Air Pollution in Delhi

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As India's capital, Delhi has grown across sectors – industry, transport, and housing – which contribute to an increase in air pollution. This, in turn, has increased health risks, which are reflected in a rise in respiratory ailments. While the benefits of some interventions in the transport sector have been apparent, it is time to focus on low-hanging fruit in other sectors in order to improve air quality and public health in the city.

During the Budget Session of the Rajya Sabha, Janardhan Waghmare addressed Question No 1417 to the Ministry of Environment and Forests (MOEF), requesting information on the current status of air quality in Delhi and seeking data about the aftermath of mass introduction of compressed natural gas (CNG) for the public and private vehicles on air quality in the capital.

In response, the MOEF minister, Jayanthi Natarajan, presented a list of activities and programmes conducted by her ministry for monitoring and regulating air pollution in the cities of India and in the annexure provided the annual averages of sulphur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter (PM_{10}) pollution measured at nine stations in Delhi (Figure 1). Her response highlighted the fact that the contribution of the transport sector to PM_{10} pollution in Delhi was between 9-21% of the total.

The PM_{10} refers to all the particulate matter less than 10 micron-meter aerodynamic diameter, with the highest propensity to penetrate human lungs and result in aggregated respiratory and cardiovascular diseases and, in some cases, premature death (Chhabra et al 2001; Pande et al 2002, 2004, 2010; Balakrishnan et al 2011).

Figure 1 raises more questions than it answers. Between 2001 and 2005, the annual average PM_{10} pollution dropped slightly, but has since risen more than 2.5 times. In 2010, the annual ambient PM_{10} concentrations averaged 260 $\mu g/m^3$, which is four times more than the national annual standard and 13 times more than the guidelines stipulated by the World Health Organisation (WHO). Pollution levels are worse in the winter months with concentrations at least double the annual averages, due to increased emissions from heating, and meteorological conditions (Guttikunda and Gurjar 2011). In December 2011, the daily average PM_{10} was 368 ± 116 $\mu g/m^3$ at four stations in Delhi (Figure 2, p 25).

Even if the CNG introduction has been a successful intervention as far as reducing pollution from the transport sector is concerned, it accounts for at most a fifth of the pollution in Delhi. Hence, this begs the questions – are we asking the right questions to address the seriousness of deteriorating air quality in Delhi? Is there something else we

Figure 1: Annual Average Ambient PM_{10} Concentrations in Delhi

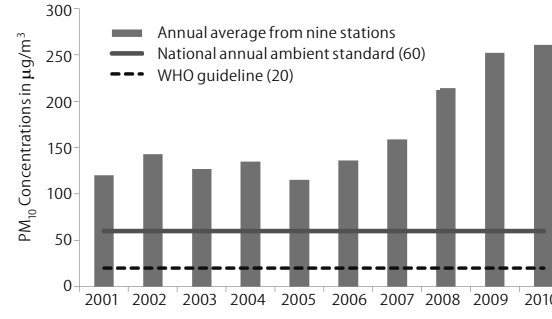

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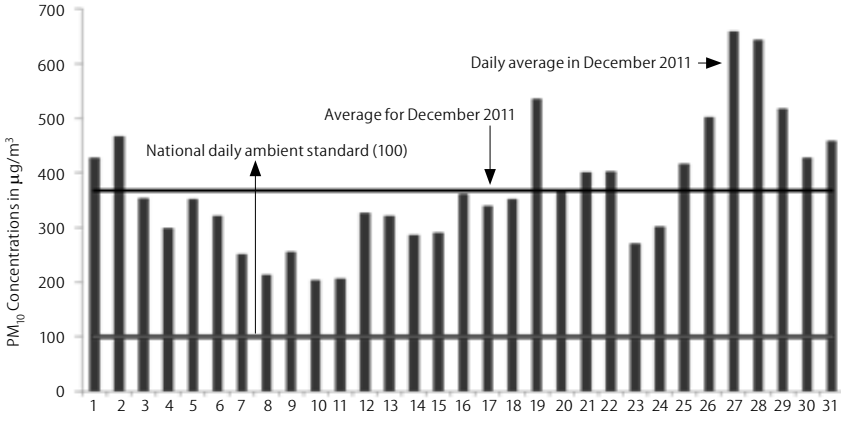
Figure 2: Daily Average Ambient PM_{10} Concentrations in Delhi



should be focusing on to improve air quality in Delhi?

What Happened?

Over the past decade, a number of initiatives were introduced to address the city's pollution problem. These included, among others:

- The largest-ever CNG switch for more than 1,00,000 vehicles (buses, three wheelers, and taxis). In the early 2000s this resulted in some decrease in PM pollution, with the largest improvement coming from retrofitting about 3,000 diesel buses (DTE 2002; Kathuria 2005; Kumar and Foster 2007; Chelani and Devotta 2007).
- Before the 2010 Commonwealth Games, a large part of the retrofitted fleet was replaced with newer CNG buses and the fleet size increased to about 5,000; special transport corridors were introduced during the Games, which are to serve as a pilot for future bus rapid transport applications.
- The city also benefited from the completion of the Metro Phase-II, increasing the coverage from 65 km in Phase I to 180 km, including an express line from the city-centre to the international airport. This resulted in some drop in on-road vehicle density towards the satellite cities of Gurgaon and Noida.
- Conversion of coal-based thermal power plants within Delhi to gas-based power plants (SOE-Delhi, 2010) and relocation of the coal and fuel oil-based industries, including brick kilns, to the city outskirts, following Supreme Court orders (Narain and Bell 2006).

While these initiatives helped improve the quality of air in the city in the early 2000s and thus the respiratory health for the citizens of Delhi, they nevertheless have fallen short in keeping up with the daunting challenges posed by the growing sources of air pollution. The benefits of leapfrogging to alternative fuels like CNG is outdone by the increasing number of passenger vehicles on the road, lack of enough public transport buses, the increase in freight movement and construction material and debris by trucks passing through the city, the lack of maintenance of trucks and buses, growing demand for electricity leading to the use of in-situ generator sets, and industrial growth.

What Is Next?

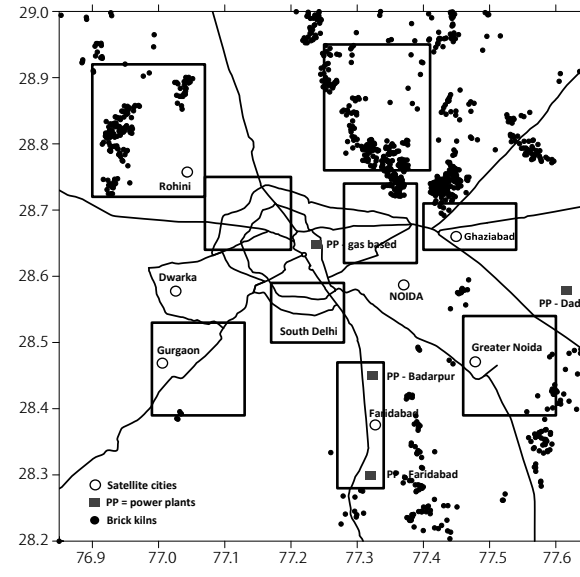
A brief landscape of activities that contribute to air pollution in the capital region is described in this section. Understanding this is the first step towards identifying the low-hanging fruit, in terms of interventions, that could help reduce air pollution in Delhi.

The construction sector is rapidly growing in India. This includes brick and cement manufacturing. In the case of Delhi, the brick kilns are located just outside the city limits, mostly along the border. The dots in Figure 3 show the location of about 1,000 kilns, with a production capacity of about 25,000 bricks per day, using a mix of coal and biomass. The area covered by the black boxes drawn north of the outer ring road contains most of the kilns (approximately 60%).

Brick manufacturing in northern India is dominated by small individual operators, each consisting of 200 to 300 daily wage workers per kiln, employed on a seasonal basis (Gupta 2003). Most of the installations are conventional fixed-chimney bull-trench kilns that are more polluting and energy-inefficient as compared to the newer, cleaner technologies, like the Hoffmann, high draught or vertical shaft brick kilns (CAI-Asia 2008; World Bank 2010). Similar kilns are found in most parts of northern India, along the Indo-Gangetic plain as well as around the cities of Bangalore, Chennai and Hyderabad in south India (Isabelle et al 2007).

The urban clusters of small-scale manufacturers, such as leather tanneries, brick kilns, smelters, and metal-working shops account for a large portion of pollution in Delhi. Moreover, it is easier to inspect and maintain 1,000 brick kilns or 6,000 other industries, compared to the six million vehicles plying on the roads. While relocation of industries proved beneficial in the past, with the growing population and city size, a more promising approach would be to introduce emerging technologies that reduce the emission rates at the brick kilns and the industrial boilers, followed by the enforcement of an inspection and maintenance programme.

Figure 3: Study Domain over the National Capital Region of Delhi



Another major source of pollution in most Indian cities is road dust (CPCB 2010), including that from the construction activities. This source, a large part of the coarse PM_{10} pollution, is often difficult to quantify as it depends on the vehicle movement on the roads, road types, silt loading on roads and at construction sites, and meteorological conditions. However, this source can be managed with measures like wet sweeping, promoting vegetation in dry areas, paving roads and completing road work that often results in ditches and pavements that are left dug up after the concerned department (telephone, sewer, electricity, and gas) has finished its work.

The passenger and commercial vehicles are responsible for an increasing portion of the energy consumption, emissions, and harmful exposure. In dense traffic zones of Delhi, large populations are exposed to the vehicle exhaust and the road dust pollution, sometimes double the ambient pollution (Apte et al 2011). A number of interventions are in place or being promoted to support mass transport. A six km-bus rapid transport corridor was piloted in 2008. During the 2010 Commonwealth Games, the public transport sector got a boost with a doubling of fleet, along with the introduction of air-conditioned buses and an extension of the metro lines. The para-transit sector, three-wheelers and taxis, also benefited from the expansion of their fleets with more licences and radio-taxi services.

The commercial heavy duty trucks are banned from entering the city limits between 6 AM and 9 PM, to reduce emission loads and exposure levels during the daytime. However, the density of these vehicles carrying raw and finished products, construction debris, sand, and bricks, has increased, resulting in more emissions at night, and this pollution tend to linger even after the trucks have stopped operating at 6 AM. The debris and sand, which is often carried without any covers, tend to add to the silt loading on these roads. This sector needs aggressive interventions to manage the freight and waste movement through city limits.

Waste management and garbage burning contribute to local air pollution – especially because most waste burning is decentralised close to the area of disposal – which means that residents are exposed to burning fumes of plastic, rubber, and soot. Considerable knowledge of best practices to improve the waste collection and management exists. The problem has been in adapting these practices to specific local conditions.

Six major power plants are located in the vicinity of Delhi (Figure 3, p 25) with a combined generation capacity of 2,700 MW (Kansal et al 2009). However, due to frequent cuts and blackouts, the electricity demand in the domestic, commercial, and industrial sectors is fuelling the need for in-situ diesel generator sets and related emissions. To compensate for electricity blackouts, in the areas such as Gurgaon, Noida, Faridabad and Ghaziabad, companies and real estate developers operate massive diesel generators capable of powering small towns. Large capacity generators in hotels, hospitals, malls, markets, large institutions, apartment complexes, cinemas, telecom towers, and farm houses are all sources of emissions and contributing to the growing PM_{10} ambient pollution levels. This is a sector which cannot be addressed by simply setting up new power plants in the region and requires a consented dialogue between power, petroleum, energy, and environment ministries.

Conclusions

Coming back to the issue raised by Waghmare – the state of air pollution in the city and the efficacy of the CNG conversion programme. As highlighted in Jayanthi Natarajan's response, pollution in the city is still extremely high compared to international, and our own ambient, standards. Data on pollution levels over the past years, as presented, shows that the situation has actually deteriorated. This has happened despite a fairly successful CNG conversion programme in the early 2000s. Part of the reason for this is because transport accounts for only a fifth of air pollution in the city.

From the CPCB (2010) study (and previously published studies like Gurjar et al 2004; Mohan et al 2007; Sahu et al 2011), we know the areas that need action. These include emissions from power plants and industrial units, waste burning, resuspension of road dust and dust from construction activities, etc. But at the end of the day, pollution is an externality (a public bad) that cannot be addressed without concerted action from the city and national authorities. This goes beyond just setting emission and ambient standards, monitoring emissions and pollution but also enforcing these for vehicles, industry, waste management and power plants.

Pollution in Delhi is a result of multiple sectors and focusing on one alone will not have an impact on the air we breathe. Instead we need to look at ways to address pollution across all sectors.

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