Status of air pollution during winter of 2015-16 and the impact of odd-even car rationing scheme on air quality

January 21, 2016

1. Overall pollution level this winter is higher than last winter. This demands emergency action

This winter has witnessed extremely high level of pollution. Typical winter conditions -- cold temperature, lower mixing height of air, calm and no-wind conditions trap air and pollution. As a result, pollution builds up very quickly and peaks. This is why winter months require tougher emergency action to reduce pollution. Weather is an important constraint in pollution management.

The winter months of November and December 2015 show higher number of days in severe category-four times the safe standard – which is the worst category according to the National Air Quality Index. November 2015 had 73% cent of days in severe category against 53% in November, 2014. December 2015 has 67% of days in severe category as against 65% in December 2014. December 2014 at least had 3% of days in good and satisfactory category but December 2015 has none. There has not been a single good air quality day this winter. On several consecutive days, the PM2.5 levels have remained in the worst category according to the national air quality index.

The odd and even programme has been implemented as an emergency action to arrest the high emergency peak when the overall pollution levels have gone 5 to 6 times higher than the standards. This is needed to protect public health in a city where every third child has impaired lungs.

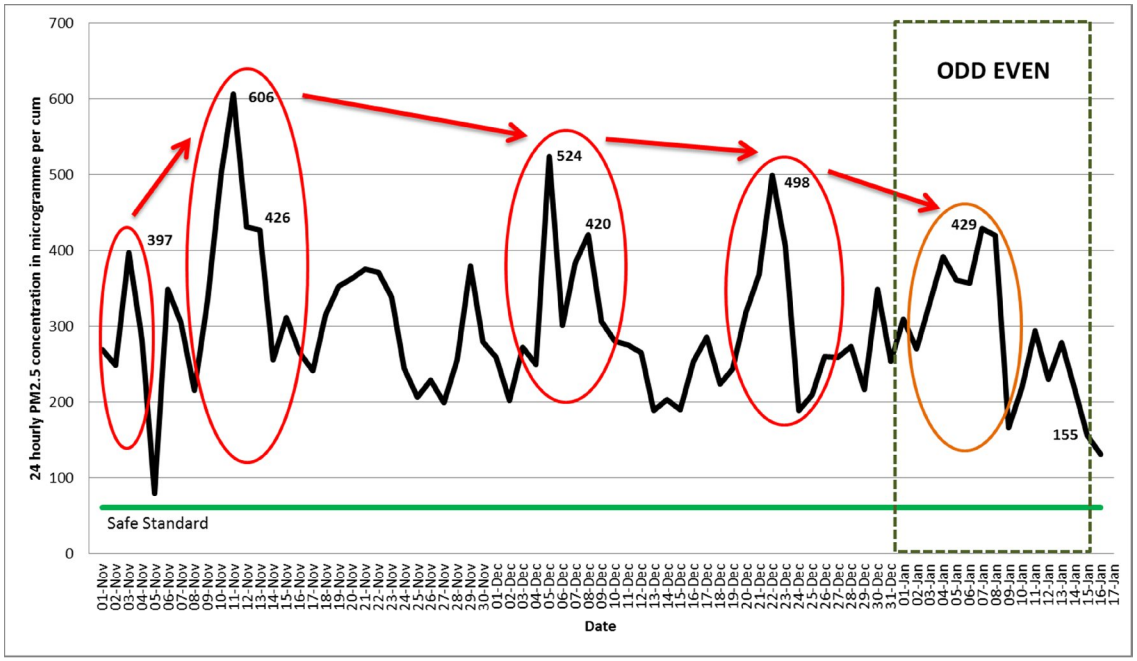
This is also not the only action that is being taken in the city to arrest runaway air pollution. The Supreme Court has taken firm steps to check heavy commercial vehicles from entering Delhi; it has issued directions on enforcement of construction and road dust as well as garbage burning. The Delhi government is also bringing

action against the Badarpur Thermal Power Plant. The odd-even scheme is designed for immediate relief as it takes off the roads almost half the private cars, which contribute to pollution from their tailpipe and pollution because of congestion.

2. The odd-even scheme has resulted in the lowest pollution peak compared to the previous high smog episodes this winter

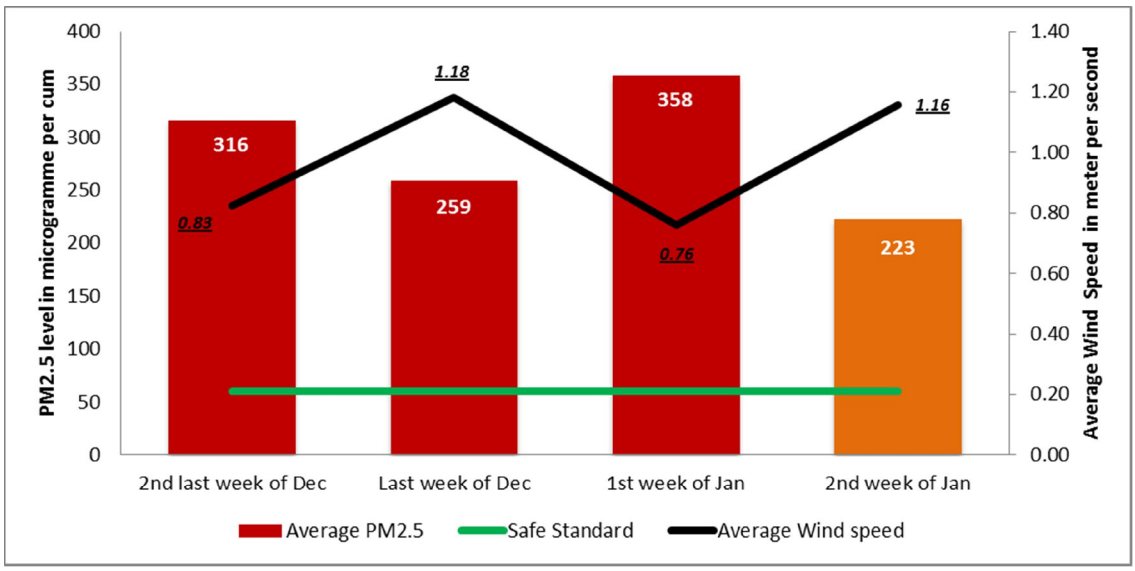
This winter out of all the severe smog episodes so far (with several consecutive days in severe category) the peak pollution during odd and even programme has been the lowest. This shows that despite the hostile weather conditions - no wind, temperature dip and western disturbance, the peak pollution during odd and even scheme has been much lower. The earlier smog episodes have seen much higher peaks and much more rapid build up compared to the rise that happened during the first week of odd and even programme. This proves reduced traffic volume has arrested the peaking of pollution. This validates the importance of emergency action. The fortnight, when the programme was implemented has clearly demonstrated that the peak pollution levels are lower than the normal smog peaks of the season – despite the adverse weather conditions.

Graph 1: Drop in intensity of smog episodes during odd-even fortnight



Source: Centre for Science and Environment analysis of DPCC real time pollution data

Graph 2: Faster clearing of smog episodes during odd-even programme in week 2: in week 2 of odd-even, wind speed was lower than last week of December, but average PM 2.5 levels were still lower

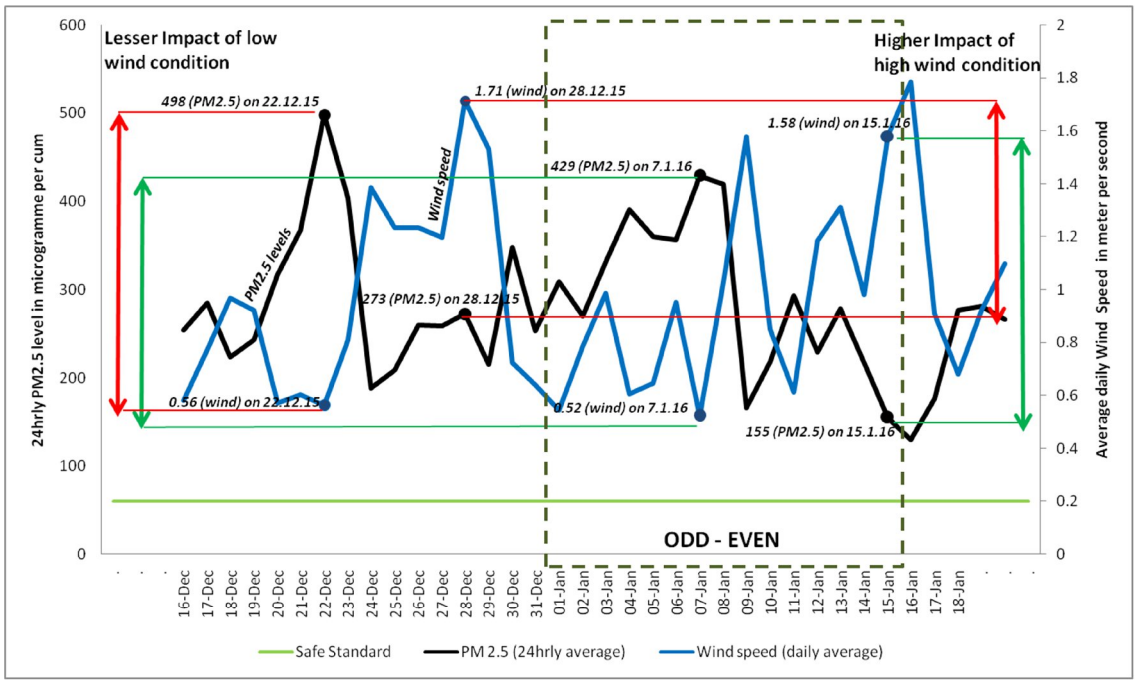


Source: Centre for Science and Environment analysis of DPCC real time pollution data

3. During odd-even programme day-hours even with lower wind speed has shown faster drop in pollution

It is also clearly evident from the air pollution data that despite the lower wind speed in some days during odd and even scheme, pollution has fallen during those hours. In fact, it is notable that during days before the programme was started pollution levels had increased when wind speed was low. This brings out the clear impact of the odd and even scheme on the pollution levels. Even when wind was not there to blow it away the scheme succeeded in arresting the upward trend. Both the real time pollution and wind data are from the Delhi Pollution Control monitoring stations.

Graph 3: Odd and even days in Delhi show that even on days without wind pollution levels declined as opposed to pre-scheme days



Source: Centre for Science and Environment analysis of DPCC real time pollution data

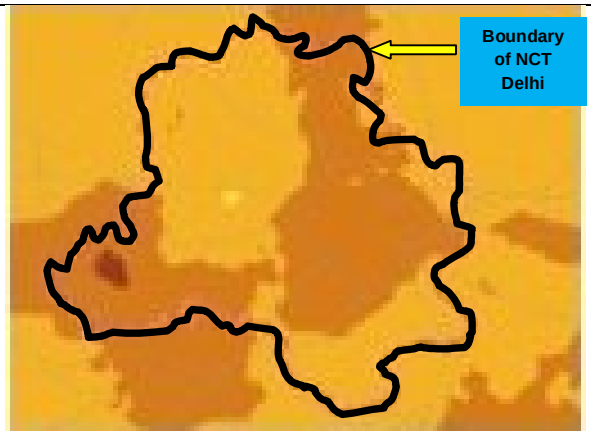
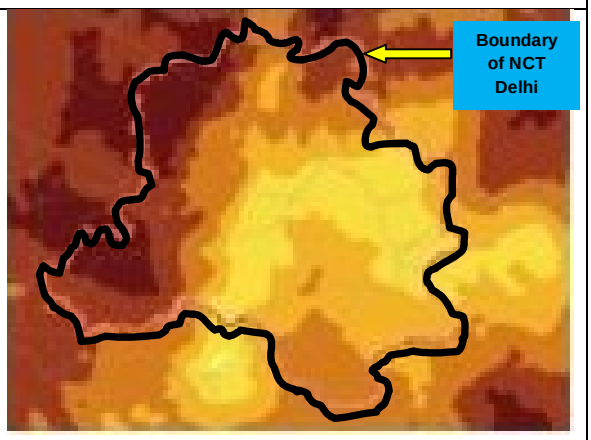
4. The cleanest day of the season was noted during the odd and even week when weather was hostile

January 15 – the last day of the odd and even scheme – was the cleanest day of this winter when PM2.5 levels dropped to 155 microgram per cum. The only day when lower levels were recorded was on November 5, 2015 when it had rained in the city. But there was no rain during odd and even fortnight. The benefits continued during the weekend that followed the fortnight with levels further dropping to 130 micrograms per cum. on January 16. But the weekend was also the most windy day of the season. The wind started to slow down on Sunday but due to relatively low traffic, PM2.5 levels rose only marginally to 176 microgrammes per cum.

5. Satellite imagery shows 'lightening' of pollution over Delhi as compared to NCR during odd-even fortnight and studies show that Delhi pollution level was less than neighbouring regions in the odd-even fortnight

Scientists of Department of Public Health Sciences, University of Miami, US have studied aerosol optical depth or how pollution in the air block sunlight by absorbing or by scattering light and prevent direct sunlight from reaching the ground. A value of 0.01 corresponds to an extremely clean atmosphere, and a value of 0.4 would correspond to a very hazy condition. An average aerosol optical depth for the U.S. is 0.1 to 0.15. They have found that this improved in Delhi after the odd-even scheme was implemented. But in areas bordering the capital and the surrounding NCR there was no effect, and saw 35% worsening.

Figure 1: Comparison in pre-and-during odd-even road rationing programme in Delhi NCR on AOD (Aerosol Optical Depth) levels

AOD: Pre Odd-Even Trial	**AOD: During Odd-Even Trial**
	
December 18 to 31, 2015	**January 1 to 15, 2016**

Legends:

Good					Bad
0 to 0.3	0.3 to 0.45	0.45 to 0.60	0.60 to 0.75	0.75 to 0.90	> 0.90

Source: Department of Public Health Sciences, University of Miami, US

Another assessment by a team of researchers from University of Chicago and University of Harvard also finds that the odd-even programme has helped to improve air quality in Delhi[1] -- by reducing particulate air pollution concentrations by 10-13 per cent in the period. This study found the following:

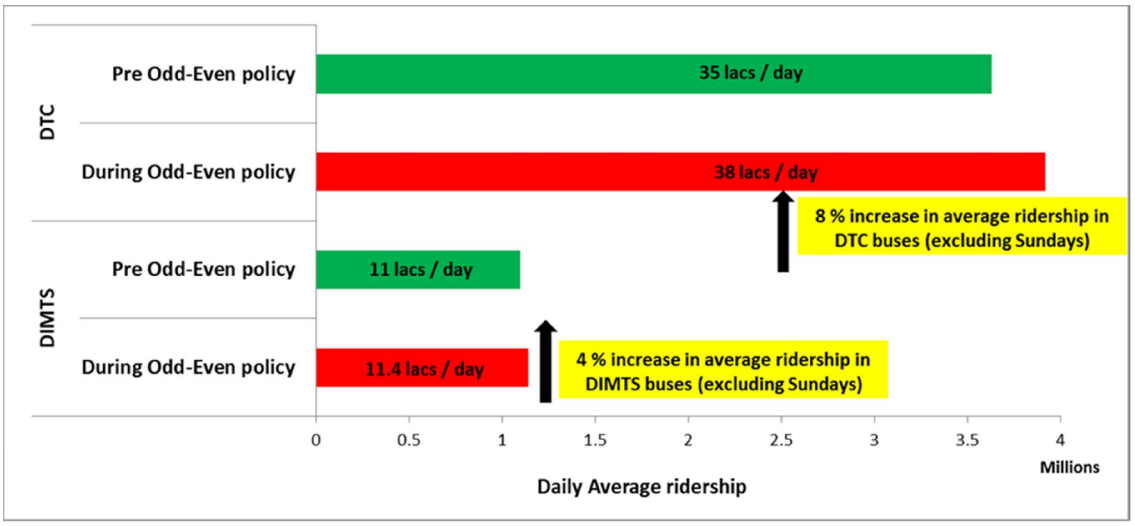
a. Starting January 1, while absolute pollution levels increased both inside and outside Delhi (for atmospheric reasons, as noted by other commentators), the increase in fine particulates in Delhi was significantly less than in the surrounding region. Overall it was a 10-13 relative decline in Delhi.
b. During the 8 am to 8 pm period – when the scheme was implemented – the impact is even more visible. Around 8 am the gap between Delhi's pollution and its neighbouring regions begins to form and steadily increases until mid-afternoon. Then as temperatures begin to fall and air pollutants are less likely to disperse, this gap starts to close. When focusing on just the hours that the odd-even policy was in effect, the estimate of the authors is that particulate pollution declined by 18 per cent because of the pilot.

6. During odd-even fortnight there was increased public transport ridership, which points to the need for augmentation of this mode of transport in NCR. Bus speeds increased and this makes them also more reliable modes of transport

Theroad rationing has allowed all forms of transport to become more efficient. In this period, buses, autos and taxis could do more kilometres and carry more people. Metro ridership has also increased. Bus passengers increased by 8%. In fact this would have been higher if two-wheelers were also brought within the ambit of the odd and even scheme. This was also possible because of more efficient utilization of the bus fleet. The DTC bus fleet utilization improved from 84% in normal days to 95% during Odd-even policy.

[1] Michael Greenstone et al, Yes Delhi it worked, in Indian Express January 19, 2016

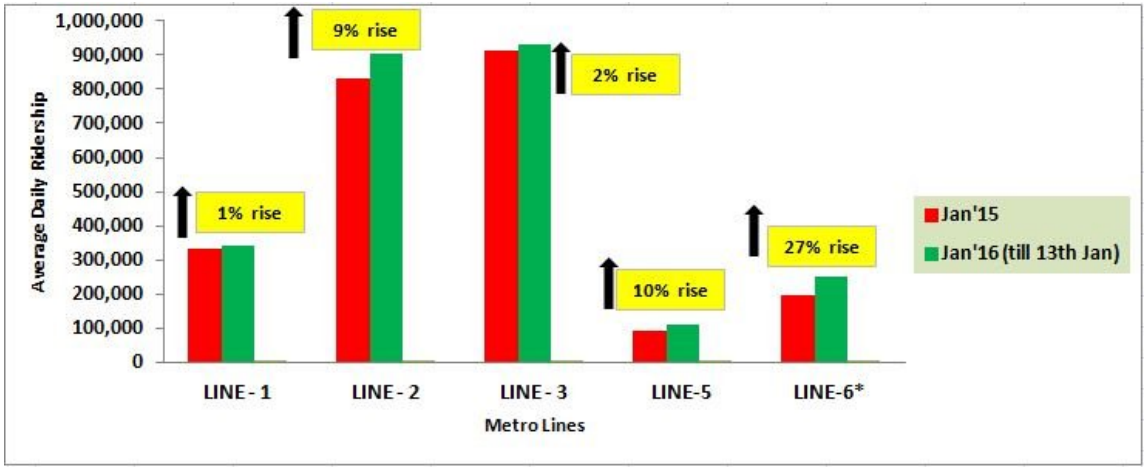
Graph 4: Increase in bus ridership during odd-even programme in Delhi



Source: Delhi Transport Corporation and Delhi Integrated Multimodal Transportation System

Delhi Metro Rail Corporation (DMRC) has informed EPCA that in any given year January is a lean period for metro ridership due to holidays. While compared to December 2015 there was a drop in absolute metro ridership during odd-even fortnight. But when this ridership is compared to previous January (2015), then during January 1-15 2016, there was an increase of 7% -- from 23 lakh per day to 25 lakh per day. DMRC has increased number of coaches from 1198 as on December 28, 2015 to 1220 on January 1 2016. DMRC also increased number of trips and rescheduled the frequency of trains in peak and off-peak hours.

Graph 5: Comparison of average ridership of metro for January 2015 and January 2016 (data till January 13, 2016)



Source: Delhi Metro Rail Corporation

7. During odd-even fortnight there was a dip in sale of petrol and diesel, which in turn will result in lower pollution

Data from Petrol Dealers Association shows that the overall petrol and diesel sales have dropped by 4.7% and 7.8% from December 2015 to January 2016.

8. During odd-even fortnight, studies show dramatic impact in terms of reduced congestion. There is a clear correlation between congestion and pollution

The data available from the 'Traffic Survey and Travel Attributes Study' conducted by the School of Planning and Architecture' Department of Transport Planning during odd-even scheme show substantial reduction in traffic volume and congestion.

The survey was carried out in 11 locations along different major arterial roads of Delhi like Gurgaon Expressway, Mathura Road, NH-24, NH-1, Bahadurgarh Road and Ring Road. It found that the average journey speed was as high as 50 kmph during odd and even period as against 20-25 kmph speed on regular days. This is due to reduction in share of cars on the road during that period.

In West and North West Delhi (Punjabi Bagh, Peeragarhi, Rajaouri Garden, Janakpuri, etc)the improvement in speed was not so considerable. The study observed that this was because of already lower share of cars in traffic, construction works along the road, heavy dependence upon two wheelers, road side encroachments.

But the busy Ring-Road experienced about 30 to 50% increase in speeds during the odd-even fortnight.

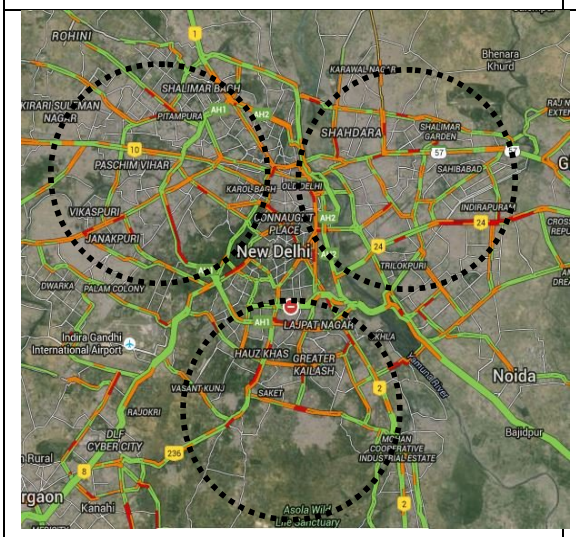
The study also found that the average occupancy in personal cars increased from 1.4 to 2.1 during the odd and even period at major nodes.

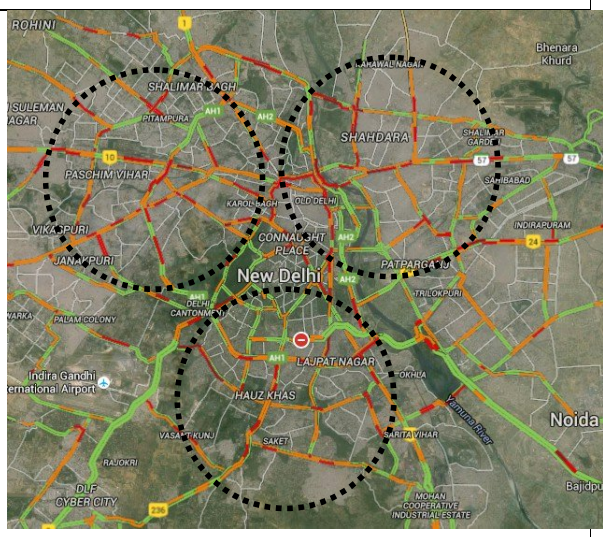
The Centre for Science and Environment has compared the live traffic updates from Google for January 15, 2016 (during odd-even) and for January 19, 2016 (after odd-even scheme was over). This shows how congestion in most roads of Delhi hasincreased after the odd and even scheme was over.

It is also important to note that the people of Delhi and neighbouring states have followed the rule – it shows their cooperation and their desire to be part of the solution to check this toxic and deadly air pollution. It is clear that we need to do more and not less to arrest air pollution and also make this scheme more successful, by reducing exceptions.

Figure 2: Impact of Odd-Even on Delhi's traffic

During Odd-Even	After Odd-Even
January 15, 2016 – Time- 10:30 am	January 19, 2016 – Time- 10:30 am





Fast		Slow

Source: Google Maps

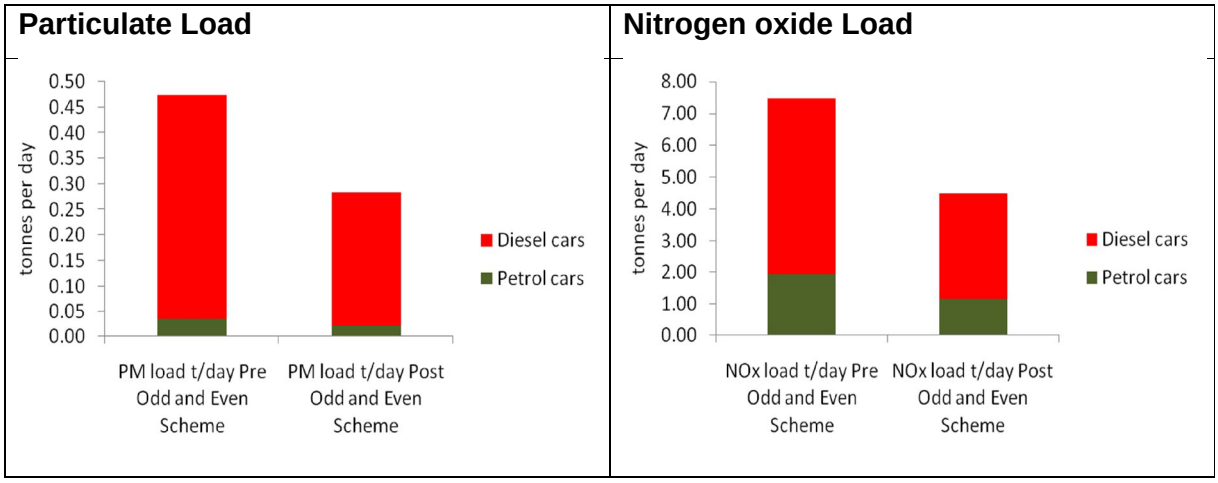
9. Pollution load from cars are lower; per capita emissions of car users is also down during odd and even programme

Both particulate and nitrogen oxide load from the cars has reduced substantially during odd and even programme – by as much as 40%. Higher share of pollution

benefits have come from reduction in diesel cars as is also evident from the sale of diesel in the city.

This indicates reduced exposure to toxic pollution from vehicles on roads and close to road side. It is estimated by the US based Health Effect Institute that the maximum impact of vehicular pollution is upto 500 meters from road side and 55% of Delhi's population live within that zone. This has serious public health implications. Studies by researchers of University of California, Berkeley have shown that in Delhi the pollution level on the road and close to road side are at least 1.5 times higher and peaks 15 times higher than the ambient concentration. This programme has therefore contributed to the reduction in exposure to toxic fumes.

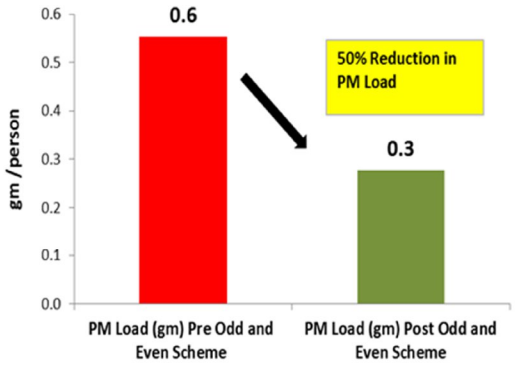
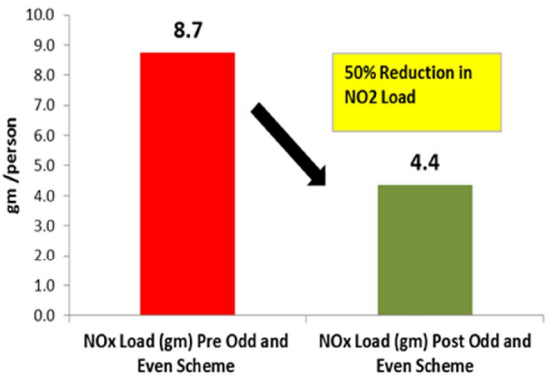
Graph 6: Particulate and nitrogen oxide load reduction from cars during odd-even scheme



Source: Centre for Science and Environment

Moreover, higher occupancy of cars due to car pooling and sharing has also reduced per capita toxic emissions of car users substantially. Shift to other modes can be even more substantial. This is a significant contribution of Delhiites to the pollution control efforts that needs to be respected and encouraged for longer term solution.

Graph 7: Reduction in per capita emission of PM and NOx due to car pooling car during odd-even programme

Particulate load	Nitrogen oxide load
	

Source: Centre for Science and Environment

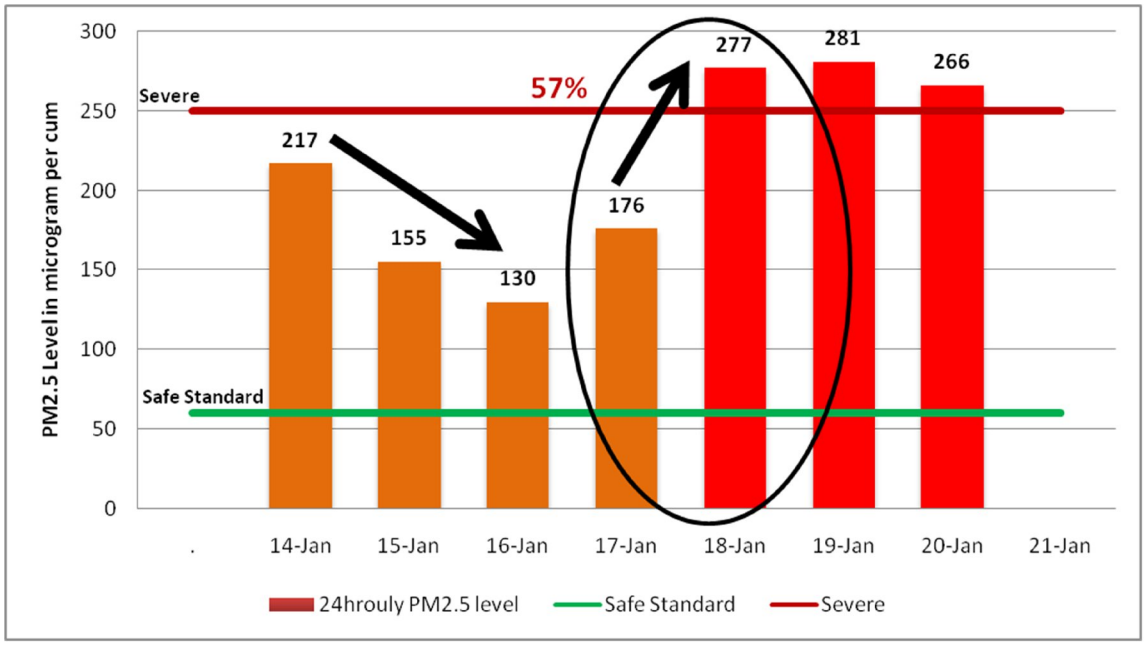
10. Air quality gains lost on the very day after the odd-even scheme came to an end. Pollution levels are much higher after the scheme

The gains of odd and even scheme were immediately lost after full traffic was back on the first Monday after the scheme came to a close. This was further aggravated by lower wind speed. On Monday, January 18, the PM2.5 levels shot up by 57 per cent within the day and once again rose to 'severe' category. With an average city wide concentration of 277 microgram per cubic metre (cum.), Delhi's air quality was back in 'severe' category.

The PM2.5 levels continued to remain in the 'severe' category on Tuesday with the levels further increasing to 281 microgram per cum. On Wednesday, there was a reduction to 266 microgram per cum. but not enough even though wind had improved by over 60 per cent since Monday. Without wind, the build-up would have been much higher. On Monday, pollution build up within the 24 hours was massive – by as much as 101microgram per cum. Despite being a windier day this was 35 per cent greater build up on January 18 than the highest observed during odd-even period – a jump of 75 microgram per cum. on January 11.

Similarly, January 1 had lower wind speed than January 18 but the PM2.5 levels rose by just 56 microgramme per cum, which means that the build-up this Monday was 80 per cent higher than on January 1.

Graph 8: Rapid increase in PM2.5 levels post odd-even scheme



Source: Centre for Science and Environment analysis of DPCC real time pollution data

CSE analysis shows that during the fortnight of odd and even scheme, the lowest pollution curve could be seen largely during the afternoon between 2 and 5 pm. But this lowering of curve is getting more flattened in post-scheme days. This means the pollution is building up throughout the day.

11. This is Delhi's first ever-emergency action which is consistent with global best practice.

In other countries duration of the programme is adjusted according to the severity and persistence of the severe pollution problem. Several countries have implemented odd and even formula as an emergency action to reduce peak pollution levels. Many of those programmes are more stringent in terms of duration, penalty and minimal exemptions. There are evidences of impact on air quality in those global cities. With this programme several cities have reported a wide range of benefits

including reduction in air quality, reduced congestion, improvement in public transport ridership etc.

Lowering of pollution levels have been reported in different cities. In Paris for instance that has implemented this programme in March 2014 and repeated in March 2015, saw 18 % reduction in traffic volume and 6% in pollution levels. But Beijing that has a longer and a more stringent programme has shown 38% reduction in PM10. This indicates that even this percentage reduction is necessary and is possible in the short term to reduce smog peaks.

12. Sign post

Given the current pollution levels and adverse weather conditions it is recommended that the Delhi Government should further strengthen emergency action roll-out when pollution levels hit 'severe' level. Delhi government should consider more such action sooner keeping in view Delhi is witnessing delayed winter.

However, more systemic solutions are needed urgently to sustain the gains demonstrated during this fortnight – slower peaking of pollution, low congestion and related air pollution benefits. Reduced traffic volume made public transport more efficient. Greatly augment public transport, walking and cycling facility so that the city can go car-free more often and as a general practice. The odd and even scheme has shown that congestion and pollution can be reduced if the city has adequate public transport systems.

Environment Pollution (Prevention and Control) Authority – EPCA – has taken on board the evidences of air quality gains of this scheme for its assessment of the winter pollution and has submitted a report to the Supreme Court. EPCA has also recommended several measures on vehicles an all key sources of pollution.

The Supreme Court has given a series of directions related to all key pollution sources in the National Capital Region of Delhi. These include quick augmentation of bus and metro; stronger action on truck traffic; closure notice on coal-based Badarpur power plant; tighter action on construction dust, road dust and waste-burning. The Supreme Court has also served notice to further advance

implementation of Euro VI emissions standards for vehicles nation-wide. This creates an opportunity for the city to speed up time bound action on all key pollution sources to meet the clean air target.

Public health emergency demands emergency action. But simultaneously push urgent action on systemic solutions for sustained air quality and public health gains.