The urban environment and health: Delhi stands up to the challenge

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Global scenario

The World Health Organization (WHO) has chosen the theme of "Urbanization and Health" for World Health Day for the current year 2010. According to WHO, as of now, over three billion people live in cities. A recent report by the United Nations Population Division observed that half of the world's population now lives in urban areas, and it has been projected that within the next 30 years, nearly two thirds people will live in cities.[1] The urban areas of the less wealthy region of the world are likely to experience much of the growth in population (growth from 1.9 billion in 2000 to 3.9 billion in 2030), with the most rapid increase in numbers likely to occur in Asia and Africa. As an example, the number of urban dwellers in the least urbanized region, Asia (1.4 billion), is already greater than the urban population in North America and Europe combined (1.2 billion) in 2000.[2]

The growing mega cities attract migrants from impoverished areas and the resulting influx of poor migrants ends up in slums where the environmental conditions and the facilities are inadequate to maintain human health. A "slum" is defined by The United Nations Human Settlements Programme (UN-HABITAT) as one that includes "a wide range of low-income settlements and/or poor human living conditions."[3] If governments neglect the environmental and urban causes of the growing health burden on the urban poor, the nations and the global society will simply accumulate massive "health debt", which will be far more expensive to pay off.[4]

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Indian scenario

Between 1951 and 1991, the Indian urban population rose from 62.4 million in 1951 to 217.6 million in 1991. About two thirds of the urban population are concentrated in 317 Class I cities (population of over 100 000), half of which lives in 23 metropolitan areas with populations exceeding 1 million.

The rapid growth of population in India and the corresponding need for transportation and energy resulted in an unplanned urban growth adding to the problem of air pollution caused predominantly by vehicles, with significant contribution by industry and thermal power plants in some pockets. The impact of vehicular emissions on the general population is heightened by the emissions occurring at the ground level. According to the Central Pollution Control Board (CPCB), "vehicles contribute significantly to the total air pollution load in many urban areas". The number of motor vehicles increased from 0.3 million in 1951 to 37.2 million in 1997, with 32% concentrated in 23 metropolitan cities. Delhi with about 8% of the total registered vehicles, had more registered vehicles than those in the other three metros (Calcutta, Chennai and Mumbai).[5] the aforementioned trends forced policy-makers to clean up the air and take action to improve the public transportation system.

Investigators studied the relationship between levels of particulate matter and daily deaths in Delhi between 1991 and 1994. The average total suspended particulate (TSP) level in Delhi was 375 micrograms per cubic metre ($\mu g/m^3$) approximately, five times the annual average standard of WHO. The levels during the time period mentioned above exceeded WHO'S twenty-four-hour standard on 97% days on which readings were taken. The authors noted that "if one cares about life-years lost, the impacts of a 100-microgram increase in TSP in Delhi are more startling".[6]

Case study of Delhi with regard to its response to the urban transport challenge

Delhi was named as National Capital Territory (NCT) of Delhi on 1 February 1992 following the Sixty-ninth Amendment to the Constitution. According to the 2001 census, India's population stood at 1028.7 million. The economic survey conducted in 2005-2006 noted a rise in Delhi's population from 9.4 million in 1991 to 1.38 million in 2001. Table 1 gives the details of Delhi's population.

Table 1: *Population of Delhi — Economic Survey, 2005-2006*

S. N.	Total population	13 850 507
1.	Males	7 607 234
2.	Females	6 243 273
3.	Total rural population	944 727
4.	Rural males	522 087
5.	Rural females	422 640
6.	Urban population	12 905 780
7.	Urban males	7 085 147
8.	Urban females	5 820 633

Delhi also has the distinction of being the most urbanized union territory with a population density of 9340/sq km against the density of 43/sq km in the Andaman and Nicobar Islands, another Union Territory.[7] According to the Ministry of Health and Family Welfare, Government of India, there has been a steady growth in urban population due to people migrating from rural areas since 1961. It is clear that urban population has increased steadily with more than 500 million now living in urban India.

The NCT of Delhi not only has the highest density of population in India but also has the largest number of people living in an urban environment, as approximately 93.7% of the population live in the city. Such urban concentration with shortage of space creates overcrowding and forces many of the immigrants to live in cramped conditions in the slums. According to the Registrar General of Census, India, it was estimated that nearly 2 025 890 people live in slums, of which the males number 1 138 063, and females comprise 887 827.[7] However, the white paper prepared on Delhi estimated that nearly 30% of Delhi's population lived in squatter slums.[8]

The present urban scenario of Delhi has resulted from an allround increase in industrial units and vehicular traffic. There were nearly 8000 industrial units in Delhi in 1951 but by 1991 this figure went up to 125 000. The number of vehicles in the city increased rapidly from 235 000 in 1975 to 2 629 000 in 1996, and is expected to reach six million in 2011. Of the total air pollution load in the region, vehicular pollution is responsible for 67% — approximately 3000 metric tonnes (mt) per day. The next contributor is industry that causes 25% air pollution. The main culprits identified are the coal-based thermal power plants. The three power plants in the NCT of Delhi together generate 6000 mt of flyash per day. There are 16 big drains traversing the landscape of Delhi, which discharge 1900 million litres per day of municipal sewage and wastewater into the river Yamuna. The industrial effluent contributes 320 million litres per day. The

amount of solid waste generated in the city is about 5000 mt per day. In certain localities, the noise levels are attaining alarming levels. An action plan was prepared towards the end of last millennium by the Union Ministry of Environment and Forests, Government of India, after undertaking monitoring for various pollutants.[8]

Monitoring: The Central Pollution Control Board, the regulatory and the chief monitoring agency regularly measures air quality at various locations in Delhi. The measurements are made for sulfur dioxide, oxides of nitrogen and particulates. The ambient air quality data have revealed elevated values for suspended particulate matter (SPM) at all monitoring stations, namely 367-452 $\mu g/m^3$ on an annual average basis as against the prescribed standard of 140-360 $\mu g/m^3$. Though the annual mean value of sulfur dioxide (15-26 $\mu g/m^3$) and oxides of nitrogen (28-46 $\mu g/m^3$) remain within the prescribed limit of 60-80 $\mu g/m^3$, there is a rising trend. As compared with 1989, the sulfur dioxide atmospheric concentrations in 1996 registered a 109% elevation, and oxides of nitrogen an 82% elevation. The suspended particulate matter atmospheric concentration has shown only a nominal rise because of the installation of electrostatic precipitators by thermal power plants in Delhi.

According to a study of air pollution in Asian countries, the respirable particulate matter (RSPM) or PM_{10} is the main pollutant. However, in cities where the number of vehicles is increasing, there is greater concern over levels of nitrogen dioxide (NO_2) and ozone (O_3). Delhi recorded the highest levels of SPM and $PM_{10,}$ much higher than the levels found in Bangkok, Beijing or Manila. Even other Indian cities like Chennai, Kolkata and Mumbai had lower values of PM_{10}.[9]

Initiatives to improve urban air quality in Delhi

An important development took place in 1998 in Delhi. In order to address the issues of environment and health, an authority, notified as the "Environment Pollution (Prevention and Control) Authority for the National Capital Region," was constituted. It comprised eminent environmentalists and executives.[10]

The Authority was conferred with the necessary powers to protect and improve the quality of the environment, and to prevent, control and lessen environmental pollution. It was empowered to issue directions in respect of complaints relating to the violation of an order passed by any authority pertaining to:

- standards for maintaining the quality of the environment in its various aspects;
- standards for omission or discharge of environmental pollutants from various sources;
- restriction of areas in which any industries, operations or processes or class of industries or processes shall not be carried out or shall be carried out subject to certain safeguards;
- procedures and safeguards for the prevention of accidents that may cause environmental pollution and remedial measures for such accidents; and
- procedures and safeguards for the handling of hazardous substances.

The compressed natural gas experiment

On 5 April 2002, a three-judge Bench of the Supreme Court directed the Delhi government to comply with its orders on the conversion of diesel-run buses in the capital to the compressed natural gas (CNG) mode. The apex court on three earlier occasions had called upon the government to replace diesel with an alternative fuel through its orders passed on 21 October 1994, 28 March 1995 and 9 February 1996. The Bench ruled that its orders could not be nullified or altered by administrative decisions of the central and state governments. The court also directed the

Government of NCT Delhi to phase out diesel buses at the rate of 800 a month, starting 1 May 2002. The Central Government was also directed to give priority to the transport sector, including private vehicles, in Delhi and other highly air-polluted cities, and eventually in the entire country, for allocation of CNG. [11]

The Central Pollution Control Board (CPCB) is the regulatory and technical arm of the Union Ministry of Environment and Forests, Government of India, which through the State Pollution Control Boards (SPCBs), and State Pollution Control Committees keeps a watch on the state of pollution throughout the country. The Board conducted a comparative study to assess the environmental impact of CNG introduction, the results of which are presented in Table 2. Except for carbon monoxide and sulfur dioxide which showed a decline, other parameters such as SPM and PM_{10} have registered an increase. Table 3 shows how immediately after the introduction of CNG in 2001, the parameters declined but started rising again.

Table 2: *Ambient air quality of Delhi — Comparison of pre-CNG introduction (2000) levels with those in 2008**

Parameter	Prescribed annual standard (residential)	2000	2008*	Percentage increase/ decrease
No. of Vehicles (Approx. in hundred thousands)		35	55	57
Sulphur dioxide	60	18	5	(-72)
Nitrogen dioxide	60	36	48	33
SPM	140	405	413	2
RSPM	60	159	192	21
Carbon monoxide	2000	4686	2348	(-50)

Source: Central Pollution Control Board (CPCB), Delhi
All values are in $\mu g/m^3$
* Data of November and December have been taken from the year 2007 for averaging the values for 2008
Observations:
Increase in number of vehicles (57%); nitrogen dioxide (33%); SPM (2%) and RSPM (21%)
Decrease in sulphur dioxide (72%) and carbon monoxide (50%)

Table 3: *Levels of pollutants in Delhi (2000-2003)*

Parameter	2000	2001	2002	2003
Sulfur dioxide	18	14	12	19
Nitrogen dioxide	36	34	39	45
SPM	405	348	424	352
RSPM	159	137	166	148
Carbon monoxide*	4686	4183	3258	3831

Source: CPCB
All values are in $\mu g/m^3$

Figure 1 shows the rise in the number of vehicles from 3 500 000 in 2000 to 5 500 000 in 2008; this led to a rise in levels of some of the pollutants in urban air.

Figure 1: ***Increase in the population of vehicles in Delhi since 2000***

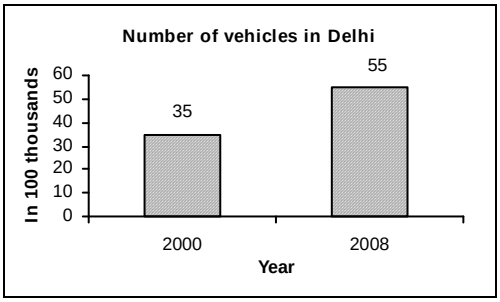
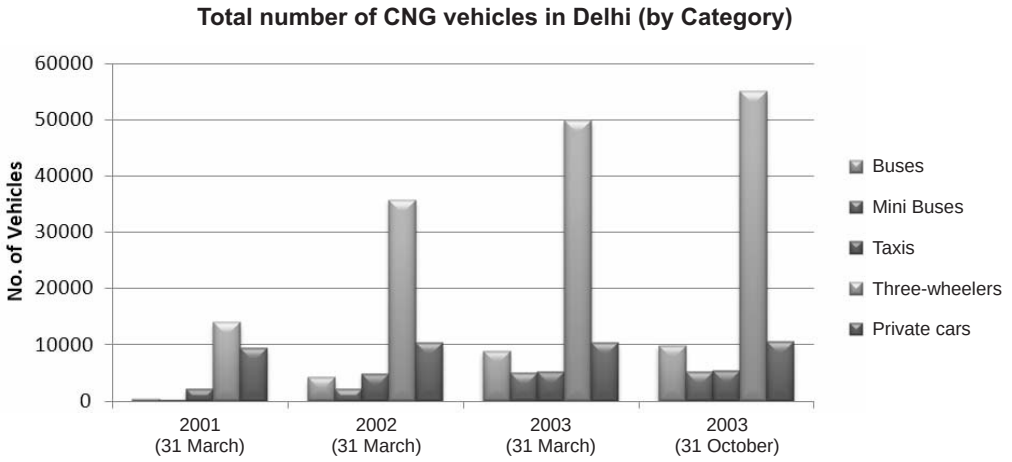


Figure 2 shows the growth of CNG-driven vehicles in NCT of Delhi. The number of CNG-based vehicles in all categories has been rising over the years, starting from 2001.

An elaborate study undertaken in Delhi found that the concentration of carbon monoxide, sulphur dioxide and PAHs recorded a significant decrease after the introduction of CNG as an alternative to diesel or petrol-fuelled vehicles, but an increase in NOx

Figure 2: ***Total number of vehicles in Delhi (by category) (2001-2003)***



concentration was noticed. However, concentrations of BTX (benzene, toluene, and xylene), SPM, and PM_{10} showed no significant changes. Nonetheless, a fall in BTX concentration was noticed due to reduction in the benzene content in petrol. Furthermore, the SPM and PM_{10} concentrations in Delhi seem to be related not only with vehicular emissions, but also with other anthropogenic and natural emission sources.[12]

Major initiatives taken to reduce air pollution in Delhi

- Unleaded petrol introduced in the National Capital Region in September 1998.
- Sulfur content in diesel reduced from 0.5% (April 1996) to 0.05% (April 2000).
- Catalytic converters introduced in passenger cars in April 1995.
- Gasoline in benzene reduced from 5% (April 1996) to 1% (November 2000).
- Restrictions imposed on operation of goods vehicles during daytime from August 1999.
- Diversion of interstate buses.
- Time clocks installed at red lights.
- Construction of fly over and sub ways for smooth flow of traffic.
- Metro rail for mass rapid transport introduced.
- Introduction of pre mixed 2T oil for two stroke engine from April, 1999.
- Introduction of CNG for commercial transport vehicles (buses, taxis, auto rickshaws etc.)
- Ethanol blended (5% petrol) introduced.
- More than 15 year old commercial vehicles phased out from 1998.
- 'Pollution Under Control' certificate with three month validity introduced
- Fuel quality standard (Bharat Stage – I, II, III and IV) introduced.

Overhaul of Delhi's urban transport system, and the Delhi Metro Rail Corporation (DMRC) Project

The Department of Transport under the Government of National Capital Territory of Delhi in 2002 prepared a plan to tackle the problems of urban transport brought about by

rising concentrations of pollutants, shrinking road space, and rising number of fatal road accidents, all of which created a public health crisis. The projection that by 2021 the population of Delhi will zoom to 27.9 million from the existing 13.8 million, added to the urgency.[13]

It was proposed that a mass transport system including a metro, commuter rail and buses be developed. Considering this, the 245 km of a metro system network to meet the demand of a rapidly-urbanizing city, 2021 was chosen as the target year. Though Phase I of this network got completed in 2005, major construction work on different routes connecting Delhi to neighbouring towns is still on to create, at the end of the day, an Integrated Rail and Bus Transit (IRBT) system. The downside of the ambitious metro rail project has been a spate of accidents at various construction sites. According to the Government of India, the two major projects under way in Delhi at present are those of DMRC, and construction of the forthcoming Commonwealth Games (CWG) sites. Construction workers employed at the DMRC and CWG sites total 120 364 and 11 089 respectively.[14]

Conclusion

The introduction of CNG was the result of a judicial directive to address air pollution in Delhi. The early results of the switch to CNG were encouraging and people could feel the improvement in air quality. However, the levels of RSPM went up and stood at 150 $\mu g/m^3$ (averaged) in 2008 – a 40% increase over the previous decade. A major contributor to this rise has been the new vehicles on the road. In 2005-2006, the number of vehicles that were registered daily was about 1000, up from 580 daily in 2000-2001. The total number of vehicles increased from 3.6 million in 2001 to 4.8 million in 2006. The growing traffic also led to an increase in the suspension of roaddust in the atmosphere; this has become a critical source.[15] Another case study shows that Delhi's population is likely to double by 2020. The number of vehicles is also likely to go up by 3.7 times over the same period. The case study also projects that travel demand in Delhi would increase from 73 billion passenger kilometres in 1997 to 253 billion passenger kilometres in 2020.[16]

The NCT of Delhi is an example where judicial activism, combined with political will and inputs provided by nongovernmental organizations and international agencies saved the city from near disaster on account of its explosive urban growth, compounded by inadequate and poorly implemented regulations. The use of CNG to reduce air pollution appears to have been a transient success, as the increase in number of vehicles are neutralizing the gains achieved through CNG. Therefore, a new and innovative strategy focused on promoting mass transportation with less dependence on fossil fuels can offer a better solution. However, the issue of air quality will continue to present a challenge to city planners.

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