pollution are seen in its capital territory, Delhi. The impacts are devastating, including in the degree of particulate matter concentrations in the air (environmental), reduction in life expectancy (health), and high costs that the state is incurring to resolve the crisis (economic). The main sources of air pollution in Delhi include vehicle exhaust, heavy industry such as power generation, small-scale industries like brick kilns, suspended dust on the roads due to vehicle movement and construction activities, open waste burning, combustion of fuels for cooking, lighting, and heating, and in-situ power generation via diesel generator sets. Stubble burning is one of the major contributors to atmospheric pollution in the world releasing

particulate and gaseous pollutants that have severe effects on human health and the environment.

PM10 is all aerosols under 10µm diameter; PM2.5 all aerosols under 2.5µm diameter. PM2.5 is a subset of PM10 and the ratio varies from city to city and source to source. The source apportionment studies conducted for PM2.5 and PM10 samples will result in different contribution charts.

Most of the PM2.5 pollution comes is combustion based. For example, more than 95% of emissions from diesel, petrol, and natural gas combustion, open waste burning pollution, biomass burning pollution, and coal combustion at cookstoves and boilers, falls under PM2.5.

Most of the PM10 pollution comes from mechanical processes – like dust, on the roads due to the constant vehicular movement, at the construction sites, and the seasonal dust storms. Close to 80% of the dust (that we commonly find on the roads) falls into the size fraction between PM2.5 and PM10. This is the main reason for finding more dust in a PM10 sample compared to a PM2.5 sample.

PM10 was, for the longest time, the only size fraction measured in India. PM2.5 was added to the list of criteria pollutants in 2009, and now measured in 40+ Indian cities using continuous monitoring station. The ground level sources like vehicle exhaust, re-suspended dust, open waste burning, residential cooking and heating, are commonly referred to as diffused sources, tend to influence the immediate vicinity and then they diffuse and disperse into the neighborhoods. And the others like industries and power plants with high stacks, their emissions have the tendency to move farther distances (depending on local meteorological conditions) and end up as pollution not only where they are sourced, but also away.

Literature review

Delhi is ranked among the most polluted cities in the world. In India, the National Green Tribunal forbids the tradition of straw and stubble burning in the highly polluted city of New Delhi, as well as in the adjacent NCR of Haryana and Punjab. Air pollution in Delhi have many reasons to look after, such as exhaust from diesel generators, dust from construction sites, burning garbage, illegal industrial activities, wood burning fires and fires on agricultural lands, among which fires on agricultural lands is one of the major causes of air pollution.

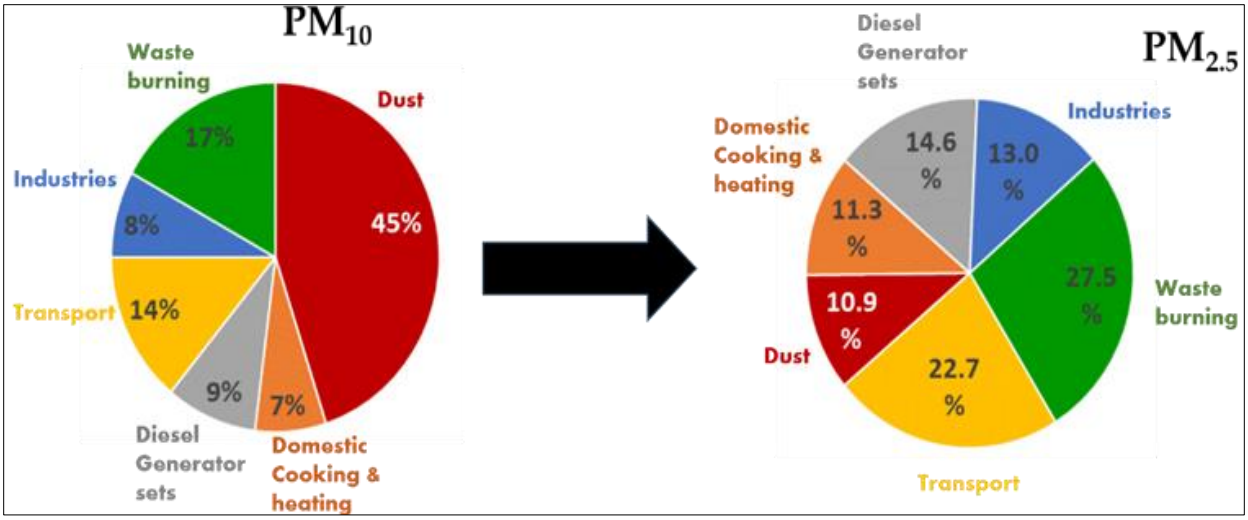
It was reported that the burning at 63 Mt of crop stubble releases 3.4Mt of Co, 0.1 Mt of NOx, 1 Mt of CO2, 0.6Mt of CH4 and 1.2 Mt of PM into the atmosphere. Latest data by the Haryana State Pollution Control Board (HSPCB) shows that between September 25 and September 29 of 2018, 120 incidents of coop stubble burning were recorded in the state. Last year, 6364 stubble burning cases were reported from the state as compared to 10288 in 2018. According to some estimates, farmers burned about 11 million tonnes of stubble in Punjab and Haryana, out of the 27 million tonnes of paddy stubble produced last year.

A large amount of husk and other biomass is also generated after farm yield in the industries. The disposal of these huge quantities of fam yield residue is far-reaching problem for the farmers. The Indian Agricultural Research Institute (IARP), New Delhi, estimates that maximum residue is generated by cereal crops, for example 352 Mt. of this amount 34% and 22% are contributed by paddy and wheat respectively (TARI, 2012, 8:32). In site burning of crop residue is used to clean agricultural fields quickly and initiate tillage practices for sowing of next crop. Stubble burning is the deliberate act of setting fire to the straw stubble that remains after wheat paddy, cotton and other grains have been harvested.

Following are the studies of pollution at Delhi by various institutions:

1. Study (001) by CPCB (2010)

This was a multi-city study conducted for PM2.5 and PM10 samples, collected in year 2006-07.



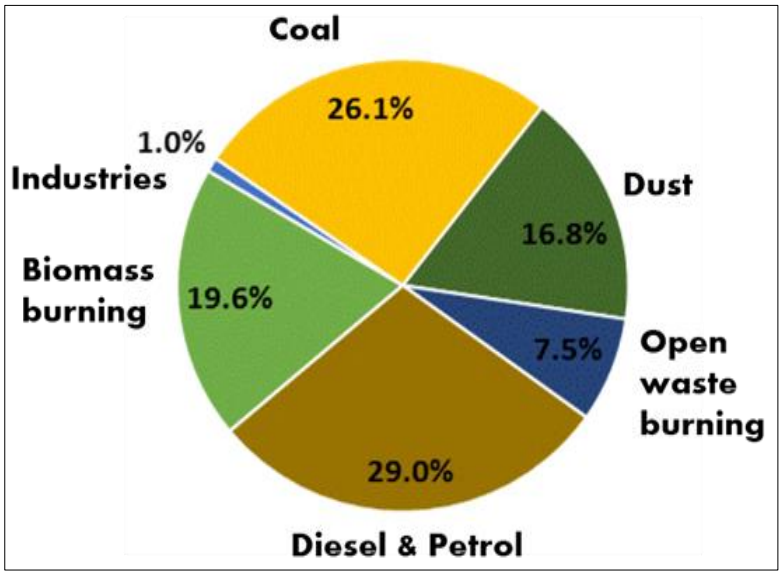
(***Source***- www.urbanemissions.info)

Fig 1: CPCB's Delhi pollution study statistics of 2010

While the results from the PM2.5 samples were are not admissible (which blamed domestic LPG burning as a key urban pollution source), the results from PM10 samples made sense. We took the liberty of converting the PM10 shares into PM2.5 – assuming 15% of the dust in PM10 surviving in the PM2.5 fraction and 100% of all the other combustion sources surviving in the PM2.5 fraction. The pie graph below is an average of all samples reported in the CPCB (2010) study report.

2. Study (002) by IIT-Kanpur (2015)

IIT Kanpur also conducted the CPCB (2010) study for Delhi and this 2015 study is considered an update, with new sample collection at six locations and two seasons (summer and winter). Contact person for the study details is Dr. Mukesh Sharma.



(***Source***- www.urbanemissions.info)

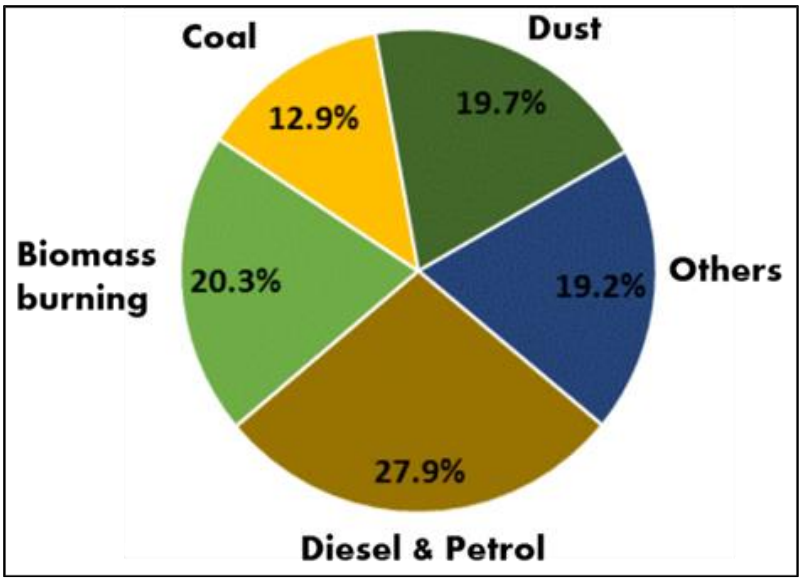
Fig 2: Statistical study chart of IIT-Kanpur (2015)

The source categories listed in this study were different from the STUDY (001). So, we took the liberty of clubbing them for simplicity. For example, the secondary sulfate aerosols, from the chemical conversion of SO2 emissions, are likely to originate from coal and diesel consumption. Similarly, nitrate aerosols, from the chemical conversion of NOx emissions, are likely to originate from coal, diesel, and petrol combustion. Clubbed all the construction, soil, and road dust into one dust category.

Since, the categories are listed along the fuel lines, we can interpret that all the diesel and petrol is linked to the vehicle exhaust and diesel generator sets; biomass burning can be linked to the crop residue burning (especially for the winter months) and biomass used for cooking and heating; coal could be consumed at industries, cooking, and heating.

3. Study (003) Georgia-Tech (2007)

This is an older study conducted in four Indian cities for four seasons. Contact person for the study details is Dr. Zohir Chowdhury. Download the study report published in the Journal of Geophysical Research and a summary report by the World Bank.



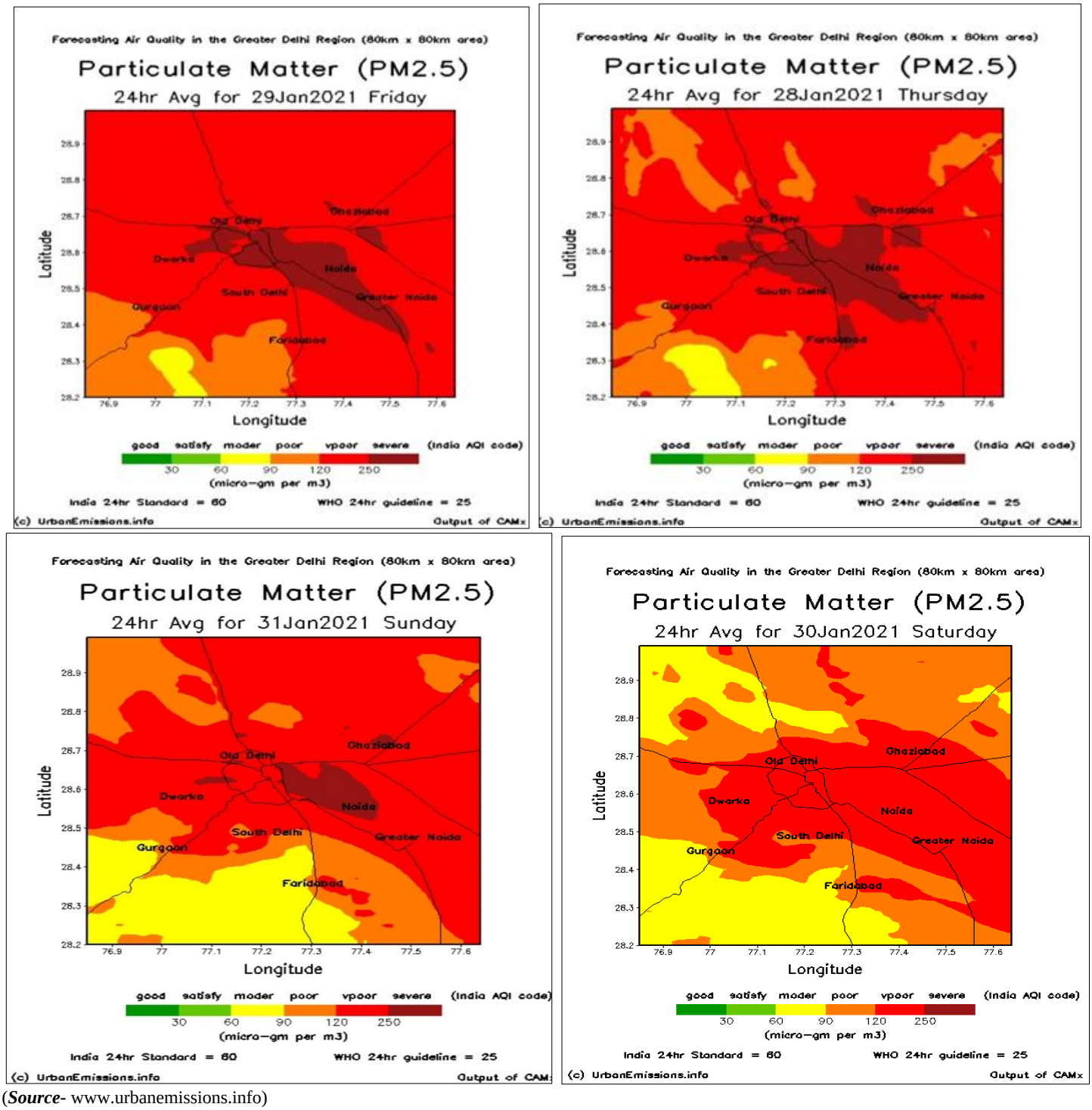
(***Source***- www.urbanemissions.info)

Fig 3: Statistical study chart of Georgia-Tech's 2007

For simplicity, we clubbed the fuel categories to match the study (001) and (002) pies and averaged all the results to represent annual shares. Since, the categories are listed along the fuel lines, we can interpret that all the diesel and petrol is linked to the vehicle exhaust and diesel generator sets; biomass burning can be linked to the crop residue burning (especially for the winter months) and biomass used for cooking and heating; coal could be consumed at industries, cooking, and heating.

4. Study (004) by UEinfo (2013)

This is bottom-up analysis study. The pie graph is an annual average based on emissions inventory and dispersion modelling, conducted at 1 km resolution for a working domain of 80 km x 80 km, including local sources like vehicle exhaust, dust re-suspension, cooking and heating, power plants, industries, brick kilns, open waste burning, and diesel generator sets, and contributions from outside the modeling domain (dust storms, open biomass fires, and fossil fuel burning in the immediate vicinity of the modeling domain).



(***Source***- www.urbanemissions.info)

Fig 4: Air quality in the greater Delhi region

Multiple dispersion model simulations were conducted to ascertain these shares by month and season. Details of the emissions inventory (spatially and temporally segregated) and modeled source apportionment are published as two journal articles – Atmospheric Environment and Environmental Development.

An updated inventory is currently in use to model air quality forecasts over the National Capital Region; including particulate source apportionment on an hourly basis (updated every day at 8PM, IST).

Current practices and limitation

1. Happy Seeder Machine

Happy seeder machine is a technique which is used for sowing wheat crop without burning of rice paddy. This technology is eco-friendly with environment. This makes the soil good and also saves the water. This machine is basically tractor like machine which cuts and lifts rice straw. Farmers have also complained about problems while sowing and low germination of wheat seeds, when sown with happy seeders. Many machines have been dumped only after two years of us.

2. Bury Scheme

The districts of Punjab state had started 'stubble burry 'scheme with the help of Agriculture department for small farmers. In this scheme farmers can remove paddy stubble from farm and bury it in own farm or in pit or wastelands. Farmers don't like this scheme because it requires at least seven to ten days to manage stubble in a pit.

3. PUSA Decomposer

The Union Government tested a straw decomposing technology developed by scientists at the Indian Agricultural Research Institute, Pusa in year 2020.This technology is used to stop farmers from burning paddy stubble. The solution is named as 'PUSA Decomposer'. It is a set of four tablets made by extracting fungi strains which helps the paddy straw to decompose at faster rate than usual and it will convert paddy straw into manure which will use for crops. In this year they tested it in all states, in thousands of hectares and based on the results they will expand it next year.

Conclusion

The air quality in Delhi is the worst of any major city in the world. It also affects the districts around Delhi. In Delhi, poor quality air irreversibly damages the lungs of 2.2 million or 50 percent of all children.

Children are more vulnerable to the negative effects of air pollution as they are growing and developing which means that they breathe a higher rate of air per kilogram of their body weight. Poor air quality is a cause of reduced lung capacity, headaches, sore throats, coughs, fatigue, lung cancer, and early death. The main adverse effects of crop residue burning include the emission of greenhouse gases that contributes to the global warming, increased levels of particulate matter and smog that cause health hazards, loss of biodiversity of agricultural lands, and the deterioration of soil fertility.

The using of agriculture waste as a bio filter media and making biofilter from crop stubble to treat the domestic wastewater before its disposal can be considered to be one of the best ways to protect the environment.

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