Toxic air and our health

Anumita Roychowdhury
Vivek Chattopadhyaya
Adarsha Kapoor
Ruchita Bansal

-- Centre for Science and Environment

Our City, We Care:
Action for Cleaner Air

A joint initiative of Artemis Hospital and Centre for Science and Environment

Gurgaon, December 23, 2014
City enveloped in smog, back to pre-CNG

Gains Of Switch
To Cleaner Fuel
Frittered Away

CITY AIR WORSE THAN EVER

New Delhi: Delhi’s air pollution has reached alarming levels. For proof, just look out of the window. The grey-white haze that has been covering the city since October 24, as experts, actually smog that is linked to the rapid rise in high pollution, p6

Delhi winter

Nov 22, 2012

During the first week of November, Delhi went under a thick blanket of smog. The breeze nearly stopped, and the skies turned grey and dank. Cool and calm weather led to fumes settling close to the ground. People held masks, scarves or handkerchiefs to their faces.

The resultant outcry in the smog-hit city had officials stubbornly insisting that this was nothing new and that it happened every winter

The new twist came as the Capital Administration said there is an economic reason for the bellowing of smoke.

Smog leaves Delhi gasping for breath

TNM | Nov 3, 2012, 01.33 AM IST

Disadvantage Delhi: Smog here to stay

Darpan Singh, Hindustan Times

New Delhi, November 08, 2012

Smog delays Sheila Dikshit’s flight to Puniab

The Centre for Science and Environment (CSE), in its latest report, has delivered the smog is here to stay. It has also warned that Delhi is in the grip of a multi-pollution as the antidote seems impossible.
Lesson from Delhi .....  
Soft options are now all exhausted

Delhi has fought hard to get breathing space
On vehicles
  - Introduced low sulphur fuels and petrol with 1 per cent benzene
  - Mandated pre-mix petrol to two- and three-wheelers
  - Moved from Euro I to Euro IV over the last decade
  - Implemented largest ever CNG based public transport programme
  - Capped the number of three-wheelers
  - Phased out 15 year old commercial vehicles
  - Strengthened vehicle inspection programme (PUC)
  - Efforts made to divert transit traffic
  - Set up independent fuel testing laboratories to check fuel adulteration
On industry
  - Relocated polluting units
  - Tighter controls on power plants. No new power plants.
Air quality monitoring
  - Adopted new ambient air quality standards
  - Expanded air quality monitoring and reporting
Other sources
  - Emissions standards for generator sets
  - Ban on open burning of biomass
Delhi losing the pollution battle

Particulate pollution decline and rise again due to rapid increase in vehicle numbers

Source: Based on air quality data of Department of Environment, Delhi and motor vehicle registration data in Delhi Statistical Handbooks of different years
PM10 trend in Delhi 2000-2012

Rising after initial stabilisation

Source: Based on CPCB air quality data
PM2.5 trend in Delhi

Tiny particles rising steadily

Source: Based on CPCB air quality data
Nitrogen oxide: Emerging problem

Nitrogen dioxide trend in Delhi

Source: Delhi Dept. of Environment
Ozone: New threat

Ozone levels: Delhi summer of 2014

Source: Delhi Pollution Control Committee
Delhi has curbed and decoupled SO2 and CO trend from vehicle growth

SO2 levels in Delhi

Carbon monoxide trend in Delhi

Source: Delhi Pollution Control Committee and Department of Environment
Toxics: Dangerous at trace level
Benzenes and PAH: Carcinogens

High benzene levels in Delhi

Levels in IGI and Civil Lines exceed the annual standard by up to 2 to 5 times.

Another toxic: PAH trends in Delhi

JNU study (Khilare *et al* 2011): PAH level had initially declined in Delhi after first generation action. Levels rising again. Cause attributed to vehicular growth especially diesel vehicles.
Winter pollution is back with vengeance……….  

CSE has tracked winter pollution this year:

Almost throughout the months of November and December 2014, the levels of PM2.5, 

-- have remained on an average at least 3-4 times the 24-hourly standard of 60 microgramme per cubic metre,

-- higher averages reaching upto 4 to 7 times the standards and

-- smog episode peaks hit 8 to 10 times the standards.
What about Gurgaon?

.... Not enough information
Gurgaon: PM10 trend this winter

PM10 levels have exceeded the air quality standard on 28 days in the month --- 16 days were critically polluted days, and 12 were High pollution days.

First fortnight of December the PM10 levels exceeded on 10 days. One day was Critical, and 9 days were high.  

Source: Based on air quality data of HSPCB http://hspcb.gov.in/GG.pdf
India has adopted Air quality Index to inform people about daily air quality: Can we implement this Gurgaon?

**National Air Quality Index and Health advisory**
Proposed Breakpoints for AQI Scale 0-500 (units: μg/m3 unless mentioned otherwise)

<table>
<thead>
<tr>
<th>AQI Category (Range)</th>
<th>PM$_{10}$ 24-hr</th>
<th>PM$_{2.5}$ 24-hr</th>
<th>NO$_2$ 24-hr</th>
<th>O$_3$ 8-hr</th>
<th>CO 8-hr (mg/m$^3$)</th>
<th>SO$_2$ 24-hr</th>
<th>NH$_3$ 24-hr</th>
<th>Pb 24-hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good (0-50)</td>
<td>0-50</td>
<td>0-30</td>
<td>0-40</td>
<td>0-50</td>
<td>0-1.0</td>
<td>0-40</td>
<td>0-200</td>
<td>0-0.5</td>
</tr>
<tr>
<td>Satisfactory (51-100)</td>
<td>51-100</td>
<td>31-60</td>
<td>41-80</td>
<td>51-100</td>
<td>1.1-2.0</td>
<td>41-80</td>
<td>201-400</td>
<td>0.5-1.0</td>
</tr>
<tr>
<td>Moderately polluted (101-200)</td>
<td>101-250</td>
<td>61-90</td>
<td>81-180</td>
<td>101-168</td>
<td>2.1-10</td>
<td>81-380</td>
<td>401-800</td>
<td>1.1-2.0</td>
</tr>
<tr>
<td>Poor (201-300)</td>
<td>251-350</td>
<td>91-120</td>
<td>181-280</td>
<td>169-208</td>
<td>10-17</td>
<td>381-800</td>
<td>801-1200</td>
<td>2.1-3.0</td>
</tr>
<tr>
<td>Very poor (301-400)</td>
<td>351-430</td>
<td>121-250</td>
<td>281-400</td>
<td>209-748*</td>
<td>17-34</td>
<td>801-1600</td>
<td>1200-1800</td>
<td>3.1-3.5</td>
</tr>
<tr>
<td>Severe (401-500)</td>
<td>430+</td>
<td>250+</td>
<td>400+</td>
<td>748+*</td>
<td>34+</td>
<td>1600+</td>
<td>1800+</td>
<td>3.5+</td>
</tr>
</tbody>
</table>
### Health Statements for AQI Categories

<table>
<thead>
<tr>
<th>AQI</th>
<th>Associated Health Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good (0–50)</td>
<td>Minimal Impact</td>
</tr>
<tr>
<td>Satisfactory (51–100)</td>
<td>May cause minor breathing discomfort to sensitive people</td>
</tr>
<tr>
<td>Moderately polluted (101–200)</td>
<td>May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults</td>
</tr>
<tr>
<td>Poor (201–300)</td>
<td>May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease</td>
</tr>
<tr>
<td>Very Poor (301–400)</td>
<td>May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases</td>
</tr>
<tr>
<td>Severe (401–500)</td>
<td>May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity</td>
</tr>
</tbody>
</table>

Source: National Air Quality Index, CPCB, page 27
Aerial raids

Stop farm fires in the NCR
Make paddy straw burning an offence in the region.
Need stringent enforcement under the Air Act 1980 to ban farm fires.
This needs be enabled with incentive and subsidy for innovative farming methods
Promote alternative uses of paddy straw for power generation.

EPCA coordinating with the concerned state governments
CSE monitors how much pollution we breathe daily …
What has CSE done?

• CSE used a state of the art portable air quality monitoring equipment to track how much pollution an individual is exposed to in Gurgaon while doing their daily chores. This dust track aerosol monitor measures both mass and size fraction of the particulate matter.

• One day (24 hours) realtime monitoring was carried out on December 18-20, 2014.

• Their 24 hours average exposure was compared with the 24 hour standards and short term exposures with background ambient levels monitored by the State Pollution Control Committee.
How much pollution we breathe in Gurgaon: CSE exposure monitoring

![Graph showing individual exposure vs safe standard for PM 2.5 and PM 10 particles over a 24-hour average. The graph indicates that individual exposure exceeds the safe standard for both PM 2.5 and PM 10.](image-url)
Deadly exposure

High exposure during night: Pollution levels are usually expected to be low during nights and early mornings. But cool and calm nights worsen the inversion effect, coupled with high pollution from truck traffic entering the city. Night time pollution inside the home close to Sohna Road remained elevated at 850 microgramme per cubic metre.

Early morning inversion condition worsens pollution impacts. This is the time when children go to school and people do their daily walk for fitness. During morning hours the hourly levels near Artemis, Hospital, and mid morning near Amity International School the levels were more than 738 microgramme per cubic metre.

High levels in busy market areas and public transport nodes with high footfalls: The levels near Civil Hospital (Sadar Bazaar, old Gurgaon) was 580 microgramme per cubic metre around noon. In Udyog Vihar the levels in the afternoon was 550 microgramme per cubic metre. Late afternoon near MGF Mall on MG Road was 675 microgramme per cubic metre. Green and clean part of Gurgaon showed exceptionally high values for particulate matter.
A day in life of Gurgaon resident

(December 18-20 2014)

PM2.5 in microgramme per cubic metre

<table>
<thead>
<tr>
<th>Location</th>
<th>Date/Time</th>
<th>PM2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sohna Road</td>
<td>20-12-14; 18.00-19.21</td>
<td>398</td>
</tr>
<tr>
<td>Udyog Vihar</td>
<td>20-12-14; 16.30-17.30</td>
<td>187</td>
</tr>
<tr>
<td>Arjun Market</td>
<td>20-12-14; 15.00-16.00</td>
<td>210</td>
</tr>
<tr>
<td>MG Road</td>
<td>13.00-14.00</td>
<td>252</td>
</tr>
<tr>
<td>Udyog Vihar</td>
<td>10.30-12.30</td>
<td>298</td>
</tr>
<tr>
<td>MGF Mall</td>
<td>19-12-14; 3.56PM-4.50PM</td>
<td>675</td>
</tr>
<tr>
<td>Sohna Road Gurgaon</td>
<td>19-12-14; 12.52PM-2.26PM</td>
<td>550</td>
</tr>
<tr>
<td>Civil Hospital</td>
<td>19-12-14; 11.20AM-12.27PM</td>
<td>580</td>
</tr>
<tr>
<td>Amity International School</td>
<td>19-12-14; 10.10AM-10.56AM</td>
<td>738</td>
</tr>
<tr>
<td>Artemis Hospital</td>
<td>19-12-14; 8.59AM-10.07AM</td>
<td>761</td>
</tr>
<tr>
<td>Sohan Road</td>
<td>18-12-14; 10.27PM-7.51AM</td>
<td>850</td>
</tr>
<tr>
<td>Gurgaon Cyber City</td>
<td>18-12-14; 8.36-10.00PM</td>
<td>1094</td>
</tr>
<tr>
<td>DLF City Phase II Gurgaon</td>
<td>18-12-14; 7.30PM-8.30PM</td>
<td>996</td>
</tr>
</tbody>
</table>
Living and breathing in Gurgaon .............

• Adity Batra, professional)
Bhure Lal, resident of Lodi Estate:


The hourly average PM2.5 level was highest between 5.50 am and 6.50 am at **1195.83 microgramme per cum** when he had gone for walk in Lodhi Garden. That was 2.7 times higher than the background ambient level.

Day 2: Monitoring was repeated on December 8-9:
Showed comparatively lower levels. But still very high.

During **5am to 6am and 6am to 7 am** the hourly average PM2.5 levels were **672 microgramme per cum and 762 microgramme per cum** respectively – **more than two times higher** than the background ambient levels.

This is the place where rich and the powerful of Delhi come for walk.
Bhure Lal: EPCA Chairperson

Date: Dai 1: November 12-13. His peak hourly exposure level was 1196µg/m³ between 5.50-6.50 when he goes for his morning walk to Lodhi Garden. His 24-hour average exposure to PM2.5 was almost 12 times higher than the safe standard and almost two times higher than PM2.5 measured at Mandir Marg.
The human story….

Our health is at stake…yet risk perception is very poor…….
620,000 premature deaths a year in India.
More than 18 million healthy life years lost due to air pollution.

GBD: High impacts in India.......

India-specific disease burden attributable to 20 leading risk factors:

- Household air pollution from solid fuels
- Tobacco smoking, including second-hand smoke
- High blood pressure
- Childhood underweight
- Diet low in fruits
- Alcohol use
- Ambient particulate matter pollution
- High fasting plasma glucose
- Iron deficiency
- Physical inactivity and low physical activity
- Occupational risk factors for injuries
- Suboptimal breastfeeding
- Diet low in nuts and seeds
- Diet high in sodium
- Diet low in whole grains
- Diet low in vegetables
- Diet low in seafood omega-3 fatty acids
- High body mass index
- High total cholesterol
- Intimate partner violence

Ambient PM$_{2.5}$ caused an estimated 17.7 million healthy years of life lost in India in 2010.
Deaths Attributable to Ambient Particulate Matter Pollution in India in 2010

- Cerebrovascular disease: 159,912
- Chronic obstructive pulmonary disease: 108,694
- Ischemic heart disease: 30,536
- Lower respiratory infections: 12,736
- Trachea, bronchus, and lung cancers: 407,17

The numbers........
Enough clinching evidences from global studies.............

This scale of study not done in India yet......

Eg-- the Arden Pope study (Journal of American Medical Association 2002) based on American Cancer Society data .....16 years, about 500,000 people in 116 metropolitan areas is what it took the researchers to arrive at irrefutable findings.

......... a mere increase of 10 microgramme per cum of PM2.5 can increase the risk of lung cancer by 8 per cent, cardiopulmonary deaths by 6 per cent, all deaths by 4 percent.

But these findings are equally valid for India ....
Amazing ... with time the numbers have galloped
Most studies done by doctors themselves……..
Studies have responded to the emerging concerns in air quality...

-- Early years: Primary focus on SPM, SO2, and little on NOX – nearly 60%

-- Subsequent years: A wider pollutant basket:

Source: CSE
Studies looking at a more diverse health end points....

Predictably respiratory health symptoms dominate....
Broadens to other health end points – cardiovascular, eye disorders, cellular changes, cancer, premature deaths....

Source: CSE
Mounting evidences
Delhi....

Delhi has generated evidences quite consistently and with regularity over the last decade......

- **1999**: Effect of air pollution on respiratory system of auto rickshaw drivers (*IJOEM 1999*)
- **2000**: Prevalence of chronic respiratory symptoms (*VPCI 2000*)

**2002**: Air pollution and emergency room visits – Emergency room visits for asthma, COAD, and acute coronary events increased by 21.3 per cent, 24.9 per cent, and 24.3 per cent respectively (J N Pande et al, 2002)

- **2002**: Cytogenetic investigations on peripheral blood lymphocytes: The vehicular fumes found to be genotoxic (*Int J Hum Genet 2002*)

**2002**: Children living in areas of high atmospheric pollution are at risk of developing vitamin D deficiency rickets (K S Agarwal 2002)

**2003**: Significantly high incidence of eye symptoms and disorders in areas with high pollution levels...(R Saxena et al 2003)

**2003**: Traffic policemen and benzene exposure -- in Delhi, Dehardun, Haridwar, Saharanpur, Muzaffarnagar and Meerut monitored for benzene exposure. Urinary phenol was very high in Delhi and Meerut policemen (*Industrial Health 2003, 41*)

- **2003**: Traffic controllers face the risk of exposure to benzene present in the ambient air as a component of fuel exhaust. (Y Verma et al 2003)

- -- Housewives and female workers being the most exposed groups. (R K Prasad et al 2003)

**2006**: Winter months have greater exposure risk (R Agarwal et al 2006)

- **2007**: People traveling in highly polluted areas and exposed to high level of air pollutants ...suffer from significantly high subclinical ocular surface disorders (*IJOEM2007*)

- **2007**: Symptoms such as redness, watering, irritation, strain, blurring and (S K Gupta 2007).

- Gaseous pollutants in spite of being lower than the standards, had significant impact on human health, especially during winter (G J Nidhi 2007)

**2008**: The air pollution levels of ozone, NO2 and RSPM increase respiratory disease related hospital visits by 24%, 13% and 3%, respectively. (G J Nidhi 2008)
Delhi’s mounting evidences ...

2010

-- 33% of Delhites have one or more respiratory symptoms; lung function impaired in 40% of residents. (CNCI/CPCB)

-- Lung Function compromised in 43.5% of school children of the urban area compared to 25.7% of the control group. respiratory symptoms were more prevalent in girls than in boys. (S Siddique et al 2010)

-- Air pollution linked with ADHD: was found in 11.0% of urban children in contrast to 2.7% of the control group. Major risk factors included lower socioeconomic status, and PM(10) level. ADHD was more prevalent among boys both in urban and rural areas. (Siddique S et al 2010)

2011:

-- Increase in respiratory ailments and hospital admissions due to PM, ozone and NO2 pollution. Effects strongest among those individuals who spend a disproportionate share of their time out-of-doors. (Atmospheric Environment 2011). Vallabhbhai Patel Chest Institute found high respiratory symptoms in high pollution areas. Now studying the ozone link.

International agencies

1997 – World Bank -- More deaths occur at younger ages in Delhi and because the impact of air pollution is greater at younger ages in Delhi than in Philadelphia (M L Cropper et al 1997)

2011: Health Effect Institute study in Delhi: approx. 0.15% to 0.17% increase in mortality per 10 μg/m3 PM10 (~0.3%/ 20 μg/m3). In Delhi where overall deaths are 100,000 annually even this increase can translate into 3000 additional premature deaths annually due to air pollution related diseases….. (HEI 2010)
2000: Marked rise in respiratory symptoms (43% in urban as compared to 14% of rural children) …(T Lahiri et al 2000)

2001: Urban group had seven times more alveolar macrophages in their sputum than controls (Senjuti Roy et al 2001)

2003: Pulmonary function abnormalities associated with exposure to automobile exhaust assessed in drivers and conductors…. (B P Chattopadhyay et al 2003)


2005: -- Respiratory health status of the roadside school children at Kolkata: Symptomatic changes like breathlessness, cough and other problems….. (B P Chattopadhyay et al 2005)

2006: -- Studies on commuter’s exposure to BTEX in passenger cars in Kolkata….. (Som D et al 2006)

2007: -- Exposure to vehicular pollution and assessment of respiratory function in urban inhabitants -- traffic load in the vicinity and higher respiratory functional deterioration……….. (B P Chattopadhyay et al 2007)

-- Occupational benzene exposure from vehicular sources and its effect on hematology, lymphocyte subsets ..... (M R Ray et al 2007)

2008 -- Source apportionment of VOCs at petrol pumps in Kolkata: exposure of workers and assessment of associated health risk: The average exposure level for benzene and toluene were 3.9 and 5.5 fold higher than the ambient air….. (D Majumdar et al 2008)

-- Santiniketan: assessment of intra- urban variability in outdoor air quality and its health risks: …demonstrated that residential exposure to highly trafficked roads is associated with respiratory diseases. (Padhi BK et al 2008)

2010 -- Air pollution and its impact in relation with nutritional status and physical fitness…. (Paulomi Das et al 2010)
2000: -- Respiratory symptoms and spirometric observations in relation to atmospheric pollutants in urban population. Respiratory and ventilatory abnormalities higher in commercial areas with higher SO2 and NOx. (Kumar KS et al 2000)

2006: Vehicular exhaust might induce cytogenetic damage in traffic police. (Sreedevi V et al 2006)
-- Reproductive outcome in the wives of traffic policemen exposed to automobile exhaust: Significant increase in the frequency of abortions in the wives of policemen, neonatal deaths in their offspring’s and significant decrease in frequency of live births in the offspring of traffic policemen when compared to the control group. (Sreedevi V et al 2006)

2008: -- Altered lung function in petrol filling workers etc (Nazia Uzma et al 2008)

2009: -- Oxidant stress, antioxidants and nitric oxide in traffic police of Hyderabad: Exposure to air pollutants can increase oxidant stress, decrease the levels of antioxidants and nitric oxide lead to lung damage. (Suresh Y et al 2009)
-- Cytogenetic evaluation of traffic policemen occupationally exposed to vehicular exhaust: A significant increase was seen in the mean frequency of chromosomal aberrations in non smoker and smoker traffic policemen (V Sree Devi et al 2009)
Toxic risk

The endpoint of the toxic risk is cancer

-- In India over 700,000 new cases and 300,000 people are set to die every year, estimates the National Cancer Control Programme (NCCP).

-- NCCP’s forecast -- by 2026, more than 1.4 million people will be falling in the grip of the disease.

-- NCCP has listed greater exposure to *environmental carcinogens* as one of the most important reasons.

-- There is no any one cause --- but the mitigation strategy must reduce environmental risk from all factors – and air pollution is an important factor

Numerous studies in the West assessed the causes such as genetic susceptibility, environment factors and lifestyle. *Found overwhelming influence of environmental factors.*
The vulnerable...children, poor, elderly, city dwellers...
Evidence in public domain

Alveolar macrophage: the biomarker of air pollution

Source: M Ray, Chittaranjan National Cancer research Institute
Emerging evidences of health impacts in India......

Alveolar macrophage - biomarker of air pollution

Exposed group; Kolkata taxi driver
Increase in AM number

Larger AM – particle laden

Control area: Sundarbans

Source: CNCI
Co-relating health evidence with air pollution

Extensive study by the Chittaranjan National Cancer Research Institute in Delhi and Kolkata

Supported by the Central Pollution Control Board

Source: M Ray, Chittaranjan National Cancer research Institute
More evidence establishing link between health and air pollution

Source: M Ray, Chittaranjan National Cancer research Institute
Health of children compromised......

2012 epidemiological study on children in Delhi (CPCB and Chittaranjan National Cancer Institute of Kolkata):
-- Covered 11,628 school-going children from 36 schools.

-- Every third child has reduced lung function. Sputum of Delhi’s children contains four times more iron-laden macrophages than those from cleaner environs, indicating pulmonary hemorrhage.

-- The levels of these biomarkers in children have been found to be higher in areas with high PM10 levels.
Poor status of nutrition, high cost of treatment make the poor specially vulnerable…..

**Bangalore**: Increased prevalence of asthma in children of lower socio economic classes. Children from heavy traffic region and low socioeconomic population had much higher prevalence. (H Paramesh)

- **Hyderabad**: Drug off-take study conducted by S V S Medical College, found highest drug sale in Punjagutta and Abids zones that have recorded highest PM1 and PM10 levels.

- **Mumbai**: The National Cancer Control Programme has listed greater exposure to environmental carcinogens as one of the most important reasons for the prevalence of cancer. Department of Preventive Oncology of Tata Memorial Centre, Mumbai, found incidence of cancer in the city’s slums very high. Air pollution plays a role in enhancing this risk.

- **Chennai**: Sensitivity of poor neighbourhoods……

*Source: CSE Review*
Where is pollution coming from?


Do not know accurately. Inventories too inadequate

Limited and partial studies constrain policy decision

Need good science to fight lobbies
Vehicular pollution: High exposure

Vehicular emissions contribute to significant human exposure. Pollution concentration in our breathe is 3-4 times higher than the ambient air concentration.

In densely-populated cities more than 50 – 60% of the population lives or works near roadside where levels are much higher. This is very serious in low income neighborhoods located close to roads.

The WHO report of 2005: Epidemiological evidences for the adverse health effects of exposure to transport related air pollution is increasing.

Some of the deadliest air toxics, also carcinogens, are related to vehicular emissions. Blamed even for killing foetus.

About 60% of health studies in India have focused on exposure to traffic pollution…
People living close to roads are most exposed to vehicular fume
Evidence from Delhi….

The Traffic Impact Area in Delhi:
New HEI Analysis: 55% of the Population within 500 meters of a Freeway; 50 meters of a Major Road

Given the large number of people living within 300-500 meters of a major road, the Panel concluded that exposures to primary traffic generated pollutants are likely to be of public health concern and deserve attention.
In Kolkata and Delhi, the people’s exposure to vehicle exhaust is 3 to 4 times higher than the world average. Exposure (iF) is the population-weighted intake fraction, or the grams of vehicle pollution inhaled per grams of vehicle pollution emitted.

Road injury impacts of motorisation – adds to disease burden
Total burden of disease from air pollution and road injuries

Rate of health years lost to injuries and air pollution from motorized road transport 2010

Source: The World Bank Group and , Global Road Safety Facility
Road accidents in Gurgaon

Accident risk increasing

More than one death per 1000 people

Source: Gurgaon Traffic Police
Deadly Highways and Expressways

60% of accidents on NH-8 expressway

Source: Gurgaon Traffic Police
Pedestrians and two wheeler riders most vulnerable

Road wise Fatal Accident Analysis W.E.F. 1-1-2014 to 30-9-2014

Source: Gurgaon Traffic Police
CSE’s rapid survey to understand people’s perception of air pollution and mobility problems in Gurgaon. The preliminary results capture the mood…

- About 85% say air pollution is worsening. About 40% feel incidences of respiratory diseases are rising.
- More than 60% have complained of increased delays during peak hours.
- The public transport has got the worst rating, with people complaining the city having no proper public transport connectivity.
- About 30% rated the auto/tempo services as average but say they are important.
- About two third think parking is causing encroachment of footpaths and causing congestion on roads.
- Nearly half -- 70%, think government should make efforts to reduce dependence on personal vehicles.
- Around 90% want more action to increase public transport and non motorised infrastructure.
- About 40- 50% percent are in favor of cycle and cycle rickshaw infrastructure.
First generation action in Gurgaon

ROUTE MAP OF BUS CITY SERVICE

• Euro IV emissions standards
• Metro connection
• City Bus Service started in May 2012 with 36 buses. Now 100 buses
• About 100 private mini buses
• About 125 interstate buses connecting other cities daily.
• Approximately 90,000 passengers travel/commute by the city buses. Buses cover more than 22,000 kilometers daily.
• Six-seater auto rickshaws are operating on many routes in the city.

• But not enough
Agenda for action......... Stringent action must gather momentum
Implement national air quality index with health advisory.

On days with very poor and severe levels:

-- There should not be any tolerance for visible smoke-emitting vehicles.

-- Only Euro III and Euro IV vehicles allowed. On very severely polluted days make public transport free.

-- Double the parking charges, ban diesel vehicles, cut down on construction activities.

-- Schools should be shut down, and ban entry of commercial vehicles inside the city.

-- All agencies need to upgrade their monitoring stations to enable daily reporting of realtime data of all pollutants including PM2.5 to enable reporting of AQI and health advisory.
Beijing: Pollution emergency measures on red alert days:
-- Kindergartens, primary and middle schools will close;
-- About 80 per cent of government-owned cars have to be taken off the roads;
-- Private cars will be allowed on alternate days according to numbers plates;
-- Freight vehicles and those transporting material for construction sites will be barred;
-- Polluting factories have to cut emissions or shut down when the orange warning signal is issued;
-- Construction sites will have to halt excavation and demolition operations;
-- Ban on barbeques and fireworks on heavily polluted days.

US cities: Rule 701 of air pollution emergency contingency actions (for PM and ozone):
-- Industrial units reduce combined emissions by at least 20 per cent of normal weekday operations.
-- For vehicles, it asks to reduce fleet vehicle miles;
-- Promotes ridesharing and telecommuting.
-- Liquid or solid fossil fuels cannot be burned in electric power generating systems unless a force majeure natural gas curtailment is in effect.
-- It also recommends all non-emergency driving be discontinued.

Paris: red alert day
-- Restricts vehicle entry into the city
-- Does not allow diesel cars inside the city during smoggy days
Leapfrog emissions standard roadmap

Source: India, Europe compiled from Diesel Net, USA data provided by Axel Friedrich, Germany

Note: Europe has additionally introduced particle number standards at Euro V level
Future norms of US and Europe are tightening NOx norms for diesel more
Motorisation based on outdated polluting technology and fuels locking up enormous pollution and ill health.....

Need stringent and preventive action and decision here to influence the future stock -- several times higher than the legacy stock.

Bharat Stage IV norms are 9 years behind Europe

Bharat Stage III norms are 14 years behind Europe

India needs stringent emissions standards

Meet Euro VI standards in 2020 – Only at this level petrol and diesel emissions equalise

Source: CSE
CNG helped us to leapfrog: Euro II diesel bus emits nearly 46 times higher PM than Euro II CNG bus in India.

PM emissions from buses in grammes per kilometre

- Bharat stage II Diesel Bus (500ppm max. sulfur)
- Bharat stage II Diesel Bus +CRT (50ppm max. sulfur)
- Bharat stage II CNG Bus + 3 way catalyst

Source: Teri
Control dieselisation

Jump from 4% in 200 to 49% in 2011

In popular car models the share of diesel car is 70-75%

After price deregulation some decline in diesel car sales reported.

Even at a moderate and flat growth rate of 20 per cent a year, the total diesel cars in 2020 will be double the size of the total car sales today.

Source: Based on market data
One diesel car emits as much NOx as 3 to 5 petrol cars. PM is several times higher.

Source: MP Walsh
In June this year the International Agency for Research on Cancer of the World Health organisation (WHO) has reclassified diesel exhaust as Group 1 list of carcinogen that have definite links to cancer.

Diesel exhaust is now in the same class of deadly carcinogens as asbestos, arsenic or tobacco among others.

The IARC-WHO has urged worldwide efforts to reduce exposure to diesel fumes as much as possible.
How safe it is to have diesel particles in our air?

Other governments consider toxic Air contaminant Unit Risk Factors to prioritise action

<table>
<thead>
<tr>
<th>Toxic Air Contaminant</th>
<th>Unit Risk/Million People</th>
<th>Detection limit (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaldehyde</td>
<td>2.7</td>
<td>0.10</td>
</tr>
<tr>
<td>Benzene</td>
<td>29</td>
<td>0.05</td>
</tr>
<tr>
<td>1,3-Butadiene</td>
<td>170</td>
<td>0.04</td>
</tr>
<tr>
<td>Carbon Tetrachloride</td>
<td>42</td>
<td>0.02</td>
</tr>
<tr>
<td>Chromium, Hexavalent</td>
<td>150,000</td>
<td>0.06 (in nanogram)</td>
</tr>
<tr>
<td>Para-Dichlorobenzene</td>
<td>11</td>
<td>0.30</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>6</td>
<td>0.10</td>
</tr>
<tr>
<td>Methylen Chloride</td>
<td>1</td>
<td>0.10</td>
</tr>
<tr>
<td>Perchloroethylene</td>
<td>5.9</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Diesel particulate matter</strong></td>
<td><strong>300</strong></td>
<td><strong>N/A</strong></td>
</tr>
</tbody>
</table>

Note: Unit Risk represents the number of excess cancer cases per million people per microgramme per cubic meter TAC concentration over a 70 year lifetime exposure.
A diesel particulate matter unit risk value of 300 is used as a reasonable estimate in the "Risk Reduction Plan to reduce Particulate Matter Emissions from Diesel Fuelled Engines an vehicles (ARB, October 2000)"
Source: California Air Resource Board
Toxicity of diesel emissions

WHO has reclassified diesel fume as class 1 human carcinogen..... Says there is definite link between diesel fume and lung cancer

Source: MP Walsh
Tighten PUC, testing method and compliance: Grossly polluting vehicles can occur at any age group or vintage and these will have to be weeded out with a good inspection programme and smoky vehicle checks.

Deploy more advanced in-use monitoring strategies. Integrate on-board diagnostic system for in-use inspection; introduce remote sensing technology for screening on-road vehicles among others.

Make PUC certificate conditional requirement for obtaining annual insurance for vehicles.

Need road worthiness tests for private vehicles.

Divert non-destined trucks and check overloading

Stringent action on visibly polluting vehicles: Smoky vehicle inspection based on spot check and on-road surveillance, high penalty and instant removal from road can make a difference inside the city as well as along the borders.
Address mobility crisis

Cities are losing battle of car-bulge: The rapid increase in vehicles is destroying all gains of air pollution and health.
Massive drop in public transport ridership since 2004

2004: Share of total public transport and intermediate public transport -- 58%

2010: Nearly 60% of travel trips carried by personal transport – cars and two wheelers

Source: RITES, 2004 and Planning for Bicycle Infrastructure: A Case of Gurgaon City
Very high vehicle ownership

If two-wheelers and cars are added then personal vehicle ownership far exceeds that of affluent Chandigarh and the capital city of Delhi.

Source: Census, 2011
Average Trip Length

Source: Integrated Mobility Plan for Gurgaon Manesar Urban Complex, 2010
Short distance travel trips dominate: Enormous potential to promote zero emissions walking and cycling

- More than 45% of trips are taken between 0-2 kms
- The trips between 2-6 kms are 8%
- 6-10 kms consists 8% trips
- As the trip length increases, the number of trips decreases drastically

Source: Integrated Mobility Plan for Gurgaon Manesar Urban Complex, 2010
Massive inflow of intercity traffic

Daily person trips in lakhs, 2004

Source: RITES Survey, 2004
Daily traffic volume at outer cordon locations in Gurgaon

- Mehrauli-Gurgaon Road, Sikandarpur Border
- NH-8, Sirhole Border
- Delhi-Gurgaon Road, Kapasheda border

Source: RITES Survey, 2004
Bus numbers inadequate

- To fulfill the current demand, Gurgaon needs 1000 more buses, while the mobility plan mentions only 300 more buses.
Implement seamless public transport system in the NCR

-- Implement NCR wide seamless bus system and para transit system and remove tolls and tax barriers across borders for public transport within a year under reciprocal agreement

-- Implement plan for improved rail network
Roads hitting dead end in Delhi

Roads expansion cannot keep pace with rising number of vehicles

Source: On the basis of Economic Survey, Delhi Govt
How can public transport, walk and cycle work here?

Engineering changes once made cannot be reversed easily… It permanently decides our travel choices and locks up pollution…..Traffic and pollution impact of infrastructure is never carried out........
Case Study – Outer Ring Road (Nehru Place Flyover)

Travelling from A to B

Originally 30M across the road

Pamposh-Enclave

Nehru Place

CR Park

Kalkaji
Case Study – Outer Ring Road (Nehru Place Flyover)

Travelling from A to B – Pedestrian Route 1

1000M via FOB

A: CR Park
B: Nehru Place

FOB

Pampush-Enclave

Kalkaji
The Transition.......Reallocation of road space. More space to high capacity and non-motorised modes and majority commuters

Distribution of Vehicles - By Mode

Distribution of People - By Mode

Moving vehicles vs. moving people

Delhi Bus Corridor
Public transport must define the urban form

1a) High Density Mixed Use within 5-min walk of stations...

Reason for success of BRT in Curitiba: Maximum people Live, Work & Play within 5-min walk of RAPID TRANSIT Stations
Density disparity along metro line in Delhi….

- Chawri Bazar
- Race Course
- Green Park
Case Study – Gurgaon Sector 28
Accessing Metro from ITC Laburnam Apts

- Emerald Court 1
- IFFCO Chowk Metro
- ITC Laburnam Apts
- MGF Plaza Mall

400M

• Shortest route not possible.
Case Study – Gurgaon Sector 28

Accessing Metro from ITC Laburnam Apts

Emerald Court 1
ITC Laburnam Apts
MGF Plaza Mall
IFFCO Chowk Metro

1800M
National Habitat Standard Mission of the Ministry of Urban Development

Guidelines for compact mixed land use

-- 95% of residences should have daily needs retail, parks, primary schools and recreational areas accessible within 400m walking distance.

-- 95% residences should have access to employment and public and institutional services by public transport or bicycle or walk or combination of two or more.

-- At least 85% of all streets to have mixed use development.

-- Need small block size with high density permeable streets etc

<table>
<thead>
<tr>
<th>Hierarchy of Facilities</th>
<th>Accessibility Standard from each home/ work place.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRTS Station</td>
<td>Approx. 800 m or 10 min walk</td>
</tr>
<tr>
<td>Metro feeder/ HOV feeder Stop</td>
<td>Approx. 400 m or 5 min walk</td>
</tr>
<tr>
<td>Bus Stop</td>
<td>Approx. 400 m or 5 min walk</td>
</tr>
<tr>
<td>IPT/ auto-rickshaw Stand</td>
<td>Approx. 250 m or 3 min walk</td>
</tr>
<tr>
<td>Cycle Rickshaw Stand</td>
<td>Approx. 250 m or 3 min walk</td>
</tr>
<tr>
<td>Cycle Rental Stand</td>
<td>Approx. 250 m or 3 min walk</td>
</tr>
<tr>
<td>Shared private parking garage</td>
<td>Approx. 500 m or 6 min walk</td>
</tr>
</tbody>
</table>

UTTIPEC guidelines

Build compact city

.........Devil is in detail
CSE Audit of connectivity and multi-modal integration in Gurgaon

• Air pollution control requires scaling up of public transport, walking and cycling.

• Gurgaon has a metro line and a formal bus system.

• CSE has carried out rapid assessment of connectivity, access and integration of all modes of transport.

• CSE has taken the draft norms for connectivity and multi-modal integration of the UTTIPEC as a reference benchmark.

• Study area -- road from HUDA city centre metro station to Sikanderpur metro station was selected, - a 3 km stretch -- a 8 lane road with heavy traffic. Both bus routes and metro lines run parallel but with little integration and feeder system.
Method

The audit has assessed

- Interconnected street network that allows movement of, their engineering and design features for footpath and cycle track;
- Crossing- Intersection and mid section protection for pedestrians and public transport users;
- Modal interchange locations and parking for all mode users; location and quality of facilities outside station premises, way finding maps; Universal accessibility;
- Amenities and safety features (Toilet, vendor space, trees, lighting, seating), and building entry locations and public transport feeder services.
- Considered 500 meter radius from the Metro stations.
- The scoring was ascribed accordingly.
Metro and bus route are parallel.
Metro Catchment: Unconnected neighbourhoods

Metro Route
Bus Route
Auto Route
Influence area
The Audit Results

All metro stations score very poor on all parameters.
The access to metro stations is not designed keeping pedestrians and cyclists – who are the potential users of metro, in mind.

There are no safe crossings around any metro stations for walkers and cyclists. Footpaths are available mainly all around the metro stations but their height and quality make them inaccessible. Cycle tracks only near HUDA city centre.

Autos, Cycle rickshaws are the major feeder services along the metro stations. But not organized.
There are hardly any bus stops outside metro stations.
Parking is provided mainly for private vehicles.

All residential neighbourhoods along the metro line are poorly connected with the transit lines.
Engineering features: People unfriendly

No safe crossings outside metro stations

Height of the footpath, making it inaccessible for users

Pedestrian entry to HUDA city centre metro station is blocked
Poor crossing and inadequate feeder services

People waiting on road to board buses as bus stand is in the service and obstructed by median

Only one bus stop was existing near HUDA city center and there were no bus stops around other metro stations
Unorganised feeders outside metro stations

Feeder services are poorly designed with no designated parking for autos and cycle rickshaws
Aesthetics and Safety

Only one cycle track near HUDA city centre but not accessible easily as it’s a one way road and not physically segregated.

Lot of obstruction on footpath makes it inaccessible.

Too much empty land and no concentrated lighting makes footpaths unsafe in the night.

Wide roads with no safe crossings, makes it dangerous for people to cross.
Universal accessibility: Poor

The signage shows parking for disabled with no provision of ramps.

The height of the footpath makes it difficult for differently able to use them.

Uneven surface, blocking access for differently abled.
Non-motorized network plan for time bound implementation

M mandate people and cycling friendly street design guidelines and standards for all roads: These should be made mandatory for approval of road network projects in Delhi.

Protect walkways and cycle tracks from encroachment and ensure safe crossing: Implement the provision of Motor Vehicle Act 1988 that bars vehicles from being parked on pavements.
Car restraint strategy

How can we use parking policy as restraint measure?

- **Parking: most wasteful uses of cars**: Out of 8760 hours/year total steering time of an average car is 400 hours. For about 90 to 95 percent of the time a car is parked.

- **Insatiable demand for land**: Current fleet of vehicles in Gurgaon makes demand for land equivalent to land area needed for 179 football fields.

- **Inequitous use of land**: A car is allotted 23 sq m for parking. A poor family 18 sq m under low cost housing scheme.

**Land is limited. Where will cities find more land to park cars?**
Personal vehicles dominate parking demand in Gurgaon

- Cars and two wheelers take majority of the space out of total vehicles parked.

Source: Integrated Mobility Plan for Gurgaon Manesar Urban Complex, 2010
More than 80% of the vehicles are parked less than one hour. Effective pricing can make a difference.

Source: Integrated Mobility Plan for Gurgaon Manesar Urban Complex, 2010
Enforcement: The first steps......

Find method in the madness....Tame the chaos
EPCA directives to MCD, NDMC in Delhi
-- Demarcate legal parking spaces. Organise them well.
-- Inventorise the parking spaces. Put out the list on the website
-- Prevent encroachment of walkways
-- Put up signages and information systems
-- Introduce metering
-- Impose penalty

-- Similar moves in other cities – Chennai, Pune, Pimpri Chinchwad etc

On-street parking cannot be eliminated. Needs to be managed well.
Proposed Asaf Ali Road, New Delhi

Off street car and auto rickshaw parking area along the road

Source: I Trans, Anvita Arora
Reduce dependence on personal cars to control pollution

Reform parking –

Organise and limit parking spaces and increase parking charges

Global studies show:
Shifting from free to cost recovery parking rates can reduce automobile commuting by 10-30 per cent especially if linked with other transportation choices

Parking charges influence commuting choices:
People will opt for alternatives

Indian cities have the lowest parking rates in the world
Other countries are limiting and pricing parking

Capping parking supply
- **Portland, Oregon** Overall cap of 40,000 parking spaces downtown. This increased public transport usage from 20-25 per cent in the 1970s to 48 per cent in mid 1990s.
- **Seattle** allows a maximum of one parking space per 100 square metres at downtown office
- **San Francisco** limits parking to seven per cent of a downtown building’s floor area

Parking pricing strategy to reduce car usage. Benefits public transport
- **New York**: Very high parking fees and limited parking supply lowers car ownership far below the US average.
- **Bogota**: Removed limit on the fees charged by private parking companies. The revenue goes to road maintenance and public transit improvement.
- **Shenzhen**: Hike in parking fees during peak hours leads to 30% drop in the parking demand.
- **Bremen**: No free parking in city centre. Parking charges higher than public transport cost.
- **Barcelona**– Parking revenue directed to a special fund for mobility purposes.
- **London**: parking income channeled to transportation projects.

Strong enforcement and penalty
- **Tokyo**: Enforcement against parking violations cuts congestion drastically. Private firms allowed to issue tickets for parking violations. This makes on-street parking expensive.
- **Antwerp**: parking fines are invested into mobility projects

Free up public space
- **Paris**: Street space freed for bike sharing and trams
- **Copenhagen**: Streets freed up for bike lanes etc
Parking and clean air

It is still not clear to many how parking management and restraints can reduce air pollution and give public health benefits.

Boston froze their parking requirements at a level that is only 10 per cent higher than the 1973 level to meet the Federal clean air standards.

New York: very high parking fees and limited parking supply have lowered car ownership far below the average rates in other US cities.

Amsterdam - parking fees expanded to meet EU directives regarding NO2 and PM10 emissions. Car plate numbers are registered with emissions information. Trucks are allowed to unload for a maximum of 15 minutes in spots where they are not allowed to park.

Zurich considers total NO2 emissions when determining the amount of parking to be allowed.

Aizawl, Sikkim have made proof of parking mandatory for purchase of cars; High Court of Jodhpur has given similar direction.
Need parking restraints and disincentives for usage of personal vehicles
-- Eliminate free parking; introduce high and variable parking charges; introduce residential parking permits with fees;

-- Implement parking management area plans to plan; implement legal parking; ban and penalise illegal parking; rationalise on-street and off-street parking; Prohibit parking in green areas and in neighbourhood parks

-- Ban parking on footpaths under the provision of the Motor Vehicle Act 1988

No option to restraint: Learn from Beijing
-- 800,000 cars were sold in Beijing in 2010.
-- In 2012 Beijing capped car sales at 240,000 cars a year – 30 per cent of what was sold in 2010
-- The current actual demand is a staggering number of 1,515,449
On-street parking pricing has major impact on vehicular use.....

Grosvenor square, London

Source: TRL in ITDP (2011): Europe's Parking U-Turn
Gurgaon Manesar Mobility Plan charts the way:

Scale up and modernise public transport

-- Provision of high capacity mass transport corridors and integration with other modes of transport
-- Medium level mass transport system -- BRT beyond the Metro network
-- Rationalisation of local bus system and its augmentation.
-- Improvement in traffic management through TSM measures.
-- Special facilities for pedestrians within the entire network specially in the core areas
-- Pedestrian subways, footpaths and road furniture along the roads
-- Diverting through traffic on bypasses, providing transport hubs at the periphery
-- Improving primary, arterial and other important roads (particularly radial and ring roads) by providing grade separation in the form of underpasses, junctions

Inform this process from the experience in other cities........
Bus pays more tax than cars in Gurgaon

**Buses pay more taxes than cars in Haryana/Gurgaon:**

Haryana transport department charges road tax (called token tax) on cars based on the value of the vehicle. Tax rates range from 3% to 9% on the value of the car. Thus, a car costing Rs 6 lakh pays Rs 18,000 at the time of registration.

Stage carriage bus pays Rs 550 per seat per annum subject to a maximum of Rs 35,000.

On the other hand a Stage carriage City Private Bus pays Rs 18,000 for half body bus per annum and 30,000 for full body bus per annum.
Account for health cost in decision making: Valuation of acute and chronic illnesses must be linked to decision on air pollution control measures.

World Bank study (July, 2013):
- Outdoor air pollution is 29% of the total environmental damages
- Health cost of PM10 is 3% of GDP
- But PM10 mitigation will cost less than 1% of GDP
- Annual savings from health benefits can be more than USD 100 billion

• But our policies do not respond to such evidences……
Our cities need upscaled transition to cut pollution and health costs

12th Plan requires major cities to comply with clean air standards. Cities have begun to work towards policies. This will have to be enabled and scaled up.

Opportunity to provide scaled up alternatives
   Public transport
   Infrastructure for walking and cycling

Reduce demand for travel and vehicle usage
   Land-use planning
   Road pricing
   Tax rationalisation
   Parking policy as a restraint measure

Leapfrog technology
   Emissions standards
   Fuel economy standards

Fund the transition: Need tax measures and resource mobilisation to create dedicated fund for pollution control in cities (Eg. Air Ambience Fund in Delhi)

This needs support. Must not be allowed to fail…Otherwise what??
Dutch Minister visits the queen

Source: GIZ
Thank You