AIR QUALITY MANAGEMENT EFFORTS IN NEW DELHI, INDIA

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About Delhi: Delhi or New Delhi, the Capital and economic center of India, has been recognized for its rich cultural heritage, history and trade. It is believed to have been inhabited prior to second millennium BC, and, now with population of ~17 million it is one of the world's most populous cities. In terms of geographical area, it is the largest city in India with total area of ~1500 km^2. It is surrounded by four other urban centers namely, Faridabad, Ghaziabad, Gurgaon and Noida, which makes it second largest urban agglomeration in the world. Rapid urbanization and vast expanse of city along with bustling mix of activities have posed serious air pollution problems, and made Delhi as one of the most polluted cities in the world.

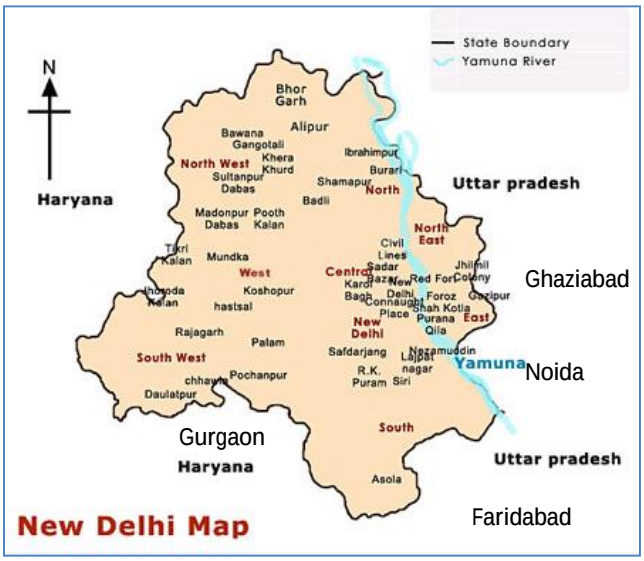

Fig.1 New Delhi and adjoining towns

Air pollution challenges: Delhi's population grew from 13.9 million in 2001 to 16.8 million in 2011, almost by 22%. There has been negative natural growth due to reduction in birth-rate in the recent years. But, being potential growth centre, Delhi attracts in-migration as well. It is estimated that the population would rise to ~22 million in 2021. The growth puts pressure on infrastructure and services, causing increase in pollution. Number of registered vehicles increased from 3.4 million in 2001-2002 to 7.7 million in 2012-2013, without proportionate augmentation of road network. It has resulted in reduced vehicle speed, more travel time, traffic congestion and therefore, more air pollution. Two-wheelers (63%) followed by

passenger cars (32%) have major share in the fleet (Fig. 2). Delhi has 36 industrial estates having ~2200 small and medium-scale air polluting industries and five thermal (two coal, and three gas-based) power plants with total installed capacity of ~1500MW. In addition, there are large number of diffused sources, such as domestic and commercial cooking and heating. Air quality monitoring network in Delhi comprises 21 continuous and 10 manual stations. Future monitoring will focus on continuous systems that provide near real-time data.

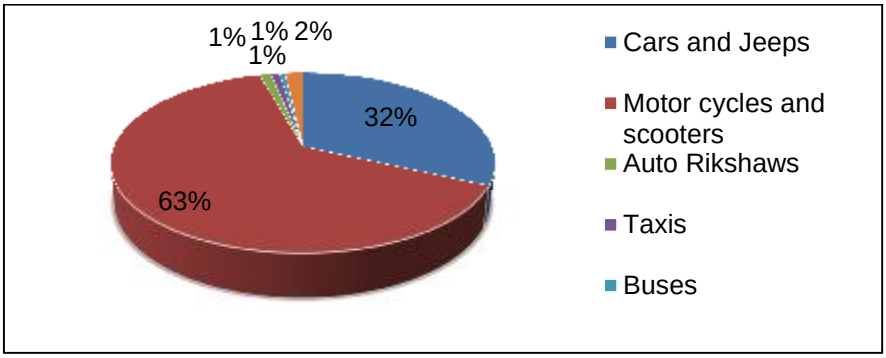

Fig. 2: Distribution of different categories of vehicles

Particulate matter (PM_{10} as well as $PM_{2.5}$) is the pollutant of most concern for ambient air environment of Delhi. The situation becomes more critical with multiplicity and complexity of sources and unfavorable meteorological conditions, especially low winds and mixing height during winter months. The prominent sources of PM emissions in Delhi include road dust re-suspension, vehicular exhaust emissions, industries including power plants, construction activities and diesel powered generators due to sporadic electricity supply.

Mitigation measures implemented: A large number of initiatives were taken for air pollution control in Delhi. Some of the important measures are listed below:

(i) *World's largest CNG fuelled public transport:* Delhi's entire public road transport was switched over to compressed natural gas (CNG) from diesel and gasoline in the year 2002. About 0.55 million city buses, taxis and three-wheelers run on CNG, which makes it world's largest CNG-fuelled public transport system. Necessary infrastructure including about 300 refilling stations was built for CNG supply. CNG consumption during 2011-12 was about 650 thousand tones, 8.9% up from previous year. The demand for gasoline dropped from 825 to 812 thousand tones, contrary to 5.6% growth in consumption in the country.

(ii) *Progressive norms for vehicle emissions and auto fuel quality:* Major initiatives on improving fuel quality and vehicle emission norms were taken in the last 15 years. Sulphur content in diesel has been brought down from 0.5% to 0.005% in 2010. Bharat

stage IV (equivalent to Euro IV) emission norms were also introduced in the same year. Besides, benzene content in gasoline has been reduced from 5% to 1%. Table 1 summarizes schedule of implementations of the norms.

CNG-fuelled city bus in Delhi

Delhi Metro rail

Table 1: Schedule of implementation of vehicle emission and auto fuel quality norms

Fuel quality improvement	Implementation year	Vehicle emission norms	Implementation year
0.5% S – Diesel	1996	1998 (Cat. Convertor Norms)	1998
0.25% S – Diesel	2000	Bharat Stage I (Euro I)	1999
0.05% S – Diesel	2003	Bharat Stage II (Euro II)	2001
0.035% S – Diesel	2005	Bharat Stage III (Euro III)	2005
0.005% S – Diesel	2010	Bharat Stage IV (Euro IV)	2010
Unleaded Petrol	2000	-	-

(iii) Strengthening of public transport system: Rail based mass transit system was introduced in Delhi in the year 2002, and currently covers route length of 190 km carrying about 2.4 million commuters daily. It is expected that by 2016, the total route length will be more than 400km. In addition, city bus service has also been augmented with inclusion of large number of low-floor buses.

(iv) Curbing Industrial Pollution: In 1996, large and hazardous industries were shifted out of Delhi, and other small-scale industries operating in non-conforming areas were relocated to industrial estates. About 600 industrial units switched to CNG fuel. One coal-based power plant was closed down, and replaced by a new gas-based plant.

(v) *Other measures:* Many other steps helped in reducing pollution – restrictions on operation of goods vehicles during daytime, construction of flyovers and sub ways for

smooth flow of traffic, phasing out of 15 year old commercial vehicles, and introduction of battery operated three-wheelers, etc.

Lot more needs to be done: Despite having taken many actions, levels of pollutants have not declined much. It appears that the pace of growth has off-set the benefits of mitigation actions. Air quality trend at ITO crossing, one of the traffic dominated monitoring locations is given in Fig. 3. Levels of PM_{10}, $PM_{2.5}$ and NO_x still exceeded the annual standards of 60, 40 and 50 µg/m^3 respectively. While no clear decreasing trend is observed, the levels have not gone up proportionately to the growth. An efficient, comfortable, and reliable public transport system will play a vital role in improving air quality. PM_{10} source apportionment study carried out during 2007-2010 provided key inputs on source contributions. Similar study for $PM_{2.5}$ is underway. Besides, a web and GIS-enabled decision support system is developed that will help in analyzing relevant data and efficacy of mitigation options. It is hoped that all these measures will lead to better air quality in Delhi.

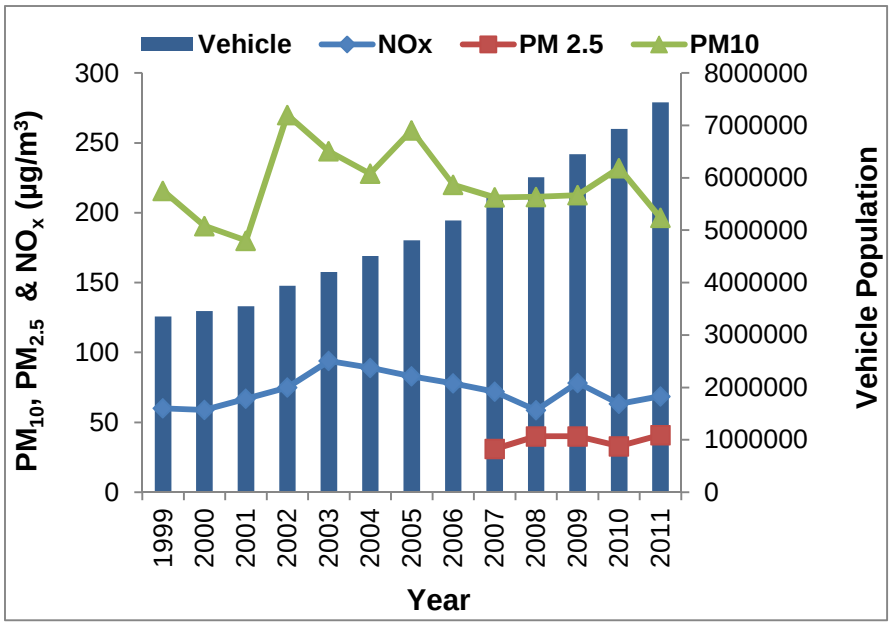

Fig. 3: Air Quality Trend during 1999-2011 at ITO, New Delhi

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