

Mapping of suspended particulate matters in the range of PM1.0, PM 2.5 and PM 10 during 15th Oct-16 Nov 2020 in Delhi NCR, Haryana, Punjab and Western UP

In the last 2 weeks, pollutants concentration in Delhi NCR, have been on the rise and have broken all past record of 4 years of showing very high emission of particulate matter. Air quality degraded to the lowest level causing an emergency type of situation. During 6-11 Nov 2020 almost on each day, 24 hours' observations show a very high concentration of both PM 2.5 and PM 1.0. A new network of smart and low cost sensors has been deployed in Delhi NCR and adjacent regions of Haryana, Punjab, and western UP as part of a NASA-funded effort led by RTI International in collaboration with IIT Delhi and other organizations. This new sensor network, uses the PurpleAir Sensors. As of date, there are about 35 sensors operational, which are providing real time data along with temperature and humidity. Concentration estimates of PM 1.0, PM 2.5, and PM 10 are available from this sensor network over a large region of 150 -200 km radius from Delhi. Note that CPCB and DPCC are not providing PM 1.0 data, which is becoming so crucial to be measured as it is considered one of the most dangerous categories of particulate matters due to its very harmful impacts on health through complex internal breathing processes.

Morning hours show very high concentration, which takes a further spike after sun rise. A hazy formation mechanism is suggested to be associated with the uplifting of fine particles from leaves, grass and ground by evaporation of existing moisture present in the form of dew. In addition, a significant portion contributed by the agriculture waste burning arrived over Delhi NCR due to again a record breaking fire counts.

As the solar radiation begins to fall on the ground evaporation begins and fine particles which are less than $2.5 \mu\text{g m}^{-3}$ and are in abundance merge together to make bigger particles in the range of $2.5 \mu\text{g m}^{-3}$ and above. Number density (Concentration) of PM 2.5 has already gone a several hundred (touching 800-1000 micro gm/m³). Low temperature in the late night and early morning hours triggers formation of haze due to condensation of fine particles.

To summarize and have a quick look at air quality in Delhi NCR and part of Haryana, Punjab, and western UP during Oct 20 -16 Nov 2020 including Diwali and post Diwali days. Last week of Oct 2020 have shown the largest concentration of PM 2.5 of the year in the range of 250 - 500 microgram/m³, from 5th to 8th Nov it remains 600-700 microgram/m³ and around 10th it has crossed 1000. These episodic enhancements were due to mainly significant contribution of the agricultural waste burning in Punjab and Haryana. Similarly PM 10 were measured almost in the similar fashion showing values about 1.5 times larger than PM 2.5.

Below are the newest observations, which are mapped for the first time over several stations together in Delhi NCR. Over the period of one month from mid Oct to mid Nov 2020 PM 1.0

remains quite high from 200 to 300 microgram/m³. However, during September it was less than 100.

To understand the dynamics and chemistry of the pollution and particulate matters ambient atmospheric conditions play a very significant role. Wind direction, wind speed, solar radiation, diurnal pressure variability, change in the temperature over Delhi-NCR and outer region, humidity, vertical wind component, boundary layer height and its upliftment during day, and transport of dust and other particles from regions outside Delhi are such important parameters, which needs continuous measurement and prediction for the air quality of Delhi NCR and northern India . For instance, observations show the difference of 3-5 degree celsius in temperature in Delhi NCR outer region and in the City. In the morning hours humidity remains around 70 percent. Due to the abundance of submicron particles it provides a favourable condition of merging of small particles in the presence of high humidity and low temperature which is causing fog, haze, smog etc. As observed, PM 1.0 also increased and they accumulated to make bigger particles. Transparency and clarity in the atmosphere depends on the prevalent meteorological conditions. Immediately after Diwali, due to rain and easterly wind cleaned the atmosphere and much suffocated air is replaced by a better air quality till the writing of this report in the afternoon of 17th Nov 2020.

Surprisingly, PM 1.0 particles emerged to be of high density, which is shown by purple air network, it was ranging up to 250-280 microgram/m³ during 7-11 Nov 2020. Such observations are not made with the routine measurement of DPCC and CPCB.

Particulate matter of size 1 µm are extremely small and can penetrate the mucus membrane of the lung and enter into blood circulation. Depending on the chemical nature of the particle, it can precipitate acute inflammatory reaction, that in persons with compromised heart function can cause acute cardiovascular event like Myocardial Infarction. It can trigger systemic allergic reactions as well. Prolonged exposure of PM 1 containing Volatile Organic Compounds (VoCs) or Polycyclic aromatic hydrocarbons (PAH) can be carcinogenic and teratogenic as well. It has also been known to increase risk of diabetes mellitus. Ultrafine particles cause neurological and neurodegenerative disorders like Alzheimer's Disease, and Parkinson's disease. These particles can enter into circulation via olfactory epithelium in the nose or by uptake in blood circulation
(1)

In children, oxidative stress can cause neurodevelopmental disorder through microglial activation (2) Fine particulate matters have shown to induce skin barrier dysfunction and, cause oxidative stress and induces activation of inflammatory cascade in human skin (3) Bakolis et al have cited evidence that increase in PM_{2,5}, NO_x, and NO₂ are associated with 18-39% increased odds of common mental disorders, and 33% of psychotic experiences only for PM₁₀
(4)

Lifetime cancer risk increases several fold with exposure to PAH, and PAH is the principal component of PM₁ particles, similarly carcinogenic heavy metals also are present in PM₁ fraction. The decrease in average hazard quotient (HQ) for children and adults was estimated in the following order: Manganese (Mn) > Chromium (Cr) > Nickel (Ni) > Lead (Pb) > Zinc (Zn) > Copper (Cu) both at road and elevated site. For children, the mean HQs were observed in safe level for Cu, Ni, Zn, and Pb; however, values exceeded safe limit for Cr and Mn at road site. The average highest hazard index values for children and adults were estimated as 22 and 10, respectively, for road site and 7 and 3 for elevated site. The road site average excess cancer risk (ECR) risk of Cr and Ni was close to tolerable limit (10^{-4}) for adults and it was 13-16 times higher than the safe limit (10^{-6}) for children. The ECR of Ni for adults and children was 102 and 14 times higher at road site compared to elevated site. Overall, the observed ECR values far exceed the acceptable level (5).

Aerosol particles of size < 1 μm diameter predominantly contain trace elements having carcinogenic and non carcinogenic risks. Caggiano et al reported integrated carcinogenic risk for children and adults at 3.45×10^{-5} and 1.38×10^{-4} respectively (6). They found chromium to be causing highest carcinogenic risk in both children and adults whereas nickel posed highest non carcinogenic risk for children.

Several studies have reported presence of carcinogenic and non carcinogenic elements in the PM_{1.0} fraction of ambient air particulate matter, in Delhi and in some industrial towns and in mining areas. Thus the risk of rise in cancer cases as a consequence is likely. We need to conduct studies to establish association between the number of cases of cancer in different cities and levels of carcinogenic material in PM_{1.0} fractions of particulate matter in air.

References

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Quote:

Dr. Arun Sharma, Professor - Director, Community Medicine, University College of Medical Sciences, Delhi University - “Main focus of air pollution narrative is on PM2.5 but the particles of size 1.0 micron or less are more harmful, as they can cross the mucus barrier and through blood circulation can reach any organ and cause damages or increase the risk of cancer.”





