TRANSPORTATION AND ENVIRONMENT

A CASE STUDY OF NEW DELHI

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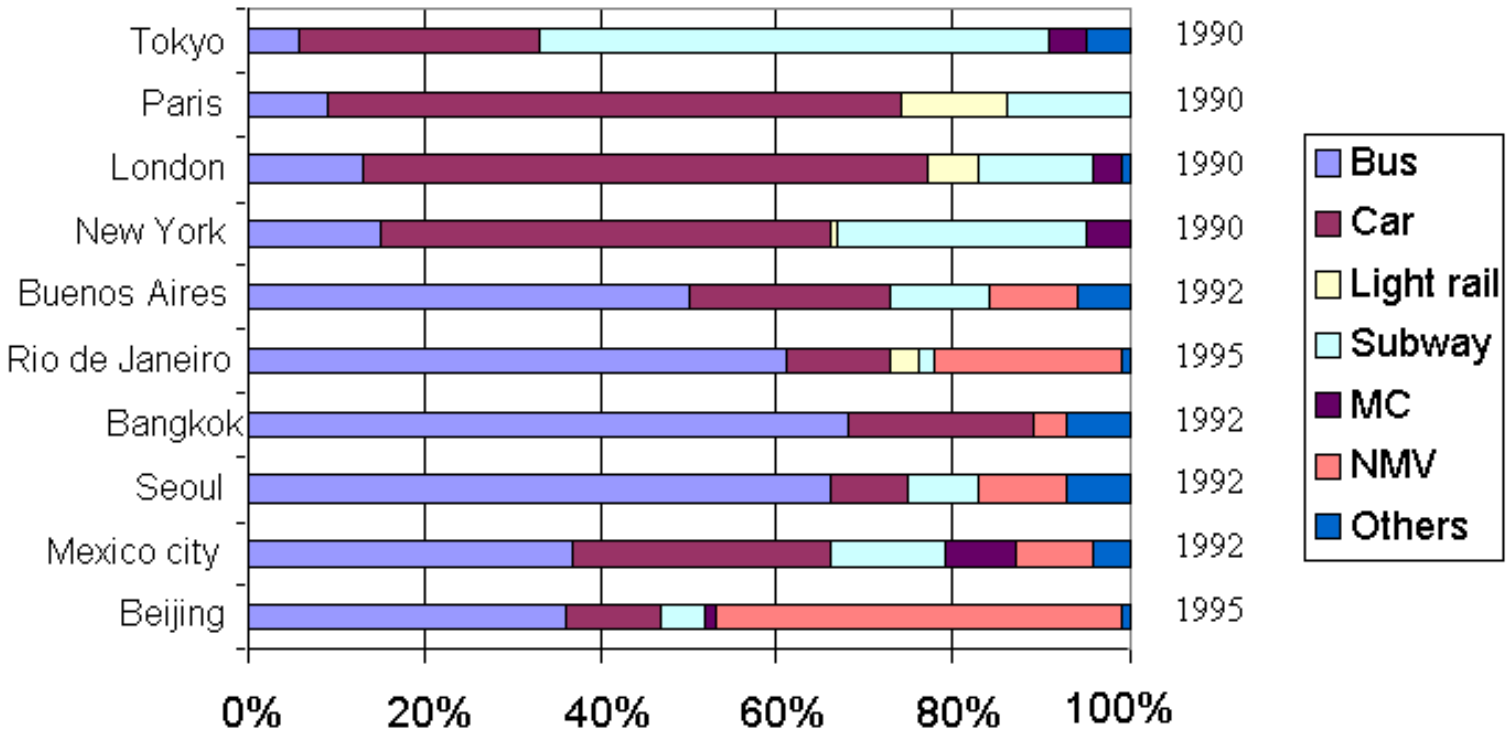
Share of Air Pollutant Emissions from the Mobile Sector

	CO	HC	NO_x	SO_2	PM
Mexico, 1994	100%	53.3%	70%	26.5%	4.3%
Santiago, 1992	94.2%	82.7%	84.6%	24%	11.5%
São Paulo, 1995	96.4%	90.9%	97.3%	85.5%	42.7%
Rio de Janeiro, 1978	96.4%	73.2%	69.6%	9.5%	3.5%
Beijing, 1992	63.4%	73.5%	21.7%		
Beijing, 1995	86.2%		49.1%	10%	
Delhi, 1995	80.5%	95.2%	69.4%	4.6%	6.6%

As the polluting industries which are scattered all around the urban area in Delhi and Beijing move out to the suburban areas and the transportation sector continue to grow, the share of mobile sources emissions will keep on rising.

Source: World Bank Report. Vehicular Air Pollution: Experience from Seven Latin American Urban Cities, 1997. Data in Beijing comes from the report titled China's Strategies for Controlling Motor Vehicle Emissions, 1997.

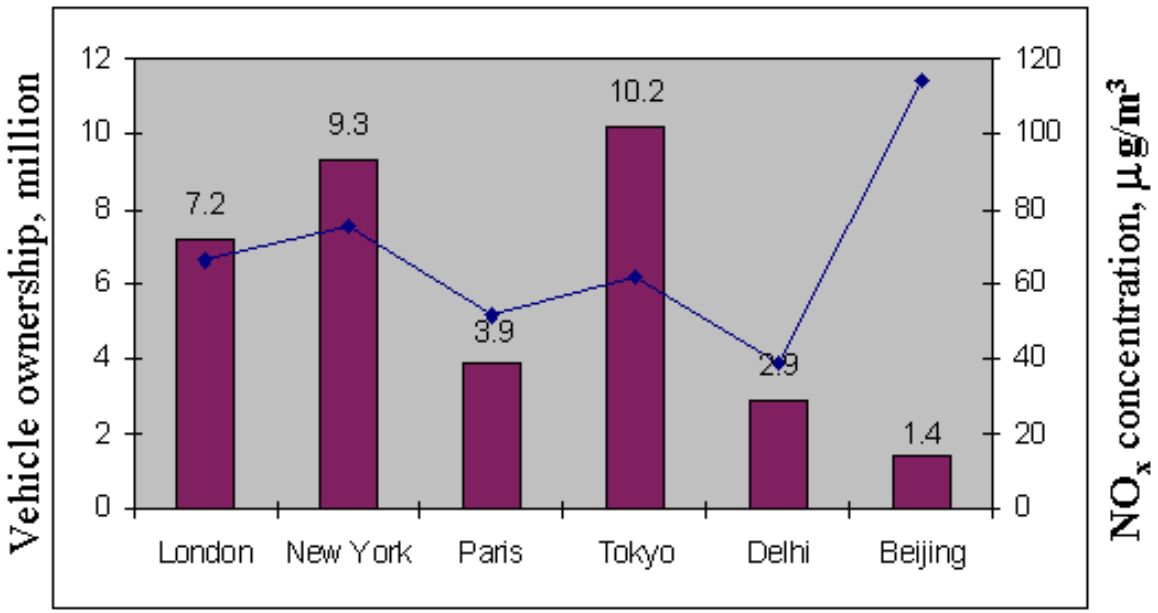
Comparison of passenger trip mix among big cities in the world



Delhi, 1994	Buses	Cars	Light Rail/Subway	MC	NMV	Others
%	62.00%	6.94%	0.00%	17.59%	6.61%	6.86%

Others:	Autorickshaws	Taxis	Rail	Others
%	2.80%	0.06%	0.38%	3.62%

Comparison of Vehicle Ownership and Pollution in Big Cities in the World



Data for Delhi vehicle number is in 1997, NO_x pollution is monthly average in 1998. Data for Beijing is in 1998. Others are in 1990.

Comparison of Road Infrastructure & # of Vehicles in Big Cities in the World

	Road Supply (m/person)	Total Vehicles per km of Road
New York (1991)	4.70	99
Paris (1991)	0.90	410
London (1991)	1.90	186
Tokyo (1991)	1.90	140
Beijing (1995)	0.94	50
Delhi (1992)	2.17	90

Source: Newman and Kenworthy (1991). For Beijing; "China's Strategies for Controlling Motor Vehicle Emissions: Summary Report", China Environmental Technical Assistance Project: B-9-3, World Bank, May 1998.

Air Pollution in Different Cities in the World in 1995 ($\mu g/m^3$)

City	TSP	SO_2	NO_2
Beijing	377	90	122
Delhi	415	24	41
Tokyo	49	18	68
Mexico City	279	74	130
London		25	77
New York		26	79
Los Angeles		9	74

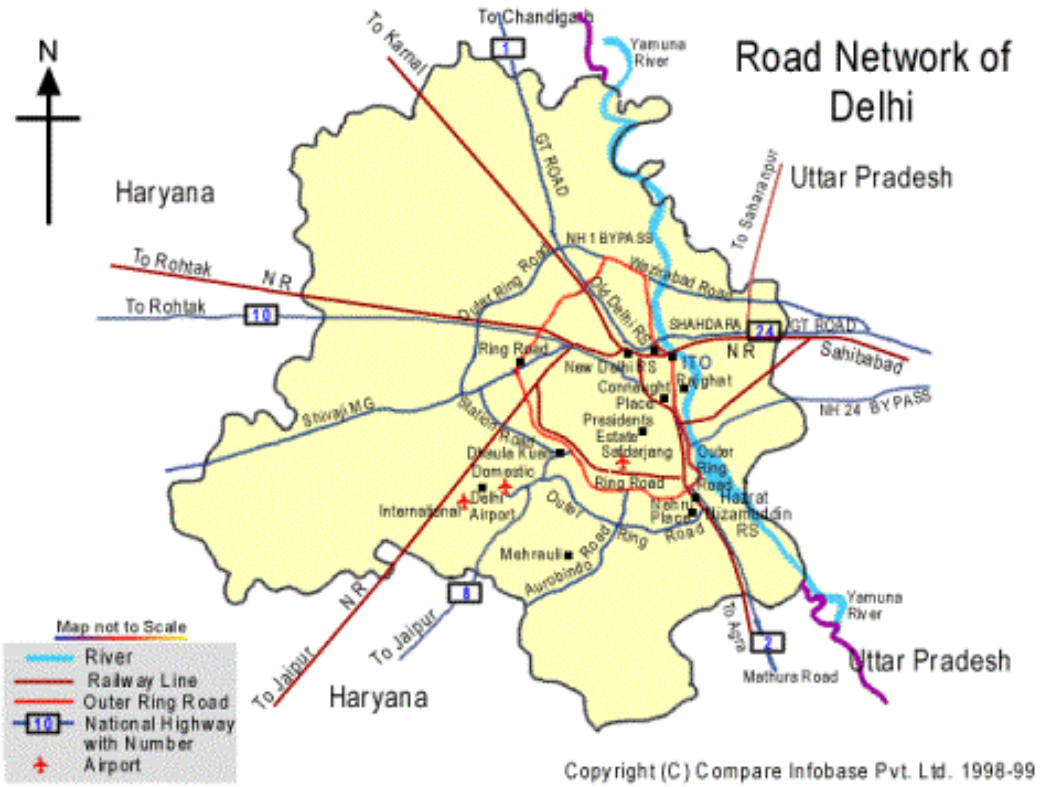
WHO Standards and Standards in Beijing

WHO / Beijing	Time-Weighted Average			Other
	1 hour	24 hours	1 year	Averaging Times
NO_x ($\mu g/m^3$)	/ 150	/ 100	30 / 50	95 (4 hours)
Ozone ($\mu g/m^3$)	150-200 / 160			100-120 (8 hours)
SO_2 ($\mu g/m^3$)	350 / 500	125 / 150	40-60 / 60	500 (10 min)
TSP ($\mu g/m^3$)		120 / 300	60-90 / 200	
PM-10 ($\mu g/m^3$)		70 / 150	50 / 100	
CO (mg/m^3)	30 / 10	/ 4		60 (30min) 100 (15 min)

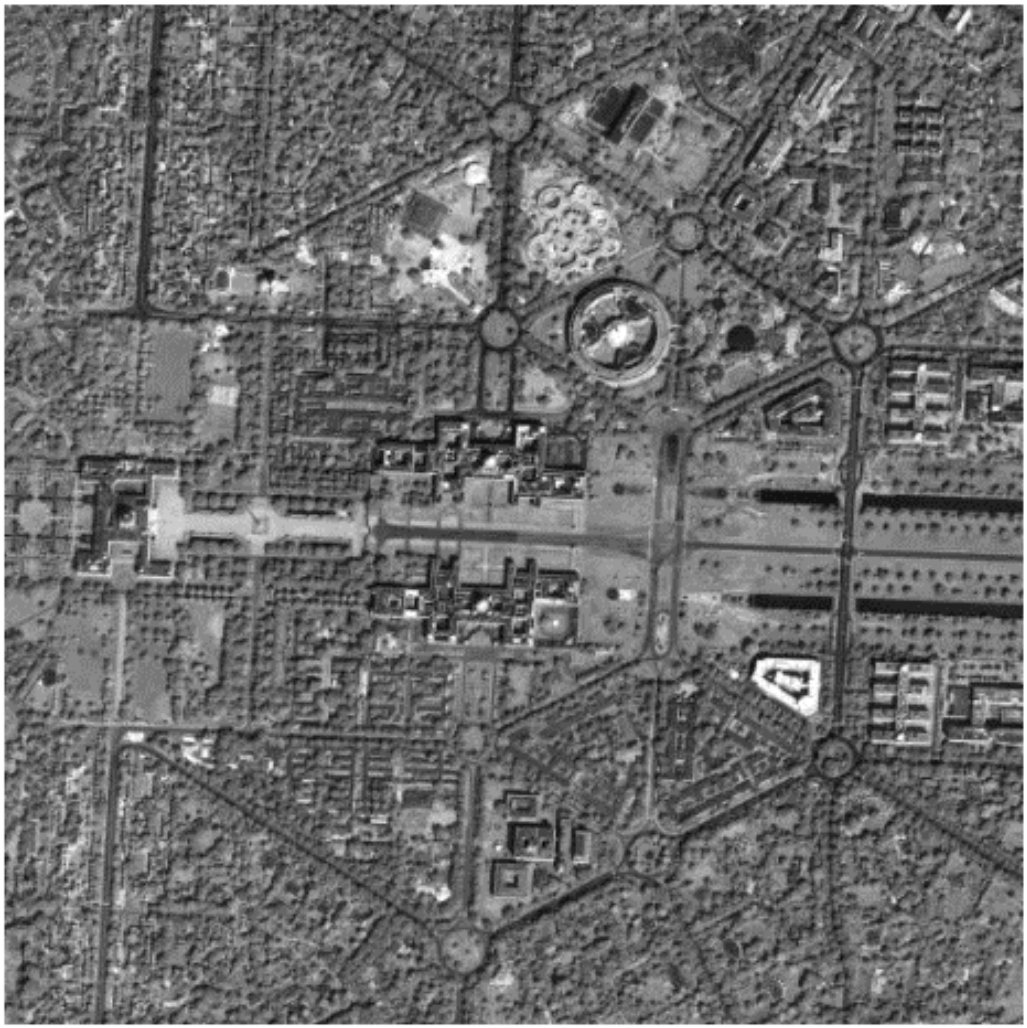
Annual Ambient Air Quality Standards in Delhi

Pollutant	Concentration in Ambient Air			WHO
($\mu g/m^3$)	Industrial	Residential	Sensitive	($\mu g/m^3$)
SO_2	80	60	15	40-60
NO_x	80	60	15	
SPM	360	140	70	60-90
PM10	120	60	50	50
CO (mg/m^3)	5	2	1	

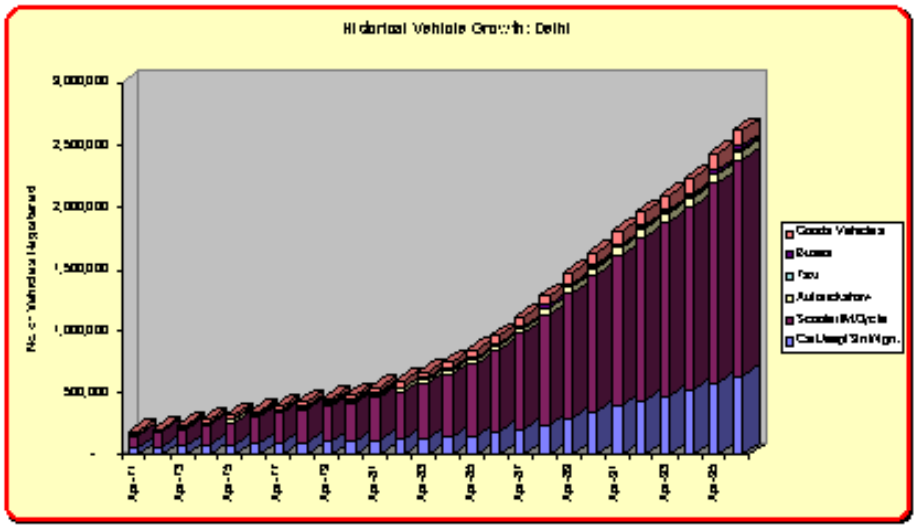
Delhi

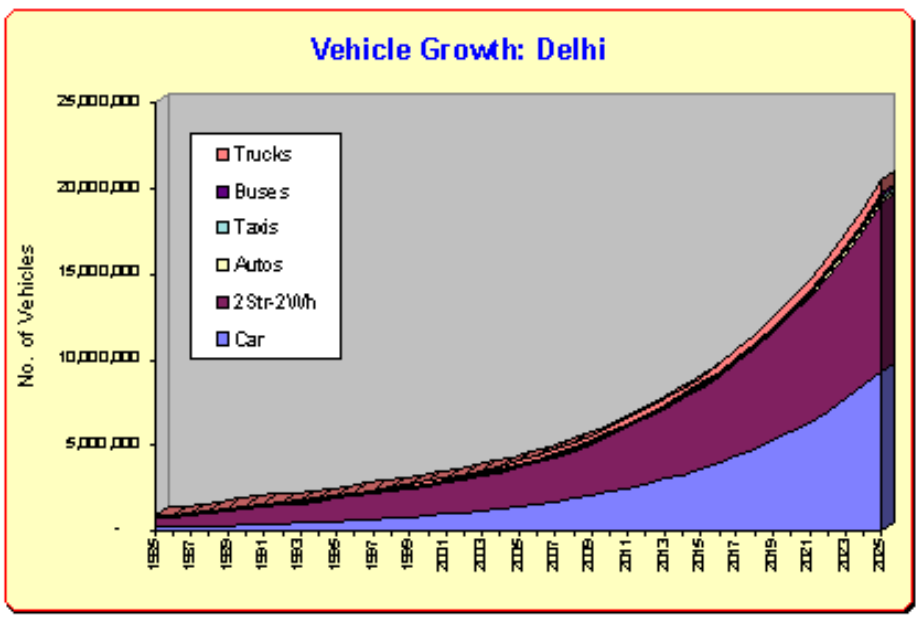


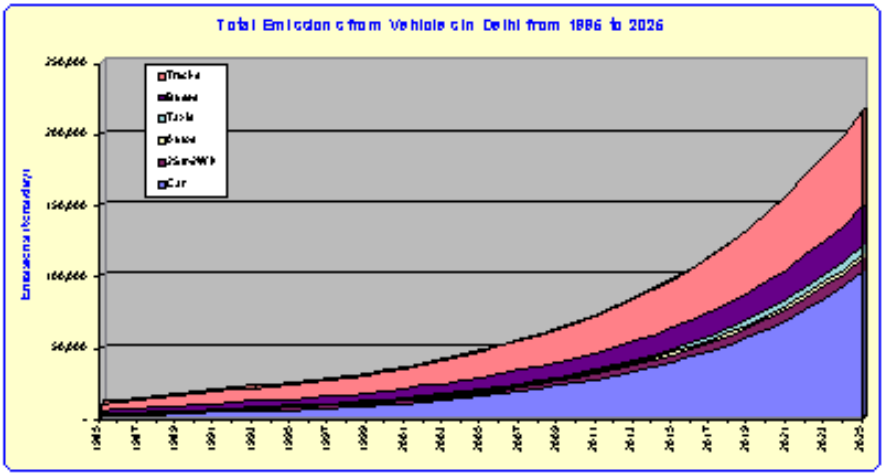
New Delhi, India

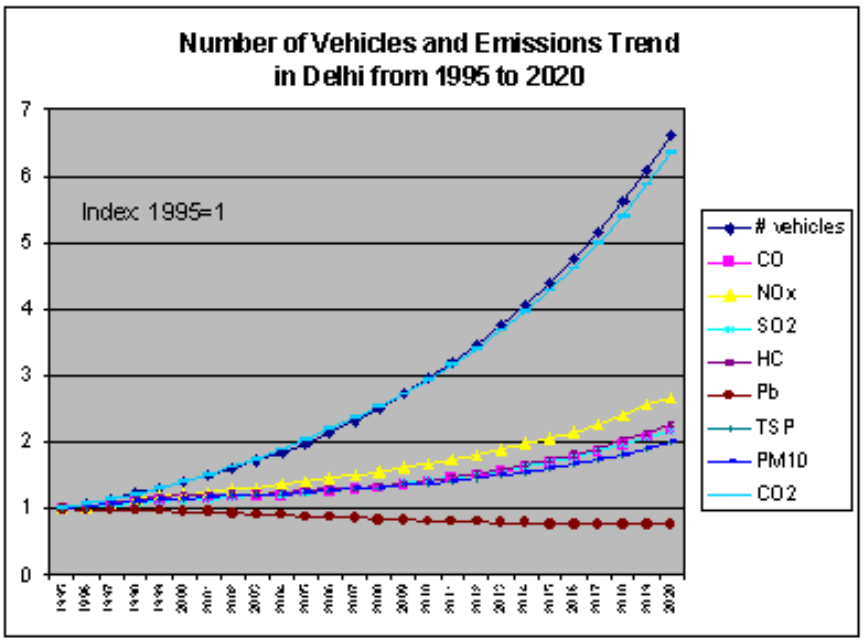


- 1 meter resolution black-and-white image of the Government District, New Delhi.
- IKONOS satellite collected the image on October 10, 1999.


Historical Vehicle Growth: Delhi
No. of Vehicles Registered
Goods Vehicles
Buses
Taxi
Autorickshaw
Scooter/M/Cycle
Car,Jeep/Stn Wgn.


Vehicle Growth: Delhi
No. of Vehicles
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
-
Trucks
Buses
Taxis
Autos
2 Str-2Wh
Car
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025


Total Emission from Vehicle in Delhi from 1996 to 2026


Number of Vehicles and Emissions Trend
in Delhi from 1995 to 2020
Index 1995=1
vehicles
CO
NOx
SO2
HC
Pb
TSP
PM10
CO2

Value of Time, Fuel Costs, & Health Costs from Passenger Transport in Delhi

million $	1995	2000	2020
Value of Time	58.53	158.99	7,810.24
Fuel Costs	650.07	866.29	10,783.42
Health Costs	472.72	1,270.48	9,664.11

million tons of carbon per year	1995	2000	2020
	2.33	4.53	21.51

# of premature deaths per year due to air pollution	1995	2000	2020
	5,441	10,943	31,427

Value of Time, Fuel Costs, & Health Costs from Passenger Transport in 2020 Under Different Scenarios for Delhi

million $	2020	2020 with 2000's speed	Difference
Value of Time	7,810.24	4,269.33	3,540.91
Fuel Costs	10,783.42	8,094.67	2,688.75
Health Costs	9,664.11	6,175.15	3,488.96
Total	28,257.77	18,539.15	9,718.62

STRATEGY:

Move people not vehicles!

For a more efficient transportation system:

* use low ***energy use per passenger-km*** modes

* use low ***emissions per passenger-km*** modes

* use modes with low ***road space consumption per passenger***

Public transportation (buses, subway, light rail) achieves best values of above parameters. Therefore, their development is essential for attaining a sustainable transportation system in the future.

Pollution Control Options for The Transportation Sector

- Technology options (such as new vehicle emission standards, fuel reformulation, alternative fuels) alone are not enough - standards will still be exceeded
- Infrastructure investments (build roads and develop infrastructure to sustain the growth in transportation) - road area in Beijing is 6.1% and in Delhi is 23%, whereas in other developed cities goes up to 30%
- Traffic management options to reduce congestion and increase speeds (a set of transportation system improvements such as arranging the traffic flow direction, and installation and better coordination of traffic signals)
- Employer based controls such as giving transit passes, arranging telecommuting programs, providing ride-matching information and services, and modified work schedules
- Enhanced I/M and accelerated vehicle retirement programs
- Improve public transit as a good alternative for the commuters and also by options such as parking management and road fees discourage extensive use of cars
- Environmental education and awareness programs
- Land use management