Fact sheet: Source contribution to particulate pollution in Delhi and impact of traffic congestion on local pollution

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Centre for Science and Environment's (CSE) has analysed real time data on source contribution by the Decision Support System for Air Quality Management of Indian Institute of Tropical Meteorology (IITM) to assess the real time trend in the relative contribution of different sources of pollution.

An additional analysis has also been done to assess the change in traffic speed in the city –a measure of congestion during early winter (27th October 2021 – 6rd November 2021) on 15 road stretches of key roads in Delhi.

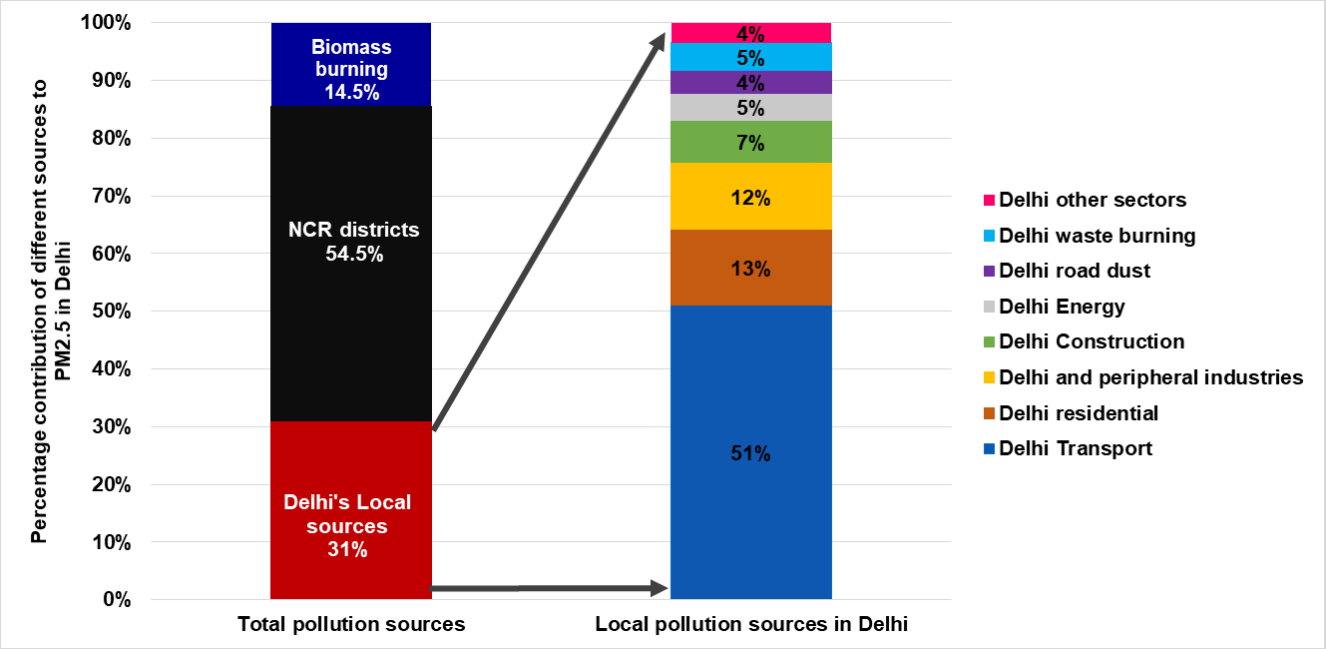
Key highlights

Vehicles dominate real time pollution source contribution to Delhi's particulate pollution: CSE has analysed the real time data on the relative contribution of different pollution sources to Delhi's air quality put out by IITM. The DSS system provides insight into the fractional contribution to PM2.5 in Delhi from 29 sources out of which eight are in Delhi (local sources). This analysis has selected eight local sources that DSS has attributed to Delhi. CSE has accessed data for every alternate hour for the period October 24-November 8 (see Graph 1: Fractional contribution of various pollution sources of Delhi to Delhi's PM2.5 – October 24-November 8 (every alternate hour). Contribution of each local source of pollution has been assessed. The pollution sources include transport, industry, construction, waste burning, energy, residential source, road dust and other group of sources.

This analysis has considered only the local sources of pollution in Delhi and assessed the contribution of different source fractions among them. If only the local sources of Delhi are considered as the total and contribution from outside sources are excluded, then transport sector contribution is around half of the pollution from only the local sources. This is followed by household pollution that has ranged between 12.5- 13.5 per cent, industry -- 9.9-13.7 per cent, construction – 6.7-7.9 per cent, waste burning and road dust each varied between 4.6-4.9 per cent and 3.6-4.1 per cent respectively. This is indicative trend and is based on the trend of every alternate hour during 24 hours of each day during the study period.

The Decision Support Systems (DSS) of IITM is part of the 'Air Quality Early Warning System' and provides information on the potential emission sources to air quality in Delhi. This uses online chemistry transport model 'Weather Research and Forecasting with Chemistry' (WRF-Chem) and its modelling uses available emissions inventory for Delhi and the surrounding 19 districts as well as the PM2.5 data from the 'Central Pollution Control Board' (CPCB) monitoring stations and satellite imaging of pollution. This provides quantitative information on contribution of emissions from Delhi's own sources and the surrounding 19 districts in National Capital Region (NCR), and also the contribution from biomass-burning in the neighbouring states. This can also estimate the effects of possible emission source-level interventions on the air-quality event in Delhi.

Graph 1: Average fractional contribution of sources of pollution to PM2.5 in Delhi (October 24–November 8, 2021)



Source: CSE's analysis based on Decision Support System for Air Quality Management in Delhi of IITM

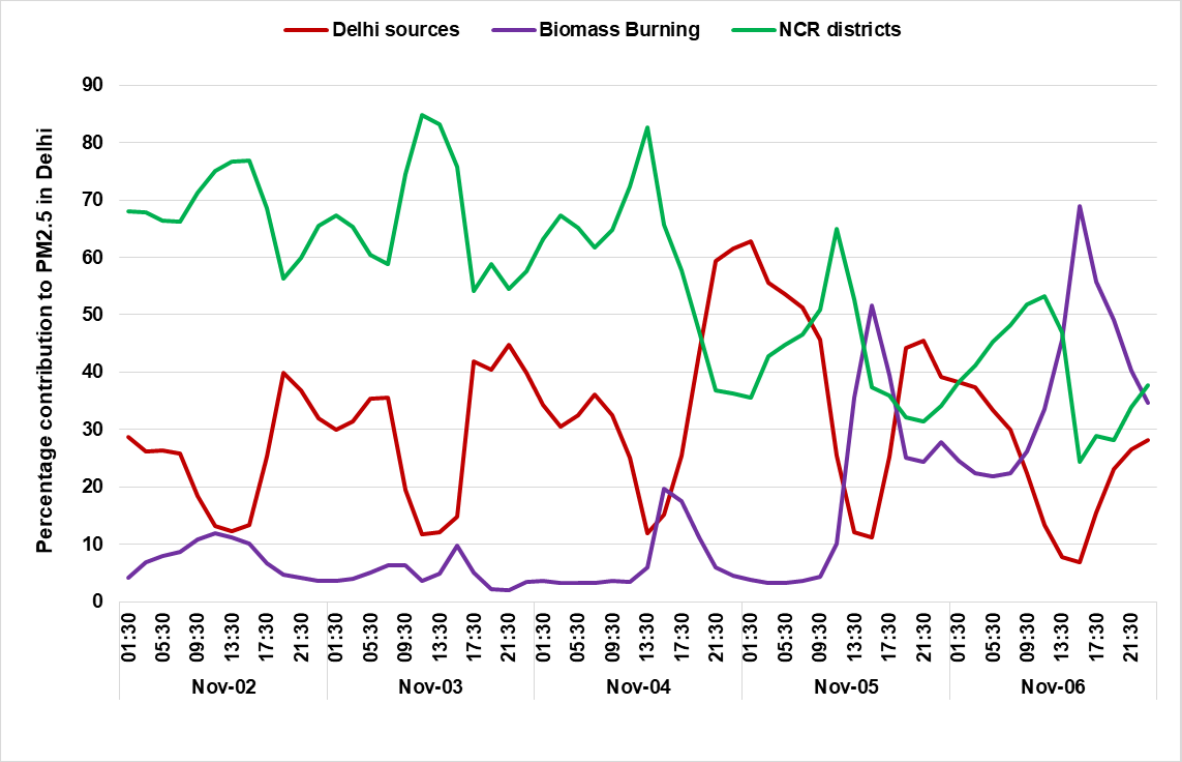
Note:

1) For the missing data, mean value substitution has been done
2) This is the mean of the daily average contribution for period October 24–November 8, 2021

Contribution of outside sources and Delhi's own sources varies during the day and also overtime: The DSS system also tracks data from sources outside Delhi – 19 districts in the NCR as well as biomass burning in neighbouring states. During November 2-6, the contribution of NCR dominated in the initial phase going upto 70-80 per cent, but its share declined during the smog episode post Diwali when the relative contribution of Delhi's own sources increased. Similarly, the contribution of biomass burning from other states remained low in the initial pre-Diwali phase but peaked post Diwali. Clearly, the calm conditions during smog episode post Diwali has reduced intrusion of cross boundary movement from NCR and enhanced the share of local pollution in Delhi. On the other hand, the long range transport wind brought more pollution from biomass burning from neighbouring states.

Also during the day it has been noticed that the overall contribution of Delhi's own sources increase normally during evening hours and lasts until early morning hours (7:30 pm to 9:30 am).

Graph 3: Relative contribution of sources to PM2.5 in Delhi from Delhi's sources, NCR districts and biomass burning



Source: CSE's analysis based on Decision Support System for Air Quality Management in Delhi of IITM

Note:

1. Data originally was available in UTC and is converted to IST for the analysis
2. Delhi sources includes Delhi transport, Delhi construction, Delhi and peripheral industries, Delhi waste burning, Delhi energy, Delhi residential, DG sets, crematoria, restaurants etc
3. NCR districts includes Muzzafarnagar, Faridabad, Rohtak, Rewari, Meerut, Bharatpur, Sonipat, Bhiwani, Ghaziabad, Alwar, Panipat, Jind, Bulandshahr, Mahendergarh, Bagpat, Karnal, Gautam Buddha Nagar, Jhajjar, Gurgaon, Others
4. Data every alternate hour during 24 hours

Congestion impacts during early winter

CSE has also carried out a rapid diagnostic assessment of the changing travel speed during October 27-November 6, 2021. CSE has analysed the Google Maps data for 15 major roads that include MB Road (South), Outer Ring Road (South), Outer Ring Road (North-West), Ring Road (South), Ring Road (North-West), Ring Road (North-East), MG Road (East), Mathura Road (East), ITO Road, Sri Aurbindo Marg (South), Central Delhi, Lal Bahadur Shastri Marg (South), Guru Ravidas Marg (South), and GT Karnal Road 1 and 2. Length of roads were identified to be representative of the geographical spread as well as the larger mobility pattern of Delhi. The travel time from origin to destination was noted for every hour from 8 AM to 10 PM for the period, which was later converted into speed in km per hour. The data was further analyzed for the peak hours (i.e. from 9 AM to 11 AM in the morning and 5 PM to 7 PM in the evening) and for the rest off-peak hours.

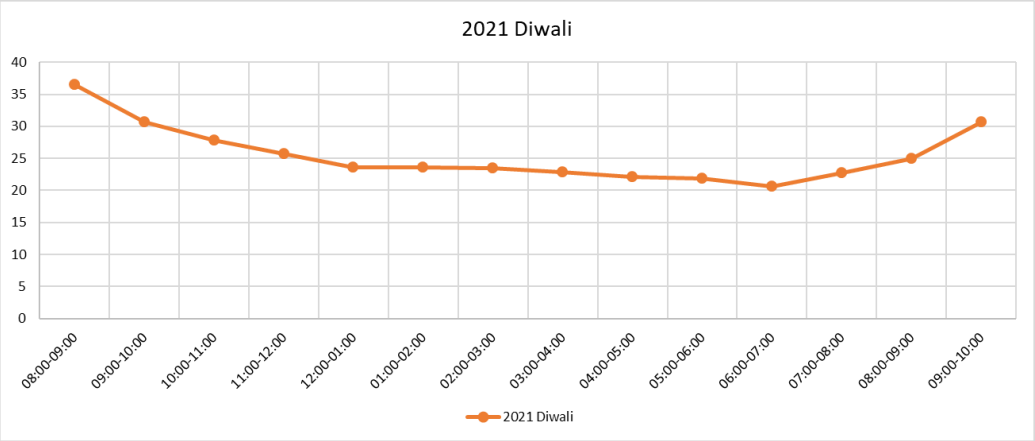
Table 1: Details of road stretches taken for the study

S.No.	Route	Length (in km)	Early winter 2021
1	Mehrauli Badarpur Road (S)	6.4	27th October 2021 – 6rd November 2021
2	Outer Ring Road (South)	3.7	
3	Outer Ring Road (NW)	6.2	
4	Ring Road (S)	6.5	
5	Ring Road (NW)	9.5	

6	Ring Road (NE)	6.3	
7	MG Road (E)	10.5	
8	Mathura Road (E)	5	
9	ITO road	3.4	
10	Sri Aurbindo Marg (S)	7.8	
11	Central Delhi	6	
12	Lal Bahadur Shastri Marg (S)	7.2	
13	Guru Ravidas Marg (S)	3.7	
14	GT karnal Road 1	11.9	
15	GT karnal Road 2	5.6	

Congestion returned to close to pre-Covid times: Travel speed is only indicative of the level of congestion on roads; this is not to build case for high-speed traffic that can compromise safety and impede other forms of mobility like walk and cycling and use of public transport. The overall traffic speed that had improved dramatically during the hard lockdown phases in 2020 has gradually increased with the reopening of the economy. The mean travel speed is 26 kmph, in peak hour it is 23 kmph. During off peak hour it has been 32 kmph. The speed during the same period in 2019 was 23 kmph in peak hour. Thus, traffic build-up has returned back to pre-Covid levels.

Graph 3: Variation in mean travel speed as per peak/off-peak hour



Source: CSE analysis of google map data

Change in peak and off peak hours: Normally in traffic studies, peak traffic flow is usually observed during morning 8am to 11 am and in the evening from 5pm to 8pm, while off peak period is during 11 am to 2pm. The traffic during morning 8am to 11 am is comparatively lower than the evening peak and that remained the same throughout the day. The main peak builds up from 6 pm to 8pm in the evening. On Diwali day and following weekend the overall traffic was observed to be relatively lower. When traffic for specific days were compared, it was observed that congestion build-up was highest on November 2. Diwali day – being a holiday, saw the least traffic build-up.

Table 2: Traffic flow heatmap (red indicates congestion)

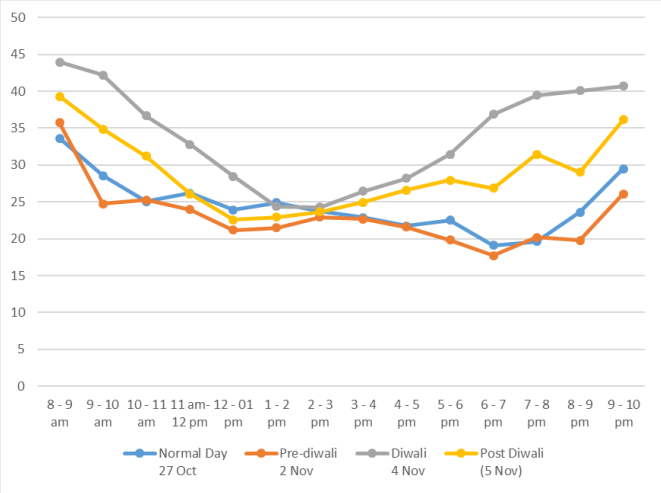
	8-9 am	9-10 am	10-11 am	11-12 pm	12-01 pm	01-02 pm	02-03 pm	03-04 pm	04-05 pm	05-06 pm	06-07 pm	07-08 pm	08-09 pm	09-10 pm
27-Oct														
28-Oct														

29-Oct														
30-Oct														
31-Oct														
01-Nov														
02-Nov														
03-Nov														
04-Nov														
05-Nov														
06-Nov														

Source: CSE analysis of real time google data

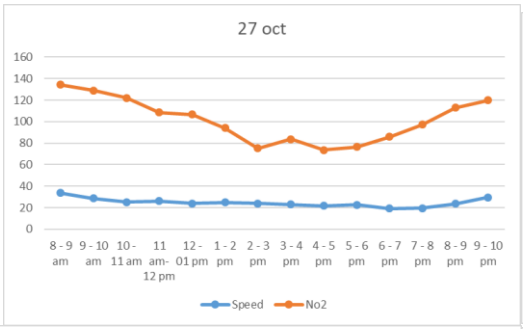
When traffic for specific days were compared, it was observed that congestion build-up was highest on November 2. Diwali saw the least traffic build-up.

Graph 4: Congestion build up during Diwali phase



Congestion and Pollution link: The traffic peaks also influence the hourly build-up of pollution during the day. While PM2.5 is influenced by several other factors the nitrogen dioxide (NO_2) is more closely related to traffic trend. During the study period, the NO_2 levels show strong correlation with congestion. The levels increase when the traffic speed plummets.

Graph 5: Co-relation of traffic speed and nitrogen dioxide on selected days – pre and post Diwali


27 oct
160
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120
100
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60
40
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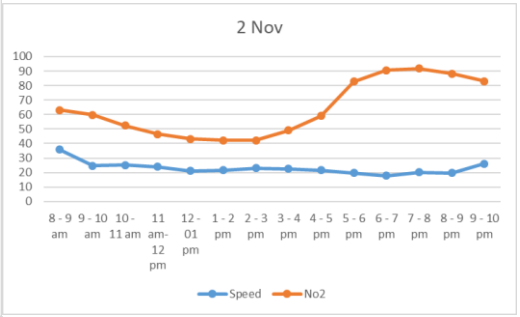
8 - 9 am
9 - 10 am
10 - 11 am
11 am - 12 pm
12 - 01 pm
1 - 2 pm
2 - 3 pm
3 - 4 pm
4 - 5 pm
5 - 6 pm
6 - 7 pm
7 - 8 pm
8 - 9 pm
9 - 10 pm
Speed
No2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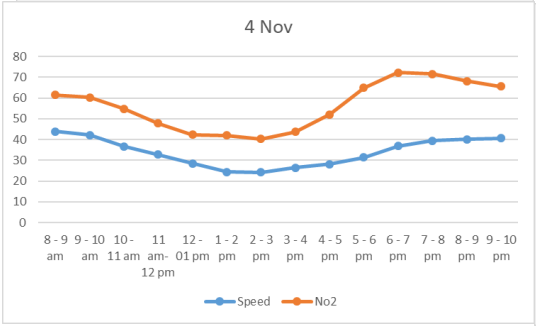
4 - 5 pm
5 - 6 pm
6 - 7 pm
7 - 8 pm
8 - 9 pm
9 - 10 pm
Speed
No2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4 - 5 pm
5 - 6 pm
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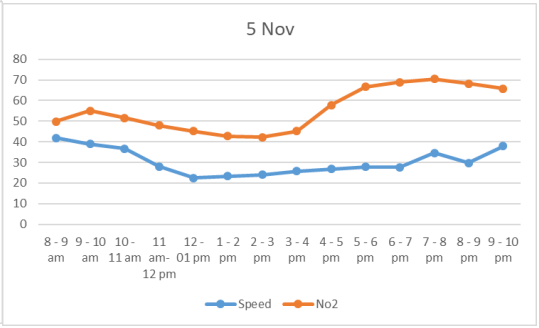
7 - 8 pm
8 - 9 pm
9 - 10 pm
Speed
No2


5 Nov
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12 - 01 pm
1 - 2 pm
2 - 3 pm
3 - 4 pm
4 - 5 pm
5 - 6 pm
6 - 7 pm
7 - 8 pm
8 - 9 pm
9 - 10 pm
Speed
No2