

## Urban air pollution

India is facing a serious double burden of disease. Most of the old infectious diseases like malaria, filariasis and kala-azar have not yet disappeared; indeed they are bouncing back. At the same time, other chronic non-communicable diseases such as cancer, cardiovascular disease and respiratory disorders are becoming more dominant.

It is becoming clear that the pattern of economic growth that we are adopting is becoming increasingly associated with environmental pollution. A study comparing the rates of economic growth and the rates of growth of vehicular pollution and industrial pollution shows that during 1975–1995, the Indian economy grew by 2.5 times, but the industrial pollution load grew by 3.47 times and the vehicle pollution load by 7.5 times<sup>1</sup>. Indeed, Indian cities are being exposed to high levels of air pollution and people living in these cities are paying a price for the deterioration in air quality. The World Bank has estimated that Indians are spending Rs 4550 crores every year on treatment of diseases caused by ambient air pollution<sup>2</sup>.

Air quality in Delhi is deteriorating. Levels of primary pollutants – suspended particulate matter (SPM), nitrogen oxide and sulphur dioxide – have gone up significantly in the last decade<sup>3</sup>. The consistently high levels of total SPM are worrying. Limited data available from the Central Pollution Control Board (CPCB) indicate that the levels of small particles less than 10 micron (PM10) are very high. This size of particulates is known to cause severe damage to the lungs. In fact, the World Health Organisation (WHO) reports that there is no safe level for particulate matter emissions<sup>4</sup>. International studies have confirmed association between elevated levels of particulate air pollution and decline in lung function or increase in respiratory symptoms such as cough, shortness of breath, wheezing and asthma attacks. Studies have also found associations between particulate air pollution and rates of hospitalization, chronic obstructive pulmonary disease and restricted activity due to illness<sup>5</sup>. A World Bank study on the health effects of air pollution in Delhi revealed that SPM in Delhi alone led to premature death of 7491 persons<sup>2</sup> in 1991–1992. The study

repeated for the year 1995 shows an increase to about 10,000 in just three years, which means a death rate of one person per hour due to air pollution<sup>6</sup>.

It is not known on what scientific database such as epidemiological studies, morbidity and mortality patterns that air quality standards published for India are arrived at. Given the knowledge of the harmful effects of particulate pollution and the high concentration of particulate matter in Delhi's air, we need to generate regular information on the ambient concentration levels of small particulates of diameter less than 10 micron and/or 2.5 micron and take urgent steps to control emissions of these particles.

It is well known that the combustion of diesel generates small particulate matter, nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>) and polycyclic aromatic hydrocarbons (PAH). Dieselization of private vehicles is accelerating in Delhi. The relatively low prices of diesel are promoting its use further, which is a factor that encourages automobile manufacturers to introduce diesel versions of their vehicles. This development is bound to worsen the air quality in Delhi, bringing in its wake a number of related health problems.

The new scientific information emerging from international studies indicates that the cancer-causing potential of diesel exhaust is very high. The Scientific Review Panel of the California Air Resources Board points out, based on human epidemiological data, that a chronic exposure to 1 µg/cum of diesel exhaust will lead to 300 additional cases of lung cancer per million people<sup>7</sup>. On this basis, for a population of ten million people in Delhi, this means 3000 extra cases of lung cancer for a chronic exposure to 1 µg/cum of diesel exhaust. A WHO study done on rats shows that chronic exposure to 1 µg/cum of diesel exhaust can lead to 16–71 additional cases of lung cancer per million exposed rats<sup>4</sup>. Recently, Japanese researchers have discovered a compound, 3-nitro-benzanthrone, in the exhaust fumes of diesel engines that may be the most carcinogenic compound ever analysed<sup>8</sup>.

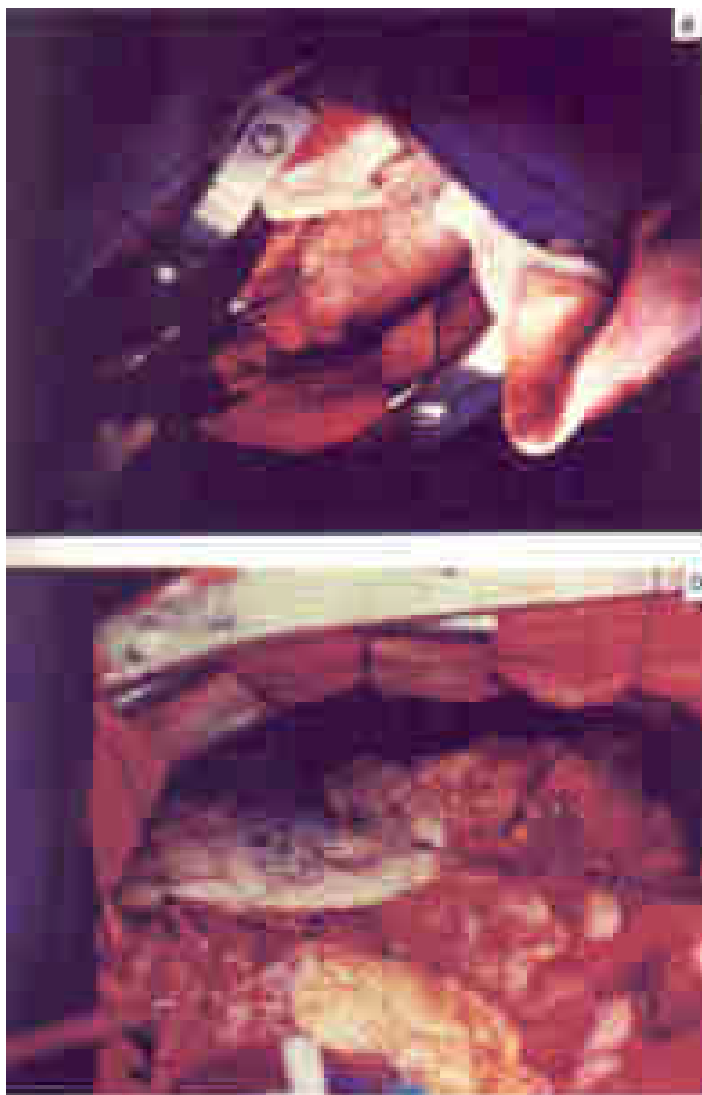
Many studies have established that diesel exhaust causes mutations in chromosomes and damage to DNA,

triggering cancer. Diesel exhaust, rich in polycyclic aromatic hydrocarbons (PAH) and particulate matter, causes 10 times more mutation than leaded petrol, which in turn is 10 times more mutagenic than unleaded petrol, according to Swedish tests<sup>9</sup>. A 1993 US study that covered six cities found a significant association between air pollution and mortality due to lung cancer and cardiovascular disease. The study found that the probability of death increased significantly with an increase in exposure to fine particulates (PM10 and PM2.5) and sulfate particles than with an increase in total particulate pollution, aerosol acidity, sulphur dioxide or nitrogen dioxide. Specifically, the study found that when people were exposed to average PM10 levels of 47 µg/cum they suffered a mortality rate as much as 48 per cent higher than those exposed to lower levels. Similar death rates were associated with sulfate particles, average levels of which went up to 13 µg/cum in the cities<sup>5</sup>.

The results of the above studies are of concern even in the Indian context, as diesel exhaust accounts for a significant proportion of small particles including sulfates in the air. In fact, the first survey of PM10 in Delhi shows that they reach extremely high levels – as much as 500 µg/cum or 5 times higher than the standard prescribed by the CPCB<sup>10,11</sup>.

Diesel also produces NO<sub>x</sub> that is easily absorbed in the blood and then reduces the oxygen-carrying capacity of the blood. It makes the lung tissues brittle and leathery and can cause lung cancer and emphysema (severe breathing problems)<sup>12</sup>. At the ITO Crossing, NO<sub>2</sub> is above the standards in one out of every five days<sup>13</sup>. Even more disturbing is the fact that NO<sub>x</sub> from diesel once out in the air forms ozone, yet another harmful gas.

Ozone causes inflammation of the airways (bronchus and bronchioles), that leads to respiratory problems. Ozone may pose its worst health threat to those who already suffer from respiratory diseases, such as asthma, emphysema and chronic bronchitis<sup>14,15</sup>. Ozone levels in Delhi are disturbing. A 1993 study by the Central Road Research Institute, New Delhi showed that average ozone levels were 10–40 per cent above WHO standards<sup>16</sup>.



**Figure 1.** **a**, The clean lungs of a patient from Himachal Pradesh. **b**, The dirty lungs of a patient from Delhi. The black spots show deposition of carbon almost like a miner's lung. It is as if people of Delhi are living in a mine. It shows that the person has been regularly inhaling polluted air with a lot of carbon particles which can come from burning of coal or from vehicular exhaust. In Delhi, diesel vehicles put out a lot of carbon soot and diesel use is nearly three times that of petrol. Damage to lungs, however, comes not so much from the carbon as much as it comes from exposure to sulphur dioxide, nitrogen oxides and fine particles (less than 2.5 microns) which are present in diesel exhaust in a big way. If carbon from diesel exhaust is getting into the lungs as shown in this picture, then so are the deadly elements of diesel and petrol exhaust.

Diesel also produces carbon monoxide, which causes severe heart problems. A US study estimated that 6 per cent of the congestive heart failures and hospitalizations in the cities were related to an

increase in carbon monoxide in ambient air<sup>17</sup>. Carbon monoxide aggravates heart diseases by binding to the haemoglobin, thereby decreasing oxygen transport to the tissues.

There is an urgent need for comprehensive epidemiological studies to show how ambient air pollution is affecting people's health and quantify this information in order to provide policy tools for air quality planning. For instance, no nationwide survey on asthma sufferers has been conducted so far even though the cumulative prevalence rate of asthma in a place such as Delhi is estimated to be 1 to 2 children out of 10 (ref. 18). According to one study, 65 per cent of the people in Delhi are estimated to suffer from morning cough and phlegm and other respiratory symptoms<sup>19</sup>.

In other countries, governments have set up national level institutional mechanisms for medical research and monitoring in the area of air pollution with a view to influence policies. Medical associations have addressed the health issues related to air pollution and have pressurized governments to take corrective action. Most notable is the recent statement from the Australian Medical Association condemning the new reform package in Australia promoting the use of diesel by slashing taxes on diesel<sup>20</sup>.

As a first step, we urge the government to stop the increase in levels of particles in the air by controlling the dieselization of the private vehicle fleet. Diesel commercial vehicles are already responsible for a significant portion of the tiny particles in Delhi's air. While it is important to conduct epidemiological studies to establish and enforce preventive policies in air pollution, there is already sufficient information available from international studies for us to start taking preventive action. Preventive action is critical for good public health management. Commercial profit and public good have to become mutually compatible and reinforcing.

1. Kumar, P. and Bhattacharya, S., *Down to Earth*, 1999, **7**, 32–40.
2. Brandon, C. and Homman, K., *The Cost of Inaction: Valuing the Economy-wide Cost of Environmental Degradation in India*, The World Bank, 1992, *mimeo*.
3. *National Ambient Air Quality Statistics of India 1995*, Central Pollution Control Board, 1997.
4. *Air Quality Management: Air Quality Guidelines*, WHO, Geneva, 1999.
5. Dockery, D. W. *et al.*, *New Engl. J. Med.*, 1993, **329**, 1753–1759.
6. Kumar, P. *et al.*, *Down to Earth*, 1998, **6**, 29–43.
7. Findings of the Scientific Review Panel

- on the Report on Diesel Exhaust as adopted at the Panel's 22 April 1998 Meeting, California Air Resources Board, 1998, *mimeo*.
8. Enya, Takeji *et al.*, *Environ. Sci. Technol.*, 1997, **31**, 2772–2776.
  9. Jones, R. R., *Br. Med. J.*, 1996, **312**, 1605–1606.
  10. Unpublished data on PM10 levels in Delhi, Central Pollution Control Board, 1998.
  11. Shah, J. and Nagpal, T. (eds), *Urban Air Quality Management Strategy in Asia (URBAIR)*, The World Bank, 1996.
  12. Raju, B. S. N., *Fundamentals of Air Pollution*, Oxford and IBH, New Delhi, 1997.
  13. Unpublished data on NO<sub>2</sub> levels in Delhi, Central Pollution Control Board, 1998.
  14. Schwartz, J., *Environ. Res.*, 1989, **50**, 309–321.
  15. *Air Quality Guidelines for Europe*, WHO Regional Publications, Copenhagen, Europe series, 1987, vol. 23, pp. 45–58.
  16. Singh, A. *et al.*, *Atmos. Environ.*, 1997, **31**, 3421–3427.
  17. Nadis, S., *Environ. Health Perspect.*, 1996, **104**, 138–139.
  18. Sharma, A. and Roychowdhury, A., *Slow Murder, The Deadly Story of Vehicular Pollution in India*, Centre for Science and Environment, New Delhi, 1996.
  19. Akbar, S. and Ashmore, M. R., Paper presented at the National Conference on Health and Environment organized by the Centre for Science and Environment, New Delhi, 1998, *mimeo*.
  20. Reynolds, A. *et al.*, Summary of an Australian Conservation Foundation Discussion Paper, 1999, *mimeo*.
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