Clean air and sustainable mobility

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Centre for Science and Environment

Media workshop

Joint initiative of the Karnataka State Pollution Control Board and Centre for Science and Environment

Bengaluru, March 22, 2013
Global Burden of disease........
Shocking findings for India

December 2012:
Global Burden of Disease (estimated by 450 scientists from 300 organisations across the world including WHO) found -- Globally air pollution related deaths have increased by 300% since 2000. About 65% of these deaths occur in Asia.

Air pollution ranked among the top 10 killers in the world
Two-thirds of the death burden from outdoor air pollution occurs in developing Asia

February 2013: GBD findings for India released........
620,000 premature deaths a year. More than 18 million healthy life years lost due to air pollution. Air pollution triggers stroke, cardiovascular and respiratory diseases, cancer.....

This has made a conversation necessary.........
More cities in grip of multi-pollutant crisis

-- Low polluted cities fallen from 10 to 2. --
Critically polluted cities (1.5 times the standards) increased from 49 to 89 cities.

-- 2005: 75% of cities exceeded the standard.
2010: -- 78% of cities

NO2 monitoring increased from 100 cities to 177 cities
2005: Only 1 city exceeded the standard. 2010: 19 cities
It is about people……

• Close to half of total urban population breath the air which exceeds the standard of PM10.

• One third of urban population live in cities with PM10 levels classified as critical -- close to Japan’s population.

10% of total urban population breathes the air which exceeds the standard of NO2.

60% of people in monitored cities live in areas with critical PM10 levels

Source: CSE based on CPCB air quality data and Census population data
Changing positions of hotspots

Non-metro cities have higher levels of PM10

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<tr>
<th>Cities with high levels</th>
<th>PM10 annual average in 2005</th>
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Source: Computed from the data provided by the CPCB
• Imperatives of the regional dialogue
PM10 levels in southern region: A problem

- Close to half -- 47% of 38 cities monitored in the four states of Karnataka, Tamil Nadu, Kerala, Andhra Pradesh have exceeded the standard

- Three cities - Tuticorin, Vijaywada & Hubli Dharwad have critical levels; 14 cities have high levels (including Bangalore, Nalagonda, Kurnool, Salem, Guntur among others); 17 cities have moderate levels (including Chennai, Trivendrum among others), and 2 cities in Kerala have ‘low’ levels
NO2 levels in southern region: emerging concern

- All cities in 2010 met the standard. But Bengaluru has exceeded standards occasionally.
- Ten cities have moderate levels (including Bengaluru, Mysore, Coimbatore, Salem, Madurai, Hyderabad, Trivendrum, Nalgonda, and Patanachaeru).
- 72% of monitored cities have ‘low’ levels.
PM10: Mixed trends in cities (Change between 2005 and 2010)

- **Significant increase** in Salem (+107%), Tuticorin (86%), Coimbatore (+63%), Hubli Dharwad (+46%), Bengaluru (+41%), Kottayam (+21%)
- **Moderate to minimum change**: Kochi, Belgaum, Hyderabad, Madurai, Mysore, Chennai and Gulbarga
- **Decline**: Palakkad -78%, Hassan -59%, Mangalore -46%, Kozhikode 37%, Thiruvananthapuram 34%, Vishakhapatnam -23%, among others
Cities with double trouble: PM10 and NO2

- Bangalore: PM10 levels bordering critical stage. NO2 levels close to the standard.
- Salem, Hyderabad, Nalgonda, and Patancheru have relatively high levels of PM10 and they also appear in the moderate category for NO2.
Tiny killers
PM2.5 monitoring must expand
Limited data shows it is a challenge

Case of Hyderabad

![Graph showing PM2.5 average levels]

Source: Based on data provided by APPCB
Toxic air

Toxics are harmful even at trace amount

Bengaluru: Benzene levels

Ozone is dangerous even for short duration

Hyderabad: Ozone levels

Hyderabad: Benzene levels
South has comparatively lower pollution levels than North...

.....But health impacts are large. Most of the health effects occur at much lower levels. Need to meet tighter targets.

Integrated Exposure-Response function for Ischemic Heart Disease

HEI Global Burden of disease, 2013
PM10 hotspots in cities
What matters is high daily exposure

**Hyderabad**: Out of 9 monitoring locations -- 8 locations exceed the annual average standard for PM10. 4 locations have critical levels and also exceed the 24-hourly average standard by more than 50% of days monitored -- CITD Balanagar, Uppal, Charminar and Paradise etc.

**Bangalore**: Out of 9 locations 3 locations show more than 50% exceedance of PM10 24-hourly standard. 7 locations out of 9 locations exceed the annual average standard. 3 locations are critically polluted. -- Graphite India, Yeshwanthpura Police Station etc.

**Chennai**: Out of six 6 locations -- 3 locations are exceeding the standard and the levels fall in 'high' zone and exceed the 24-hourly average standard on 22% of monitored days -- Thiruvottiyur. Govt. High School at Manali and Akthivakkam.

Source: APPCB.
Cities with cleanest air?

- **Kerala has two cities with cleanest air in the country**: Of the 180 cities monitored in the country for SO2, NO2 and PM10 nation-wide, only two -- Malapuram and Pathanamthitta in Kerala -- meet the criteria of low pollution (50% below the standard) for all air pollutants.

- But other cities in Kerala are falling victim to moderate to higher pollution levels -- Trivandrum, Kottayam, Kollam, Wayanad, Alappuzha etc
• Our health matters........
Trend in health impact studies

Published air pollution and health impact studies in India
(1980 - 2010)

Post 1998: 72% of studies conducted

Source: CSE
Most studies done by doctors themselves…….

Who has done the studies?

- Doctors, 53%
- Researchers, 31%
- Doctors & Municipal Corporation, 15%
- Doctors & Researchers, 1%

Source: CSE
Health studies -- From polluted mega cities to smaller cities ....

14% of studies in small and medium cities – 64% in 4 metros only

North and western India has maximum studies

Source: CSE
Local evidences over the last decade: Snap shots

**Chennai:** Traffic police, bus drivers, and auto-shop workers significantly associated with lower levels of haemoglobin. (Toxicol Ind Health. 1996 Sep-Oct;12(5).

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

**Hyderabad:** Traffic police exposed to vehicular emissions show increased oxidant stress, lung damage and other respiratory problems (India in Environ Pollut. 2000 Aug;109(2)

**Hyderabad Drug off-take study** found highest drug sale in Punjagutta and Abids zones that have recorded highest PM1 and PM10 levels.

**Vehicular exhaust might induce cytogenetic damage in traffic police.** (Sreedevi V et al 2006)

**Altered lung function among petrol filling workers** etc (Nazia Uzma et al 2008)

**Exposure to air pollutants increase oxidant stress,** decrease the levels of antioxidants …,,,,lead to lung damage. (Suressh Y et al 2009)

**A significant increase in chromosomal aberrations in non smoker and smoker traffic policemen** (V Sree Devi et al 2009)
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: VOCs, PM2.5, PAH etc

-- Benzene and its impacts in more than 10% of studies since 2000.

-- VOCs and PAHs in a few studies since 2000.

-- But very little on ozone – only one in Delhi.....

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....

![Bar chart](chart.png)

Source: CSE
Global studies ....
Looking beyond lungs ......

**Diabetes:** First large-scale population-based study links diabetes with air pollution. Increase in insulin resistance in lab test .... and an increase in markers of inflammation (which may contribute to insulin resistance) after particulate exposure. Strong and consistent association between diabetes prevalence and PM2.5 concentrations. For every 10 μg/m3 increase in PM2.5 exposure, there was a 1 percent increase in diabetes prevalence. Counties with highest versus the lowest levels of PM2.5 pollution had a more than 20% increase in diabetes, which remained after controlling for diabetes risk factors. (Diabetes Care 2011)

**Heart:**
Acute Effects of Fine Particulate Air Pollution on Cardiac Arrhythmia: Conclusion: PM2.5 exposure within approximately 60 min was associated with increased PVC counts in healthy individuals. (He F et al 2011The APACR Study. Environ Health Perspect)

**Blood pressure**
Traffic-related Air Pollution and Blood Pressure in Elderly Subjects With Coronary Artery Disease: Found positive associations of systolic and diastolic BP with air pollutants. The strongest associations were with organic carbon, multiday average exposures, ect. (Delfino, Ralph J.a et al 2010,, Epidemiology, May 2010)

**Effect on foetus:** Studies have shown damaging impact of PAH on even fetus
Emerging evidences of health impacts in India......

Alveolar macrophage - biomarker of air pollution

Exposed group; Kolkata taxi driver
Increase in AM number

Control area: Sundarbans

Larger AM – particle laden
India and Asia’s unique public health challenge

• The Asiawide review of existing studies show that the estimated health effects are similar to those found in the extensive studies in western countries.

• But the risk in south Asia could be more serious. Science has yet to assess our unique risk factors

• Extremely high levels of particulates and pollution cocktail -- the problem of exposure to multiple pollutants

• Impact of poverty: Socio economic variables are not included in health studies to influence public policy. Sporadic studies elsewhere show poor are more susceptible

Understand risk transition

• Double burden of disease. Modern or community risks increasing

• This has important implication for environmental monitoring strategies

We need strong controls at the early stages of motorisation
Need air quality index and health advisory for public information system

Delhi is developing air quality index and health advisory

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**AQI Range**

- **0 to 50**: Healthy
- **50 to 100**: Moderate
- **100 to 150**: Unhealthy (Sensitive Groups)
- **150 to 200**: Unhealthy
- **200 to 300**: Very Unhealthy
- **> 300**: Hazardous
• The complex story of vehicular pollution
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 fume: special concerns

- 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.

- Poor have a higher prevalence of some underlying diseases related to air pollution and proximity to roadways increases the potential health effects.

- In three cities World Bank review found vehicles contributing an average 50% of the direct PM emissions and 70% of PM exposure.

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

- Public transport users, walkers and cyclists are the most exposed groups – most of them are also poor.
Vehicles’ contribution to particulate pollution is significant

Vehicular emissions dominate NOx load

### Bangalore

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<thead>
<tr>
<th>Source</th>
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<td>Industry</td>
<td>8%</td>
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<td>Hotel</td>
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<td>Construction</td>
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<td>Transport</td>
<td>67%</td>
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<td>Domestic</td>
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<td>Road Dust</td>
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Chennai: Source-wise NOx emissions load (kg per day)

- **Vehicle Exhaust**: 68%
- **Restaurants/Bakeries**: 11%
- **Domestic Combustion**: 9%
- **Others**: 1%

### Chennai

- Vehicles are responsible for 2/3rds of NOx emissions.
- Diesel generator and transport emissions contribute to more than 90% of the NOx emissions in the Bangalore city. (Sources: National summary of source apportionment studies)
People living close to roads are most exposed to vehicular fume
Evidence from Delhi….

Stunning evidences in Delhi

New research in Delhi from University of California, Berkeley:
--- Commuters breathe far more harmful particles inside vehicles while traveling compared to the ambient concentration.

-- The PM2.5 concentrations inside vehicles can be 1.5 times higher than the surrounding background air and ultra-fine levels about 8.5 times higher.

-- The short-term peaks during travel can go above 1000 microgramme per cum – nearly 16 times the daily limit.

Large number of people live within 300- 500 meters of a major road. Exposures to primary traffic generated pollutants are of public health concern. Change monitoring practice…. Include road side monitoring…..
Effect of traffic on pollution

Ozone, PM2.5 and CO levels remain high during morning and evening peak hours. Even night time NO2 levels high – influence of truck traffic.

Source: CSE analysis based on CPCB air quality data
• Impact of first steps….
What has Delhi achieved?

**On vehicle technology and fuel quality**
- Mandated pre-mix petrol to two- and three-wheelers

**On alternative fuels**
- Implemented largest ever CNG programme
- Largest ever public transport bus and three-wheeler fleet on natural gas

**Other measures related to vehicles**
- Capped the number of three-wheelers
- Phased out 15 year old commercial vehicles
- Strengthened vehicle inspection programme (PUC)
- Efforts made to bypass transit traffic

*Relocated polluting industry. Stricter action on power plants*

*Other major Indian cities have also begun to implement clean air action plans nearly patterned along the same line....*
Delhi got cleaner air: it avoided pollution

PM10 at ITO Traffic Intersection

PM10 trend projection pre Supreme Court directions

PM10 trend March 98- Dec 05, Post Supreme Court directions
Early steps in big cities in south

**On vehicle technology and fuel quality**
- Introduced unleaded and low benzene petrol
- Mandated pre-mix petrol to two- and three-wheelers

**On alternative fuels**
- Implemented LPG programme for autos and small vehicles
- Beginning of CNG bus programme
- Beginning of electric vehicles
- Limited programme on bio diesel

**Other measures related to vehicles**
- Strengthened vehicle inspection programme (PUC)
- Efforts made to bypass/restrict truck traffic
- Green tax

**Industrial pollution control and notices for non-compliance;**
- Open burning of biomass and solid waste banned in municipal area

**Improved air quality monitoring etc**
Pollution and Growth
(\% increase during 2002-2008)

Eg. Hyderabad: Only SO2 trend delinked from economic growth. Other pollutants rising.
Action helps to protect public health

Evidence of action: Health
Benefits: Dip in PM10 leads to
13,000 less premature deaths
and reduction in respiratory illness\(^1\)

Source: Based on NAMP data, CPCB, 1. World Bank 2004,
• Second generation challenge
Delhi has lost its gains. After a short respite pollution curve turns upward.
PM10 levels remain elevated in three southern metros despite first generation action.
Air quality standards are stricter today. This raises the bar of public health protection

Key highlight of the new national ambient air quality standards

- **Uniform health based standards for all land-use classes.** The current practice of setting separate standards for residential, sensitive and industrial areas discontinued.

- **Annual sulphur dioxide and Nitrogen dioxide standards tightened**

- **Annual NO2 and SO2 standards for designated ecologically sensitive areas introduced**

- **PM10 standards for industrial areas aligned with the tighter standards for residential areas**

- **PM2.5 and Ozone standards introduced for the first time**

- **Standards for air toxics** including benzene, benzo (a) pyrene, nickel, and arsenic) introduced. Standard for ammonia continues
Clean air targets still elusive

- India needs time bound air quality targets to meet standards
- No punitive action on state governments for not meeting the ambient air quality norms.
- Abatement plans are not designed to meet local air quality demands
- Emissions regulations are kept weaker for most of India.

- In the US the air quality standards are federally enforceable. If the states fail to meet the air quality targets the EPA can impose sanctions, such as cut highway funds. Civil society can sue the state governments. “Citizen Court Suits” is explicitly allowed in the Act against EPA for failure to promulgate NAAQS, failure to adopt emissions standards, failure to develop or implement adequate state implementation plans.

- In India the eleventh five year plan, already underway, mandates the central government to set monitorable target of air quality -- achieve the standards of air quality in all major cities by 2011–12

Ensure enforcement of air quality standards, accountability and compliance.
• Second generation technology challenge
Explosive growth in India

30 years to reach the million mark in 1971.
Another 20 years to add two more million
In next 10 years (1981-91) another 14 million
Another 10 years (1991-2001) – jumped by 28 million
This decade just in four years (2001 to 2004) we have added 16 million

Vehicles: a special concern: Vehicle emissions contribute significantly to human exposure, higher health impacts, and warming. Vehicles will require more aggressive interventions.

Source: MOSRTH motor vehicle registration data
Galloping vehicle numbers

Vehicle registration in selected cities

Source: Compiled from statistics by transport departments and Road transport year books of Ministry of road transport and highways, Delhi
Vehicles threaten energy security

The guzzler: Nationally, transport sector uses up nearly 40 per cent of total consumption of oil and oil products

Hyderabad
- Cars and two wheelers use more than 50% of the fuel consumption in the transport sector. With increased dependence on personal vehicles the oil consumption will increase two times by 2030, with highest increase from four wheelers. (SIM Air study of 2009).
- By 2030 CO2 emissions will increase substantially from four wheelers – as much as 3 times. (SIM Air 2009)

Bengaluru
Greenhouse gases and health-damaging local air pollutants are increasing. Heavy-duty diesel vehicles accounted for 60% of the carbon dioxide emission, a warming gas.

Without interventions carbon dioxide will double over the next decade. Diesel consumption rate has been higher than that of petrol.

Our country still does not have fuel economy standards for vehicles
Vehicles of the rich and the heat trap

Number of motorised vehicles co-relate strongly with CO2 emissions
Cities with less vehicles have less CO2 emissions

Source CSE (Data from SIM Air and Wilbur Smith)
The subtle link between local air pollution and warming.

- **Local pollution can enhance the warming effects**…Eg, HC + NOx lead to regional ozone but also to background hemispheric ozone; CO becomes CO2 but consumes OH radicals along the way increasing CH4; Diesel PM increases PM10 & PM2.5 & ultrafine PM but also black carbon

- **Warming can also enhance local public health impacts** …Eg, each increase of 1 degree Celsius caused by carbon dioxide, can enhance PM and ozone build up. The resulting air pollution can lead thousands of additional deaths and many more cases of respiratory illness and asthma etc. (Mark Jacobson 2008)
• Second generation action... to meet clean air targets and public health goals.............
Unacceptable time lag
-- Bharat Stage III 12 years behind Europe
-- Bharat stage IV seven years behind

Diesel car emission norm trajectory and India’s position

During 12th plan refinery capacity will expand 1.6 times.

But this is not linked with stringent emissions standards roadmap.

There is no fiscal strategy

Source: Compiled from European Commission, MORTH, India, Diesel Net
Bharat Stage IV norms in few cities
Why are we creating two classes of citizens?
Diesel: License to Pollute

NOx norms for cars

PM norms for cars

One diesel car emits as much NOx as 3 to 5 petrol cars. PM is several times higher

Source: MP Walsh
Ironic: Rich use diesel subsidy to spew toxic emissions
But regulations do not force diesel to meet the clean benchmark

Better fuel efficiency of diesel cars is being traded off for a very serious toxic risk

Source ARAI
The shocker: Cancer risk of diesel

June 2012

The WHO/International Agency on Cancer Research reclassify diesel emissions as class 1 carcinogen, -- same class as tobacco for its strong link with lung cancer.

But India is dieselising very rapidly

Source: MP Walsh
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>Methylene 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>Diesel particulate matter</td>
<td>300</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: Unit Risk represents the number of excess cancer cases per million people per micrgramme 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 and vehicles (ARB, October 2000)”. Source: California Air Resource Board.
Clean diesel technology and fuel that can reduce emissions by 90% are not available in India.

Do not replace a new petrol car with a diesel, unless they meet US Tier 2 or Euro 5 Standards and ULSD is Available.

NOx control an additional challenge in the future… SCR challenge.
Cost benefit analysis convince other governments to take hard action.....

USEPA calculates cost benefit of clean air regulations to justify aggressive action. India looks away.........

Leapfrog with CNG….
Bengaluru, Hyderabad… on CNG route….

Huge drop in PM emissions. NOx emissions also decline

<table>
<thead>
<tr>
<th>PM emissions (grammes per kilometre) from tested buses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.35</td>
</tr>
<tr>
<td>0.3</td>
</tr>
<tr>
<td>0.25</td>
</tr>
<tr>
<td>0.2</td>
</tr>
<tr>
<td>0.15</td>
</tr>
<tr>
<td>0.1</td>
</tr>
<tr>
<td>0.1</td>
</tr>
<tr>
<td>0.05</td>
</tr>
<tr>
<td>0.0</td>
</tr>
</tbody>
</table>

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

Moderate drop in NOx emissions
-- Euro II diesel: 6.24 g/km
-- Euro II CNG: 5.35 g/km

Source: Teri
Clean fuel… but need more robust technology..

Maintenance challenge

Need appropriate regulations and institutional measures

Develop institutional capacity to address regulatory, safety and operational issues.

Need certification and monitoring of conversion agencies for quality conversion

Periodic third party inspection of safety measures and in-use emissions. Prevent safety compromises, component failures, and borderline emissions performance

Quality audits of the conversion workshops and conversion agencies

Maintain effective price differential with conventional diesel and CNG fuels

Network plan and implementation of the refueling infrastructure

Two wheelers – yet another challenge …… Need urgent discussion
• Address mobility crisis.............
Challenge of mobility crisis

...... an increasing share of our daily trips are being made by cars that occupy more road space, carry fewer people, pollute more, guzzle more fuel. They edge out pedestrians, bicycles, cycle rickshaws and buses ...........
Mobility challenges

Bengaluru:

-- About 3.8 million vehicles registered till June 2011. The vehicle stock in Bengaluru is half of that of Delhi. Yet gridlocked.

-- More than 1200 vehicles are registered every day, of these 250 are cars and close to 900 are two-wheelers. Two wheelers and cars are 90% of the total registered vehicles.

-- Travel speed has dropped to 15 kmph during the peak hours.

-- On most roads traffic volume is 2.5 times higher than its designed capacity – result gridlocks.

-- An average citizen of Bengaluru spends more than 240 hours stuck in traffic each year resulting in loss of productivity, reduced air quality, reduced quality of life, and increased costs of goods and services.

-- 120 lakh person trips by mechanical modes are estimated to be generated in 2025. Present modal split of 54% in favor of public transport is estimated to fall to 49% by 2025.
Mobility Challenges

**Chennai**
Vehicles increased from less than 5 lakhs in 1991 to more than 30 lakhs now.

Cars are 20%, and two-wheelers are 55% of the total fleet.

Two-wheelers and cars are 31% of the total travel trips and approximately 75% of the total vehicular fleet on road.

If two-wheelers are added Chennai has higher rate of motorisation than Mexico city. (CDP)

**Hyderabad**
Average peak hour journey speeds as low as 12 km/h.

Enormous delays at intersection, waste of time, energy loss, high emissions.

The vehicle density in Hyderabad is 720 vehicles per km of road (passenger car units per km of road) compared to 290 (Chennai) and 240 (Mumbai), which is very high, according to CDP
Roads hitting dead end in Delhi

Rajiv Gandhi Road expansion cannot keep pace with rising number of vehicles

Source: On the basis of Economic Survey, Delhi Govt
Positioning the debate

- 30-60% trips carbon neutral and low polluting.
- Logical in cities where average distance of 85% of travel trips is less than 10 km; nearly 40-45% is less than 5 km.
Volume of travel much higher in bigger cities
Total daily trips (in lakh)

Source: Anon Wilbur Smith/MOUD
Our advantage
Majority walk, cycle and take public transport
Compact city design reduces travel distances

Average travel distance high in Bengaluru, Hyderabad, Chennai. But less in smaller cities. Majority trips within small distance range.

In Chennai and smaller cities walking and cycling trips are higher than car and two-wheeler trips. In Hyderabad it is nearly equal. In Bengaluru and Kochi walking and cycling trips have fallen below car and two-wheeler trips.
Congested and paralysed……

Bengaluru, Chennai, Hyderabad face severe congestion

Source: Anon Wilbur Smith/MOUD
Reality check in Delhi
Public transport losing ground

Source: Anon 2008, transport demand forecast study: study and development of an integrated multi-modal public transport network for NCT of Delhi, RITES, MVA Asia Ltd, TERI, September
Why buses?.............

-- **Spine of public transport:** Buses provide the bulk of public transport services – as much as 40-60 per cent – in cities that have city bus services.

-- **Buses allow greater flexibility, geographical coverage, cost effectiveness, and space efficiency.** Can flexibly and easily meet the needs of changes in demography and land use. It can cover areas with lower travel demand.

-- **A bus occupies twice the road space taken by a car but carries 40 times the number of passengers.** Bus can displace anywhere between 5 and 50 other vehicles and allow enormous oil and pollution savings (IEA).

-- **Poor people are most dependent on affordable and cheap public transport to access jobs and services.** Urban poor can use upto 25-30 per cent of their income on transportation.

-- **Per person emissions several time less than cars**

---

**Bus transport can make a big difference...**

- **BANGALORE:** ADB study -- An increase in bus share from 62% to 80% saves equal to 21% of the fuel consumed in the base case.

- Leads to 23 per cent reduction in total vehicles and frees-up road space equivalent to **taking off nearly 418,210 cars from roads.**

- CO2 emissions can drop by 13 per cent. PM can drop by 29 per cent and NOx 6 per cent

- **BMTC had made significant turn around in bus operations**
Fuel cost is a serious barrier

Recent diesel price hike for buses staggering and mindless. For cars its pittance

Diesel cost is close to 65% of the total variable costs and around 38% of the total costs of BMTC in Bengaluru.

For MTCL in Chennai, fuel costs is almost 30% of the total costs and 54% of the operational costs.

This will push up bus fares. Erode bus ridership…. Minimum bus fares are Rs 5-7. The running cost of a two wheeler is Re 1 to Rs 2 per km

High costs can compromise quality of bus services

Need fiscal measures to reduce the costs of bus operations. Reduce fuel costs for buses and rationalise other taxes

Source: CSE - based on data from Operational Statistics
Rationalise taxes on transport

Buses bear significantly higher tax burden in India

-- Buses pay more taxes than cars
-- 12th five year plan documents states – taxes can be a quarter of the total costs of bus operations
-- Tax concessions available for metros but not buses
Indian style socialism
Tax burden on buses higher than personal cars in all southern states

<table>
<thead>
<tr>
<th>City</th>
<th>Time period</th>
<th>Tax on two wheeler</th>
<th>Tax on car</th>
<th>Tax on bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chennai</td>
<td>1 year</td>
<td>Rs.266.66 - Rs.320</td>
<td>Car costing Rs.4 Lakh-Rs.6 lakh: Rs.2,666.66- Rs.4,000 Car costing Rs.6 Lakh-Rs.10 lakh: Rs.4,000- Rs.6,666.66</td>
<td>Rs.80,000</td>
</tr>
<tr>
<td>Bengaluru</td>
<td>1 year</td>
<td>Rs.333.33- Rs.480</td>
<td>Car costing Rs.4 Lakh-Rs.6 lakh: Rs.3,466.66- Rs.5,600 Car costing Rs.6 Lakh-Rs.10 lakh: Rs.5,600 – Rs. 9,333.33</td>
<td>Seating: Rs.48,000 Standing: Rs.4,000- Rs.8,000</td>
</tr>
<tr>
<td>Hyderabad</td>
<td>1 year</td>
<td>1st vehicle: Rs.300-Rs.360</td>
<td>Car costing Rs.4 Lakh-Rs.6 lakh: 1st vehicle: Rs.2, 400- Rs.3, 600 and 2nd vehicle: Rs.3, 200-Rs.4, 800. Car costing Rs.6 Lakh-Rs.10 lakh: 1st vehicle: Rs. 3,600- Rs.6,000 and 2nd vehicle: Rs.4, 800- Rs.8, 000</td>
<td>Rs. 40,000- 50,000 (Indicative)</td>
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Contd......Indian style socialism

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<td>Car costing Rs.4 Lakh-Rs.6 lakh : Rs.2,666.66-Rs.4,000</td>
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<td>Cochin</td>
<td>1 year</td>
<td>Rs.200- Rs.240</td>
<td>Car costing Rs.4 lakh-Rs.6 lakh- engine capacity up to 1000cc: Rs.1,600-Rs.2,400 &amp; engine capacity 1500-2000cc: Rs.2,133.33-Rs.3,200</td>
<td>Ordinary services: Rs.1, 04,400-Rs.1, 12,800 Fast passenger and express services: Rs.1, 16,400-Rs.1, 22,400</td>
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## Contd......Indian style socialism

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<td>Rs.266.66 -Rs.320</td>
<td>Car costing Rs.4 Lakh-Rs.6 lakh : Rs.2,666.66- Rs.4,000 Car costing Rs.6 Lakh-Rs.10 lakh: Rs.4,000- Rs.6,666.66</td>
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<td>1 year</td>
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<td>1 year</td>
<td>Rs.200-Rs.240</td>
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<td>Seating: Rs.48,000 Standing: Rs.4,000-Rs.8,000</td>
</tr>
<tr>
<td>Puduchery</td>
<td>1 year</td>
<td>Engine capacity up to 100 cc:Rs.110 Engine capacity of 150-200cc: Rs.110-Rs.160</td>
<td>A car with an Unladen weight within 1,500-2,000 Kg :Rs.910</td>
<td>Stage carriage urban bus:Rs.24,000 Intrastate bus:Rs.41,600</td>
</tr>
</tbody>
</table>
Green Tax in Tamil Nadu Section 3-A of the Tamil Nadu Motor Vehicles Taxation Act, 1974 requires motor vehicles operators to pay an additional tax known as green tax in addition to tax otherwise payable under the Act. The green tax in Tamil Nadu is on old vehicles. The tax rates in Tamil Nadu are represented by the following table:

### Green Tax in Tamil Nadu with effect from 1st August, 2003

<table>
<thead>
<tr>
<th>Class of Motor Vehicles</th>
<th>Tax (in Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Motor vehicles other than transport vehicle which have completed 15 years from the date of registration</td>
<td>500 (for 5 years) 1000 (for 5 years)</td>
</tr>
<tr>
<td>i) Motor cycle</td>
<td></td>
</tr>
<tr>
<td>ii) Other motor vehicles</td>
<td></td>
</tr>
<tr>
<td>2. Transport vehicles which have completed 7 years from the date of its registration. (other than auto rickshaw)</td>
<td>500 per annum</td>
</tr>
<tr>
<td>3. Auto rickshaw</td>
<td>200 per annum</td>
</tr>
<tr>
<td>(with effect from 10th June, 2005)</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Government of Tamil Nadu, State Transport Authority
Fuel economy of buses worsening

Fuel economy performance of the bus fleet in Bangalore
Figure: HSD KMPL
Leyland and Tata BS-I vehicles

Need fuel economy standards for buses

Source: BMTC
Reorganise roadspace to allocate more space to public transport. You may ask – where is the space? But available road space is used inefficiently. Look at Delhi. So much roadspace is wasted. Only one lane available for motorised traffic.
The Transition........Reallocation of road space. More space to high capacity and non-motorised modes and majority commuters

<table>
<thead>
<tr>
<th>Distribution of Vehicles - By Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicles</td>
</tr>
<tr>
<td>Buses</td>
</tr>
<tr>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Distribution of People - By Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicles</td>
</tr>
<tr>
<td>Buses</td>
</tr>
<tr>
<td>Cycle &amp; Cycle Rkshw</td>
</tr>
</tbody>
</table>

Moving vehicles vs. moving people

Delhi Bus Corridor
Delhi is developing guidelines for modal interchange location

Bus stop, cycle rental: within 50 meter level walk from station exit

Cycle and two wheeler parking: within 100 meter level walk from station exit

Auto rickshaw stand: within 150 meter level walk from station exit

Private car/taxi/auto rickshaw “drop off”: with barrier-free of exiting pedestrians and NMT

Pedestrian exits, bus-stops and Cycle-rickshaw stands must be closest to main pedestrian exits from station.

Car parking if provided, must be BEYOND 250 M distance of Station/ or PT interchange point

Pairing of Origin-Destination (O-D) Nodes:
Provide cycle/ auto stands at nearby important destinations.

Signages at both end locations.
Private car parking only at Terminal Stations.
Discourage car parking at Stations within inner-city urbanized areas.
Multi-modal public transport network in Bangalore

- A multi-modal public transport network for the BMA has been proposed to be developed to meet expected commuter’s travel needs.
- The city has come up with a multi-modal integration of different modes to ease the traffic and have the effective use of public transport.
Hyderabad

- Formation of a Unified Metropolitan Transport Authority (UMTA) for HMA. UMTA act as a singular authority in decision making relating to traffic and transport.

Bangalore

- BMLTA through executive order. BMLTA is mainly concentrated to Bangalore city and DULT concentrates more on two tier cities.
- INITIATIVES: Intermodal hubs planned at 3 stations, comprehensive transportation study for the city
- Service level benchmarking twice in the city in 2008 and 2011; Integration of ticketing system with BMTC and metro. NMT projects undertaken; renovation of 40 odd to accommodate NMT facilities according to IRC guidelines. All the metro stations are supposed to accommodate NMT facilities.

Chennai

- The Chennai Unified Metropolitan Transport Authority (CUMTA) was formed in November 2010 as a single nodal agency that directs planning, operations, and monitoring of various transport modes In Chennai Metropolitan Planning Area.
- Key responsibilities -- preparation of a Comprehensive Transport Plan that looks at the planning and development of public transport options and their implementation through various agencies.
Urban design guidelines in Delhi to induce Modal Shift in favour of public transport, IPT, cycling and walking modes with an approximate target of 80-20, especially for short trips.

Network Density criteria are being set

*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
Need walkways to improve usage of public transport

Dedicated lanes for bicycles and pedestrians

G Tiwari
Poor walking infrastructure in Delhi

Captive walker in poor neighbourhood (Govindpuri and Zaffrabad): Traffic and people on collision course…..

- Discontinuous, poorly paved footpaths, and not easily accessible
- Height and width of pavements violate norms
- Poor signages, no pedestrian refuge islands -- crosswalks are ordeal
- No kerbed ramps or blended crossings to access the crosswalk facilities
- Exposure to traffic very high.

Source: CSE
Indian style socialism

Aurangzeb Road and Govindpuri

We have counted 3 persons per 10 minutes in Aurangzeb Road and 100 person per five minutes in Govindpuri

Urban planning does not keep people in focus

Source: CSE
Car infrastructure severing neighbourhoods and pedestrian routes

(All India Institute of Medical Sciences intersection)

Cloverleaf flyover disrupt at-grade continuity and direct shortest route, increase walking distance for the ailing visitors using public transport. At least in one direction use of subway is unavoidable.

Source: CSE
Jay walking….asserting their right to cross where convenient
But car centric design does not allow safe, quick and shortest crossing

Seamless and signal free traffic is interrupting shortest direct route for pedestrians. This is inciting jay walking

Sai Chowk, Patparganj
Scindia House, CP

Source: CSE
Unusable infrastructure: Wasteful

Guidelines of Indian Road Congress are inadequate

Eg. In the absence of proper guidelines on height of pavements unacceptably high pavements without proper gradients are being made…..

Source: CSE
Chennai: Dare to walk and cycle...

Source: CSE
Hyderabad: immobility...

Cycling, walking?? Can you

Wait for bus...or take a two wheeler?

Roads are meant for vehicles isn’t it?

Source: CSE
Bangalore: Bus reforms…a step way forward. But need mobility management to reduce congestion and pollution.

Source: CSE
Retrofitting changes…..

- Sidewalks are now being rebuilt in Delhi

Source: CSE
It is possible to change
Redesigned streets in a small town of Nanded in Maharashtra

Before

After

Source: Pradeep Sachdeva
This is an air pollution control measure

Walking and cycling lane in the bus rapid transit corridor
Policy murmurs

- **Bangaluru**: Framed a policy on pedestrian Movement for BMR in 2008
- Some zones -- Gandhi Nagar & Chickpet Areas are to be pedestrianised
- Commercial Street and Brigade Road - To be designated as ‘CLOSED FOR VEHICLES FROM 10 A.M TO 9P.M.’ and supported by parking at other road areas
- Renovation of 40 odd roads to accommodate NMT facilities according to IRC guidelines. All the metro stations are supposed to accommodate NMT facilities.

- **Chennai**: Among others a cycle track project is being planned. The bicycle tracks are proposed in a pilot project in Anna Nagar to improve conditions for pedestrian, cyclists, and other NMT users of the street.

- **Kochi**: The Kochi Corporation will strive to provide pedestrian-friendly infrastructure in keeping with the Indian Roads Congress (IRC) norms, especially on busy roads
Para transit: victim of air pollution control measures

Three-wheelers and cycle rickshaws are part of the solution....
High share of short trips make para transit convenient and affordable. Even buses are not convenient for short distances.

But most cities have harsh policies against them

Delhi is reorganising this sector:
-- All three-wheeler drivers to get public service vehicle badge and smart cards.
-- GPS connectivity to improve the meters and compliance.
-- In-use vehicle fitness and emission testing systems
-- Integrate with mass transit system.
Parking policy to control air pollution

- **Parking -- most wasteful uses of cars**: For about 90 to 95 per cent of the time a car is parked.

- **Insatiable demand for land**: In Delhi cars uses up 10.8% city’s urbanised area. The forest cover in Delhi is 11.5%.

- **In Hyderabad and Bengaluru** the land requirement for parking is more than 100 football fields in a year. In Delhi equal to 310 football fields.

- **Inequitous use of land**: Poor families get less land (about 18-20 sqm of land to build house) than car parking slot (23 sq m). The car owning minority using up more road space and urban space.
Parking aggravates congestion

On-street parking very high in Kochi (56% of roads used for parking, Madurai (52%) and Trivandrum (47%) which impedes both NMT and motorised movement and walkability.

Major Roads Length used for Parking (%)

Source: Wilbur Smith/MOUD
Reform parking pricing

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; delay journey to avoid peak parking charges; or go somewhere else......
Parking and air pollution control

The Khan Market imbroglio in Delhi..... Shoppers wanted free parking for their affluent clientele. Contested priced parking in court....Shoppers pay license fee to NDMC but do not charge users; Defeats user pay principle; have fixed a lower bound fee

Shopkeepers asked how parking policy is linked with clean air
• Global examples presented........
  • 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.
  • Amsterdam - parking fees expanded to meet EU directives on NO2 and PM10 emissions. Car plate numbers are registered with emissions information. ...
  • Zurich considers total NO2 emissions when determining the amount of parking to be allowed.

Resistance in Delhi to parking charge hike..............
Principles for parking pricing

NUTP sets the parking pricing principles

-- Parking fee should reflect true economic costs of land and facility
-- Only priced parking, eliminate free parking to encourage people to use public transport
• -- Do not provide unlimited parking
• -- Improve public transport connectivity and reduce parking supply
-- Introduce Graded parking rates to influence behaviour
-- Tokyo with more cars provide less parking in commercial areas (0.5 ECS/100 sqmt) as opposed to Delhi will less cars (3 ECS per 100 sqmt)

These principles must guide the practice. Municipal agencies to make explicit provisions on the following:

Free parking for cycles and cycle rickshaws and reduced/free rates for battery operated vehicles and public transport vehicles.

Parking rates should be higher for big cars and SUVs
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
What other options do we have?
Other governments are proposing restraints on personal vehicles use..

Delhi High Court order: Equitable distribution of road space….. Task force to propose car restraint measures…
Ministry of Urban development issues advisory on congestion pricing

Other governments enforcing tax and road pricing measures and caps on car sales to reduce congestion and pollution…

Congestion charges:
-- London: This has reduced traffic delays by 30 per cent.
-- Seven European cities are adopting congestion charges.
-- Trondheim, Norway: peak hour traffic dropped by 10% after the introduction of congestion charges.
-- Singapore’s road pricing measures: This reduced percentage of commuters entering central areas from 56% to 23%.

Caps on cars in Beijing, Singapore and Shanghai
-- Shanghai has adopted a system of auctioning a limited number of car licenses per month. This has helped the city to cap car registration at not more than 7,500 cars per month -- or 250 cars per day.

Do not repeat mistakes …..It is more expensive to undo mistakes
A spate of laws in India..
• December 1984: Bhopal Gas Disaster
• India learns the pain of industrial growth.
• 1986: The Environment Protection Act is passed.
• Environmental Impact Assessment mandated.
• Environmental audits introduced.
• But by the mid-1990s things were out of hand.

…. But pollution in cities, - toxic contamination growing.

• National Urban Transport Policy and JNNURM

…..But Congestion growing

…. No fuel economy regulations for cars yet …but car numbers galloping. Threatening energy security and climate
• **The paradox**: Trend toward strong environmental laws.

• Weak government action.

• Role of Judiciary and vigilant civil society important

• Public interest litigation (PIL) an opportunity for civil society to drive policies

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Deepen policy and public understanding to strengthen action
CHAPTER IV: PREVENTION AND CONTROL OF AIR POLLUTION

20. Power to give instructions for ensuring standards for emission from automobiles

- With a view to ensuring that the standards for emission of air pollutants from automobiles laid down by the State Board tinder clause (g) of sub-section (1) of section 17 are complied with, the State Government shall, in consultation with the State Board, give such instructions as may be deemed necessary to the concerned authority in charge of registration of motor vehicles under the Motor Vehicles Act, 1939 (Act 4 of 1939), and such authority shall, notwithstanding anything contained in that Act or the rules made thereunder be bound to comply with such instructions.

- Planning Commissions: State pollution control Boards reduced to industrial pollution control boards.....
19. **Power to declare air pollution control areas,**

- (1) The State Government may, after consultation with the State Board, by notification in the Official Gazette declare in such manner as may be prescribed, any area or areas within the State as air pollution control area or areas for the purposes of this Act.
- (2) The State government may, after consultation with the State Board, by notification in the Official Gazette,-
  - (a) alter any air pollution control area whether by way of extension or reduction;
  - (b) declare a new air pollution control area in which may be merged one or more existing air pollution control areas or any part or parts thereof.

So how do we address mobility management for air pollution control?
Cities are moving away from car centric infrastructure.

Before

After

Seoul’s Cheonggyecheon restoration project

Cities that have destroyed roadways

San Francisco
Milwaukee
New York
Portland
Toronto
Seoul
Our cities need upscaled transition to pollution and health costs

Cities have begun to work towards policies for low carbon and clean transportation. 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 and charges

Leapfrog technology
   Emissions standards
   Fuel economy standards

Fund the transition: Need tax measures to allocate resources efficiently and raise revenue. Taxes on public transport is 2.6 times higher.
This needs support. Must not be allowed to fail..
Otherwise what???
Towards livable cities......

Thank You