Transportation and Environment: Problems in Delhi and Beijing

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2 March, 2001

World Bank
Seminar

GOALS

- Put new emission standards in perspective
- Show relative impacts of health and congestion benefits
- Show need to integrate land-use planning and traffic management into environmental management
- Show usefulness of Decision Support models in data poor situations

Outline

- Substantive Work
  - Comparative Statistics
  - Delhi Studies
    - Kokaz, Harshadeep, Rogers
  - Beijing Studies
    - Kokaz, Liu, Rogers
  - City comparison
  - Some comments on application of DSMs
- Analytical Work
  - GIS
    - Srinivasan
  - Simulation
    - Harhadeep, Kokaz
  - Optimization
    - Kokaz

- *Recently with the population growth and economic expansion, the number of vehicles has been increasing rapidly in China and India.*
- *Automobile emissions are the most rapidly growing source of urban air pollution in most developing cities.*
- *These emissions contribute to a disproportionate amount to human exposure. And also, the highest polluting vehicles provide an huge amount of these total emissions.*
- *Therefore, targeting vehicular pollution control may be more cost effective than the industrial sector.*
- *The following slides include some international comparisons in transport system characteristics of different cities in the world, the description of Delhi's and Beijing's transportation sector and its effect on the environment.*

Share of Air Pollutant Emissions from the Mobile Sector

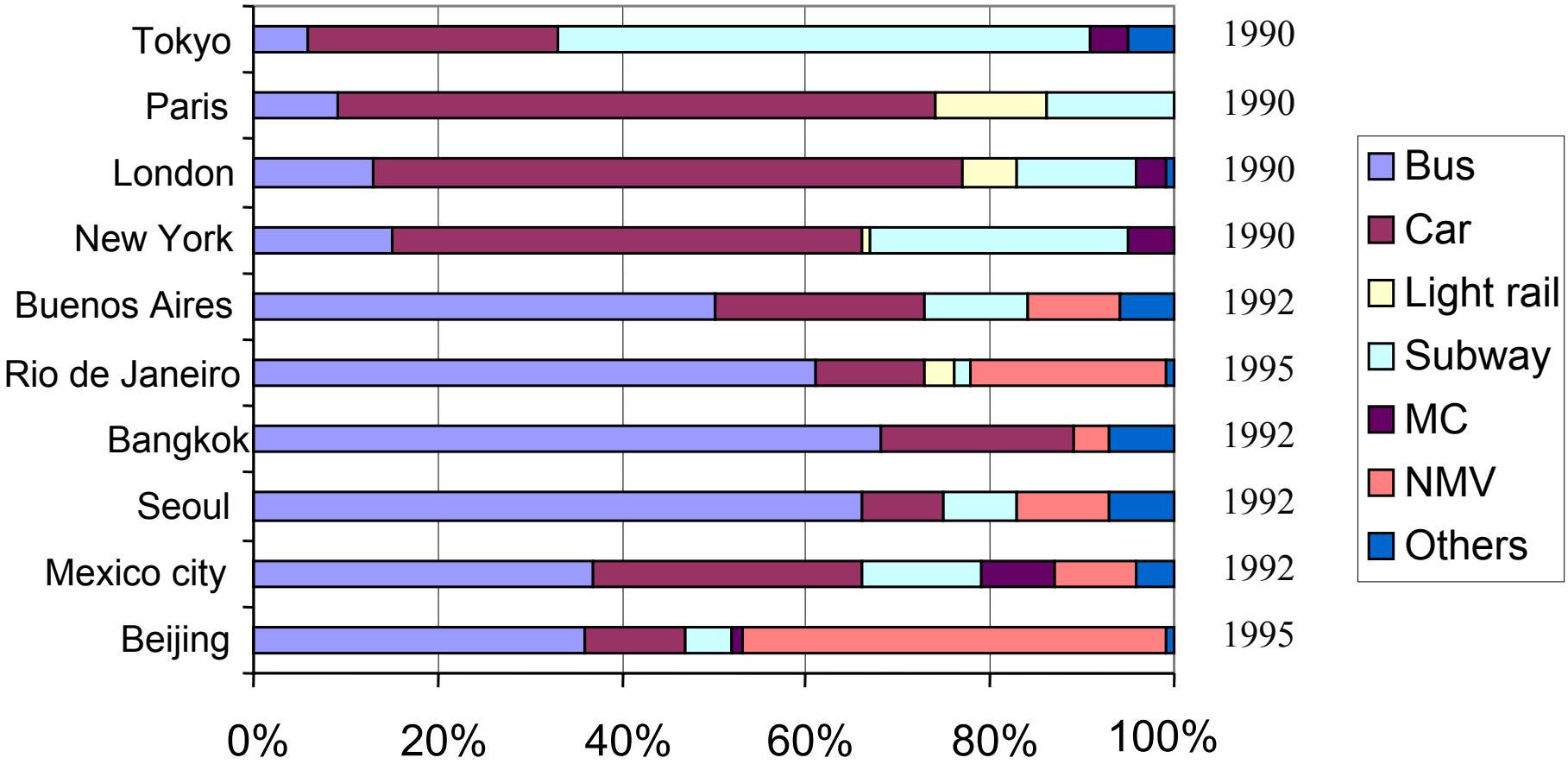
	CO	HC	NO_x	SO_2	PM
Mexico, 1994	100%	53.3%	70%	26.5%	4.3%
Santiago, 1992	94.2%	82.7%	84.6%	24%	11.5%
São Paulo, 1995	96.4%	90.9%	97.3%	85.5%	42.7%
Rio de Janeiro, 1978	96.4%	73.2%	69.6%	9.5%	3.5%
Beijing, 1992	63.4%	73.5%	21.7%		
Beijing, 1995	86.2%		49.1%	10%	
Delhi, 1995	80.5%	95.2%	69.4%	13%	12%

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 continues 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 for Beijing comes from the report titled *China's Strategies for Controlling Motor Vehicle Emissions, 1997.*

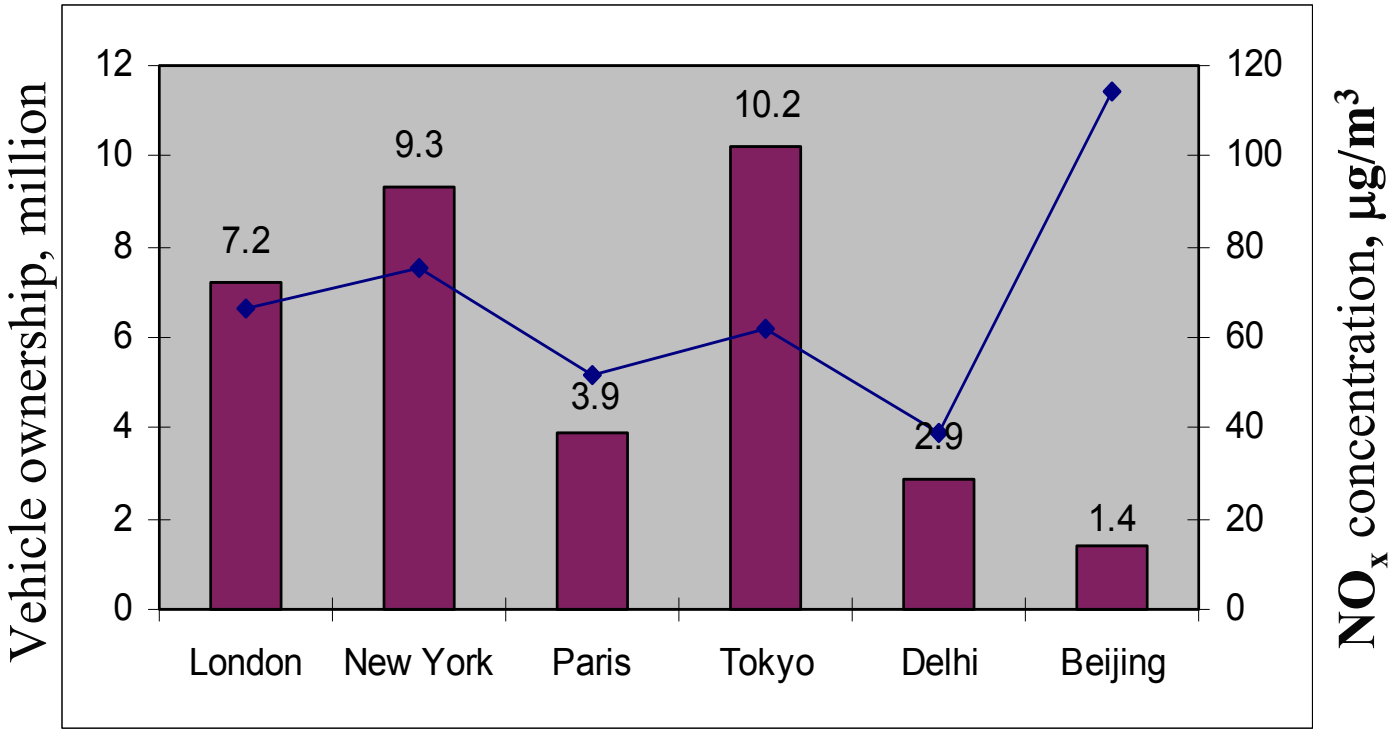
Comparison of passenger trip mix among big cities in the world



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

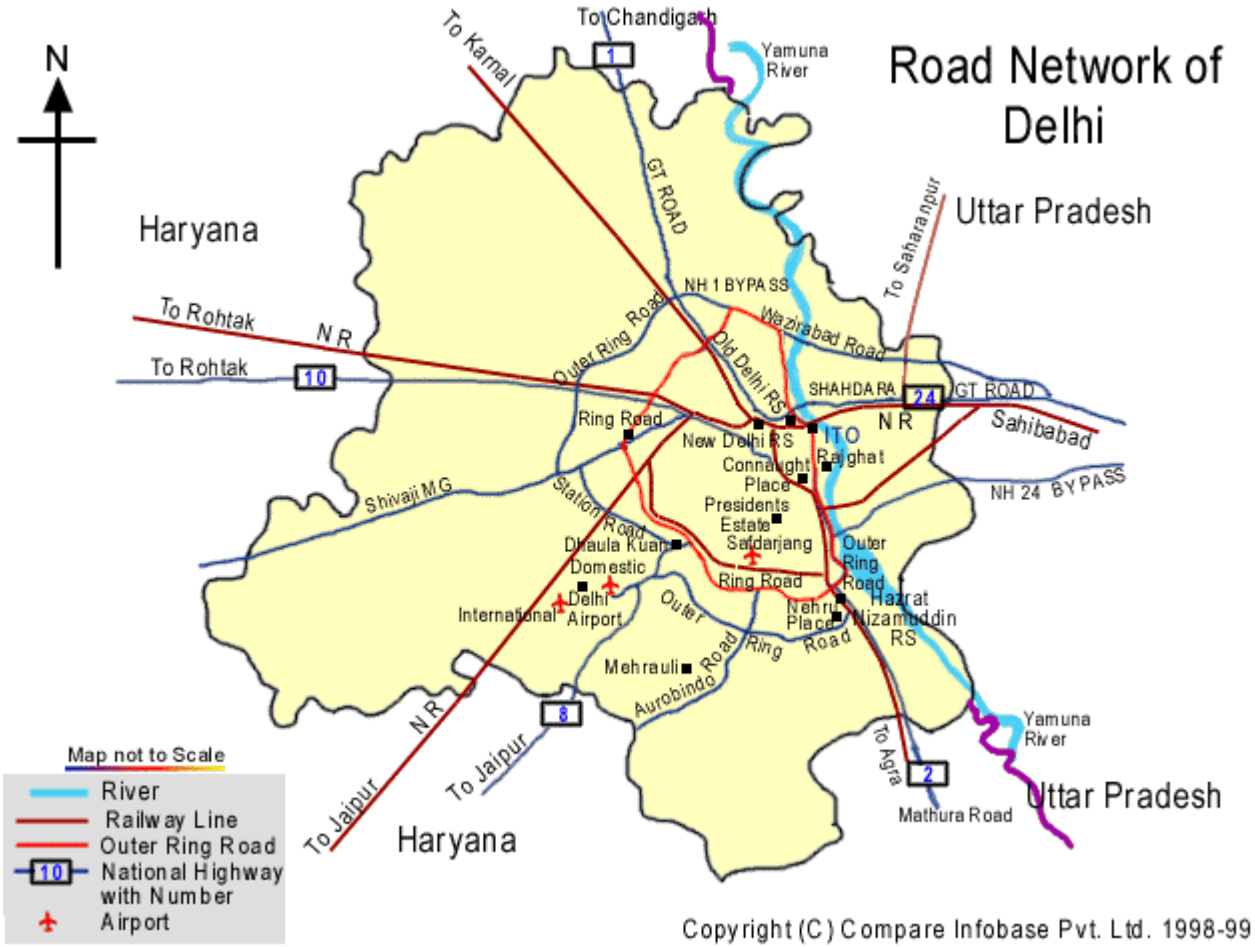
Source: Newman and Kenworthy (1991). For Beijing; "China's Strategies for Controlling Motor Vehicle Emissions: Summary Report", China Environmental Technical Assistance Project: B-9-3, World Bank, May 1998.

Air Pollution in Different Cities in the World in 1995

annual average ($\mu g/m^3$)

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

Delhi


Road Network of Delhi
N
Haryana
Uttar Pradesh
To Karnal
To Chandigarh
Yamuna River
GT ROAD
NH 1 BYPASS
To Saharanpur
To Rohtak
NR
To Rohtak
10
Outer Ring Road
Old Delhi RS
Wazirabad Road
SHAHDARA
24
GT ROAD
Ring Road
New Delhi RS
ITO
NR
Sahibabad
Connaught Place
Rajghat
NH 24 BYPASS
Shivaji MG
Station Road
Presidents Estate
Dhaula Kuan
Safderjang
Outer Ring Road
Domestic
Ring Road
Delhi Airport
International
Outer Ring Road
Nehru Place
Hazrat Nizamuddin RS
Mehrauli
Aurobindo Road
NR
8
To Jaipur
To Jaipur
Haryana
To Agra
2
Mathura Road
Yamuna River
Uttar Pradesh
Map not to Scale
River
Railway Line
Outer Ring Road
10
National Highway with Number
Airport
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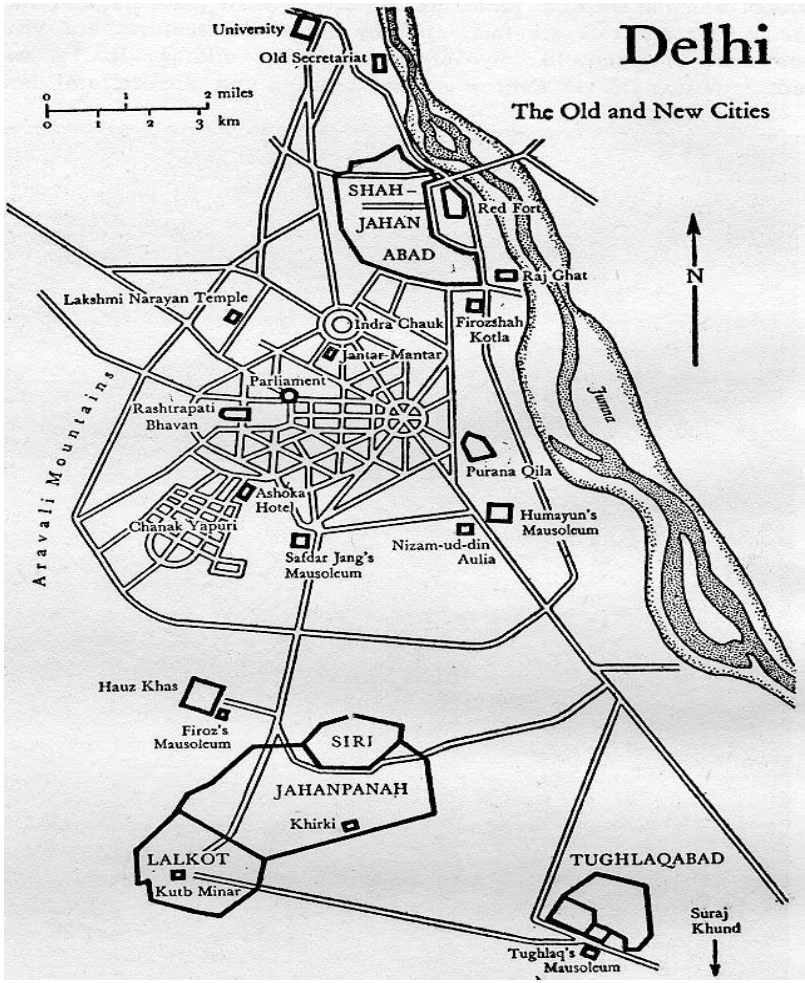
Outline

- New Delhi – an overview of plans and infrastructure
- Creating a database to understand transportation, land use and air quality management in New Delhi
- Land use and transportation planning in New Delhi
- Air quality issues in New 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.

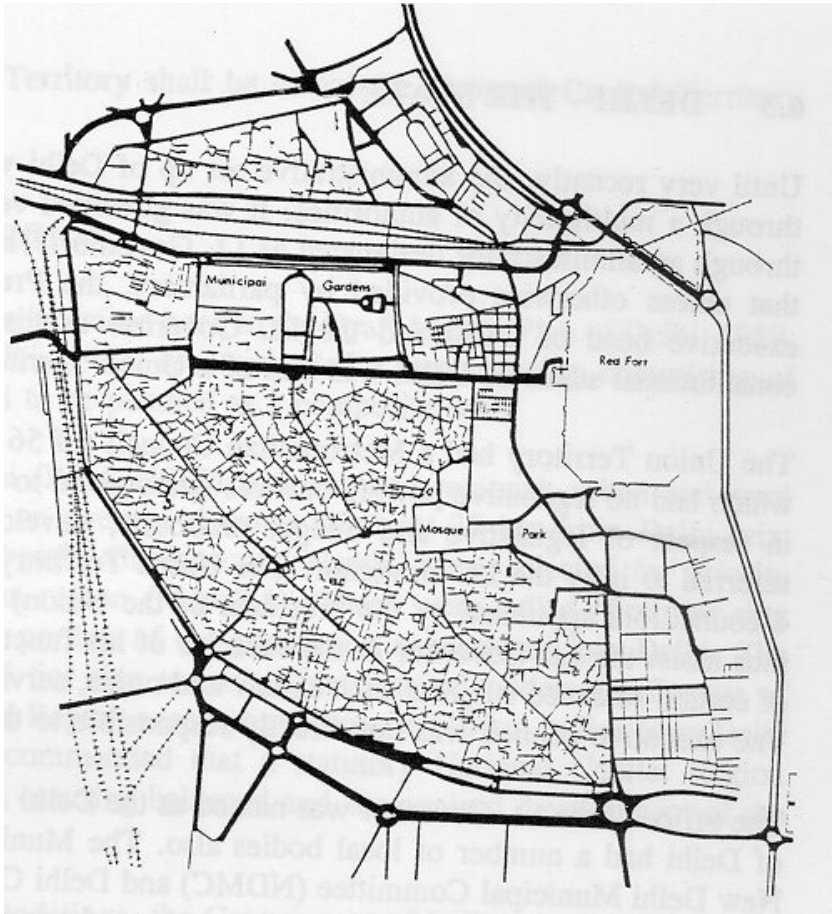
Historical images of Delhi - 1



Seven cities of Delhi:
Lalkot,
Siri,
Tughlakabad,
Jahanpanah,
Firuzabad,
Sher Shahi (Purana Quila),
Shahjahanabad

Sources: A. K. Jain, The making of a metropolis

Historical images of Delhi - 2

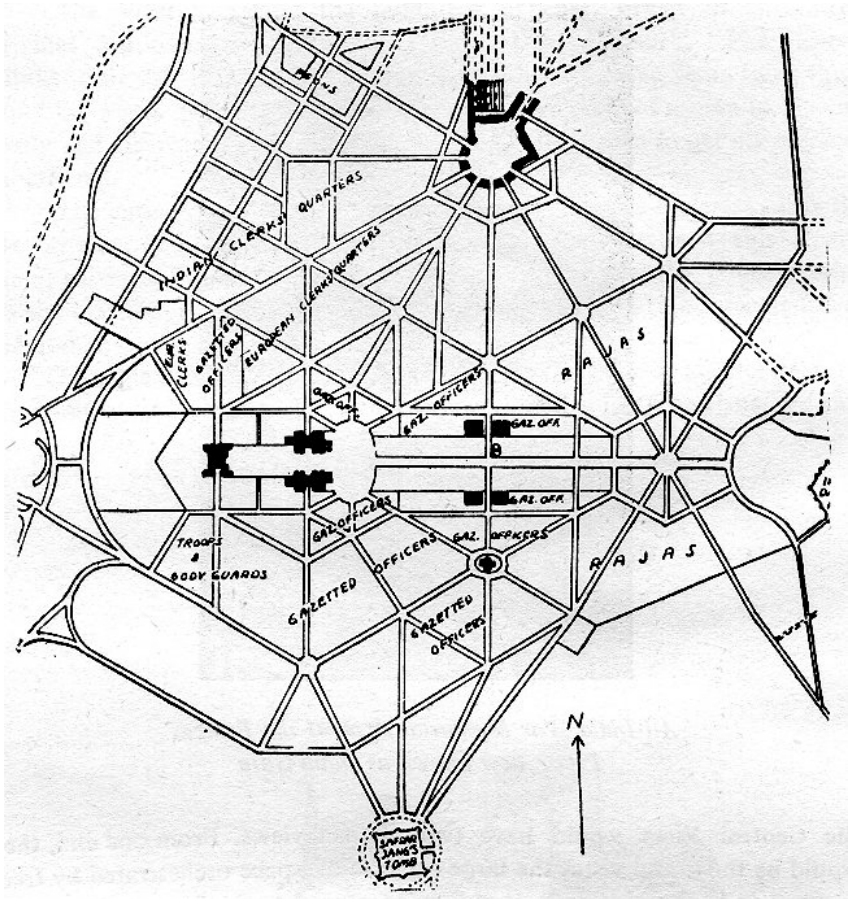


Historic walled city of Delhi

- Built in 1638 A.D. by Shahjahan
- Fortified with wall of 6 km circumference

Sources: Breese 1966

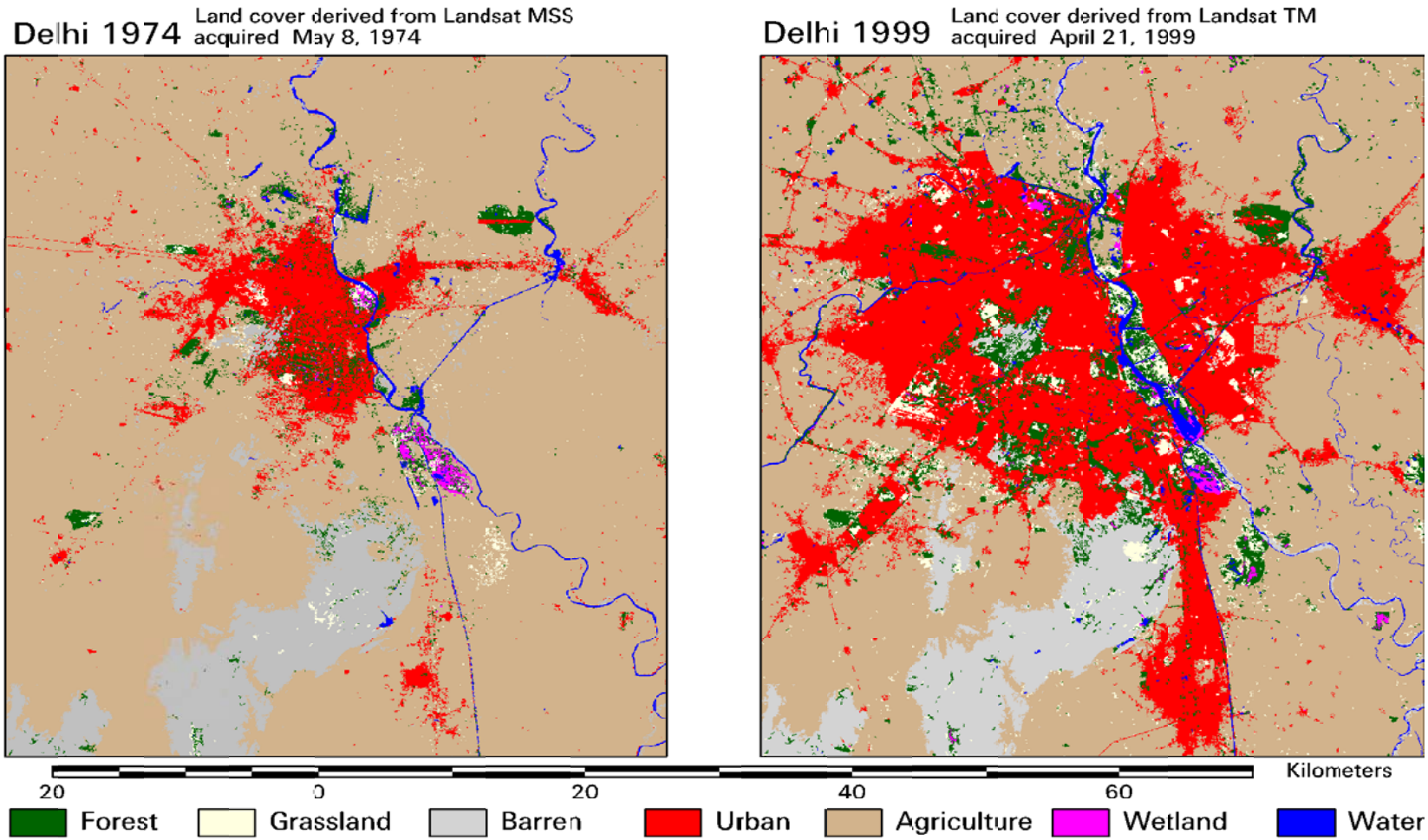
Historical images of Delhi - 3



- Came into existence in 1911 construction completed in 1931
- Planned on a hexagonal grid system
- Dominated by wide vistas, enormous buildings and large gardens

Sources: A. K. Jain, The making of a metropolis

Land use change in New Delhi



Database development

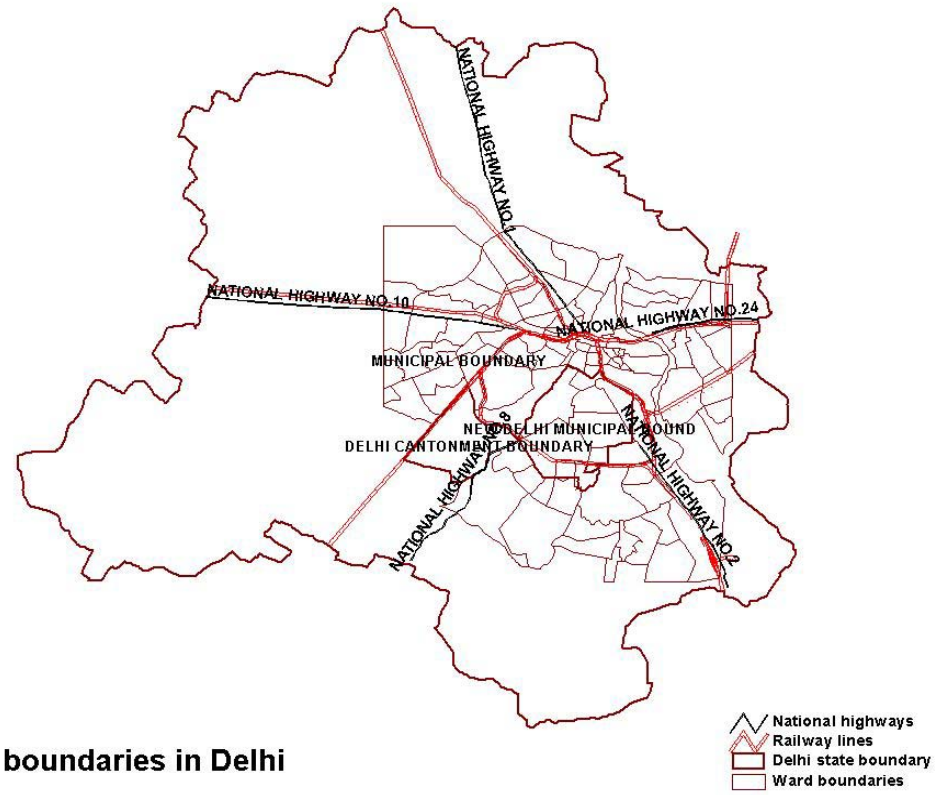
- Sharing of publicly available data from the local level agencies such as
  - DDA
  - NDMC
- State level agencies such as
  - Government Ministries
  - Town and Country Planning Organization
- Central Government Agencies such as the Central Road Research Institute,
- And other concerned data users and providers (Academic institutions, NGO, TERI)

Land use planning for New Delhi

- Who plans for
  - the City of Delhi?
  - the NCT?
  - the NCR?

- Integrated Land use and transportation planning is vital in cities with the growth rate that we can see in Delhi. Successful cases of such integration include:
  - Curitiba, Brazil
  - Portland, Oregon, USA
- Note that the variety of land uses is high in New Delhi

Modern Delhi



Ward boundaries in Delhi

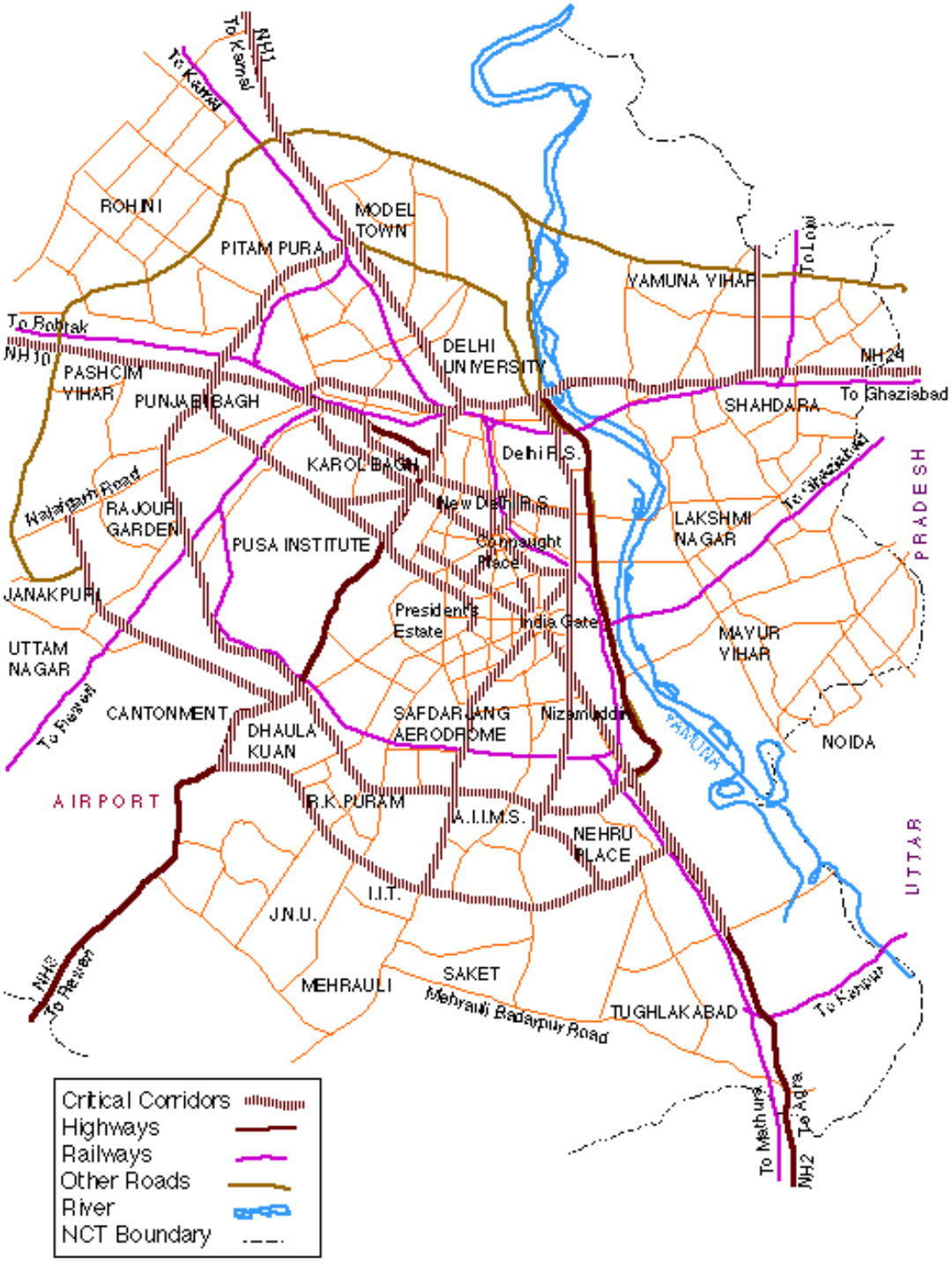
- Became state in 1992
- 2000 Population: 13,964,000
- Key bodies for all municipal services:
  - MCD (Municipal Corporation of Delhi)
  - NDMC (New Delhi Municipal Committee)
  - Delhi Contonment Board
- Has 70-member legislative assembly and a 7-member council of ministers

WHO announces Delhi to be one of the top ten most polluted cities in the world!

- Particle levels in Delhi consistently remain 3 to 5 times the national standards and maximum levels have even reached 8 times the standards during the winter of 1998.
- Particulate pollution kills 1 person per hour in Delhi
- WHO: Delhi is the 4th most polluted city in the world in terms of SPM.
- One out of two policemen suffers from respiratory diseases and one in every four have been diagnosed positive for initial symptoms of tuberculosis (Times of India, October 1998).
- If air pollution is reduced to WHO annual average standards then several thousand premature deaths, 4 million hospital admissions and sickness requiring medical treatment, and 242 million incidences of minor sicknesses (including RADs and RSDs) could be avoided in Delhi.

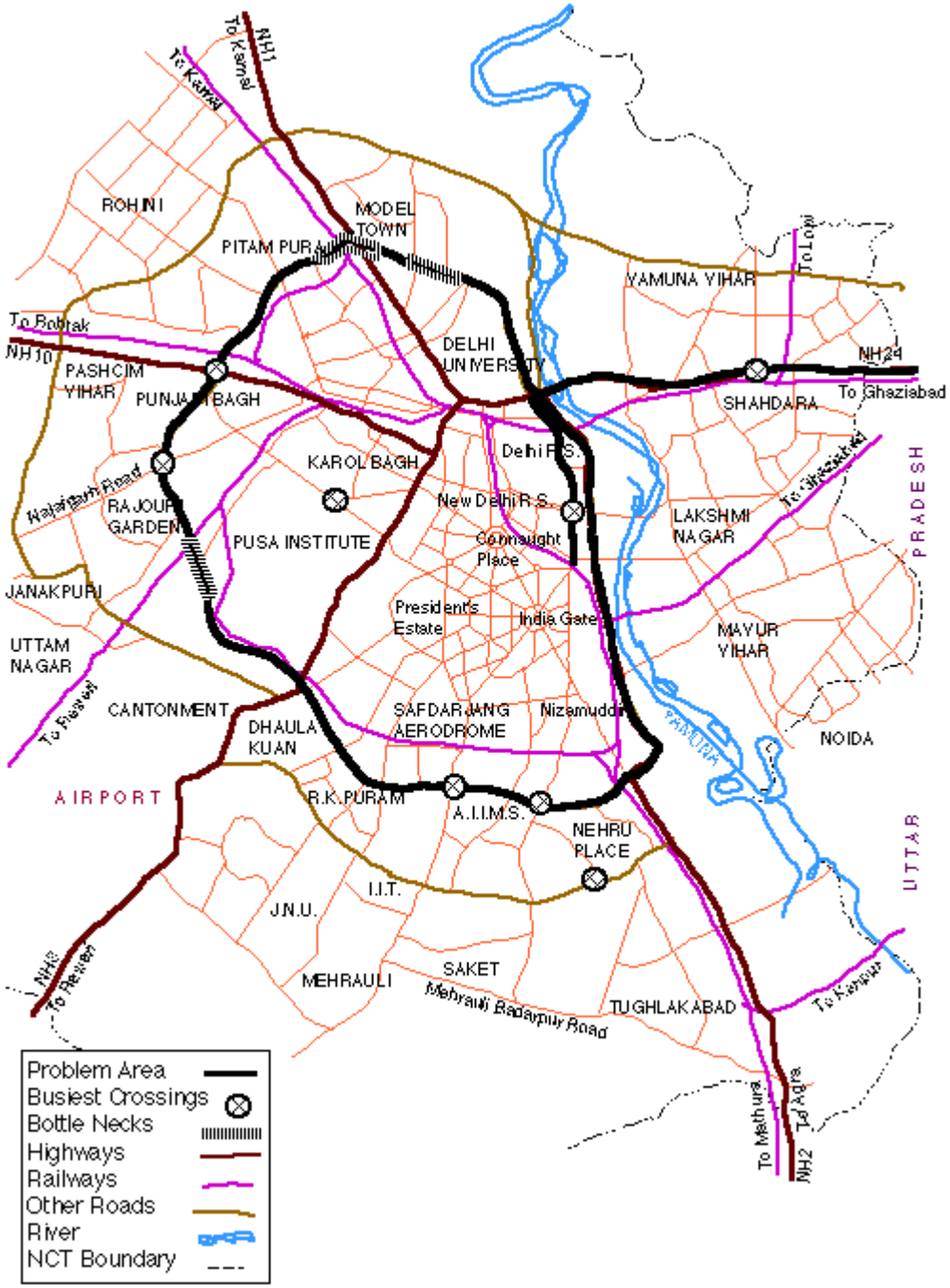
•(Source:Jian Xie, Jitendra J. Shah, Carter J. Brandon, "Fighting Urban Transport Air Pollution for Local and Global Good: The case of two-stroke engine three-wheelers in Delhi", 1998.)

Infrastructure issues - Traffic corridors



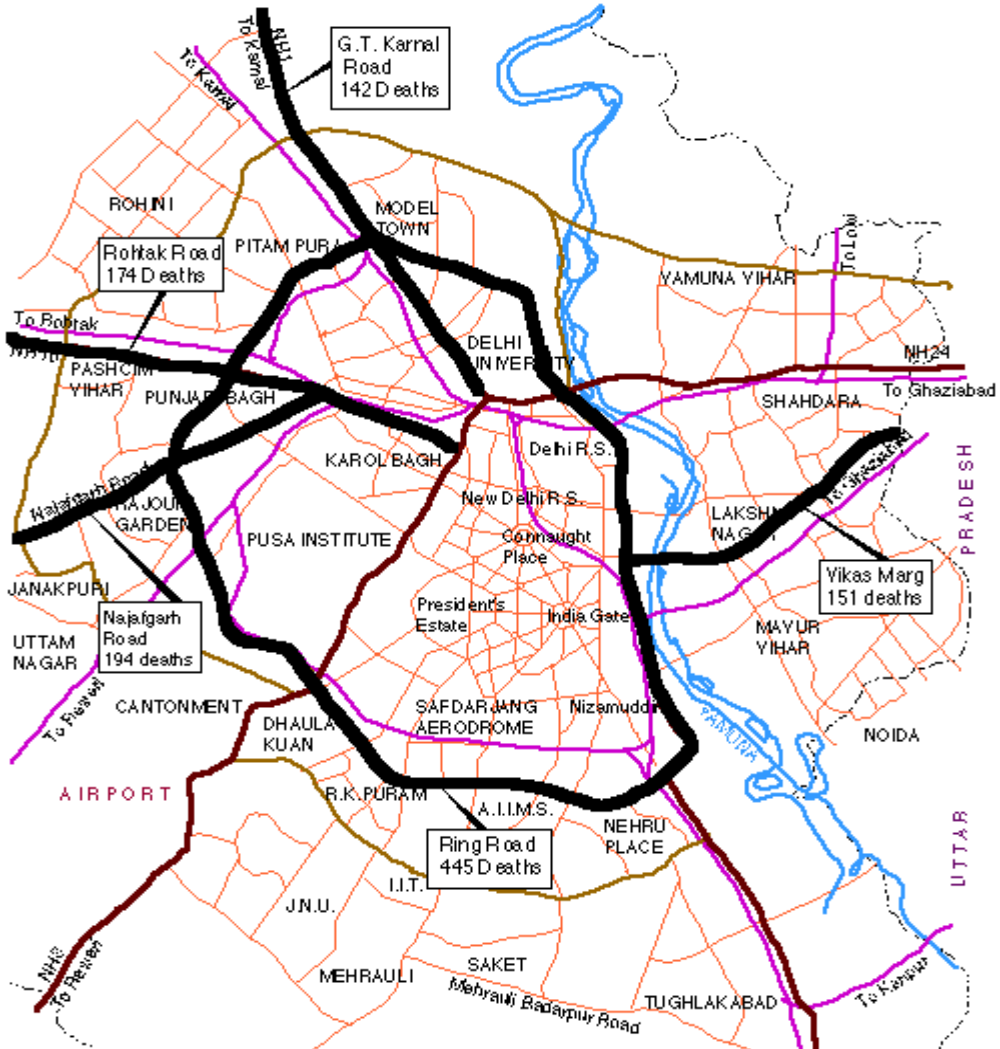
Source: www.isl.uni-karlsruhe.de/vrl/resp/delhi/respdwww/coverpage.html

Traffic problem areas



Source: www.isl.uni-karlsruhe.de/vrl/resp/delhi/respdww w/coverpage.html

Traffic accidents



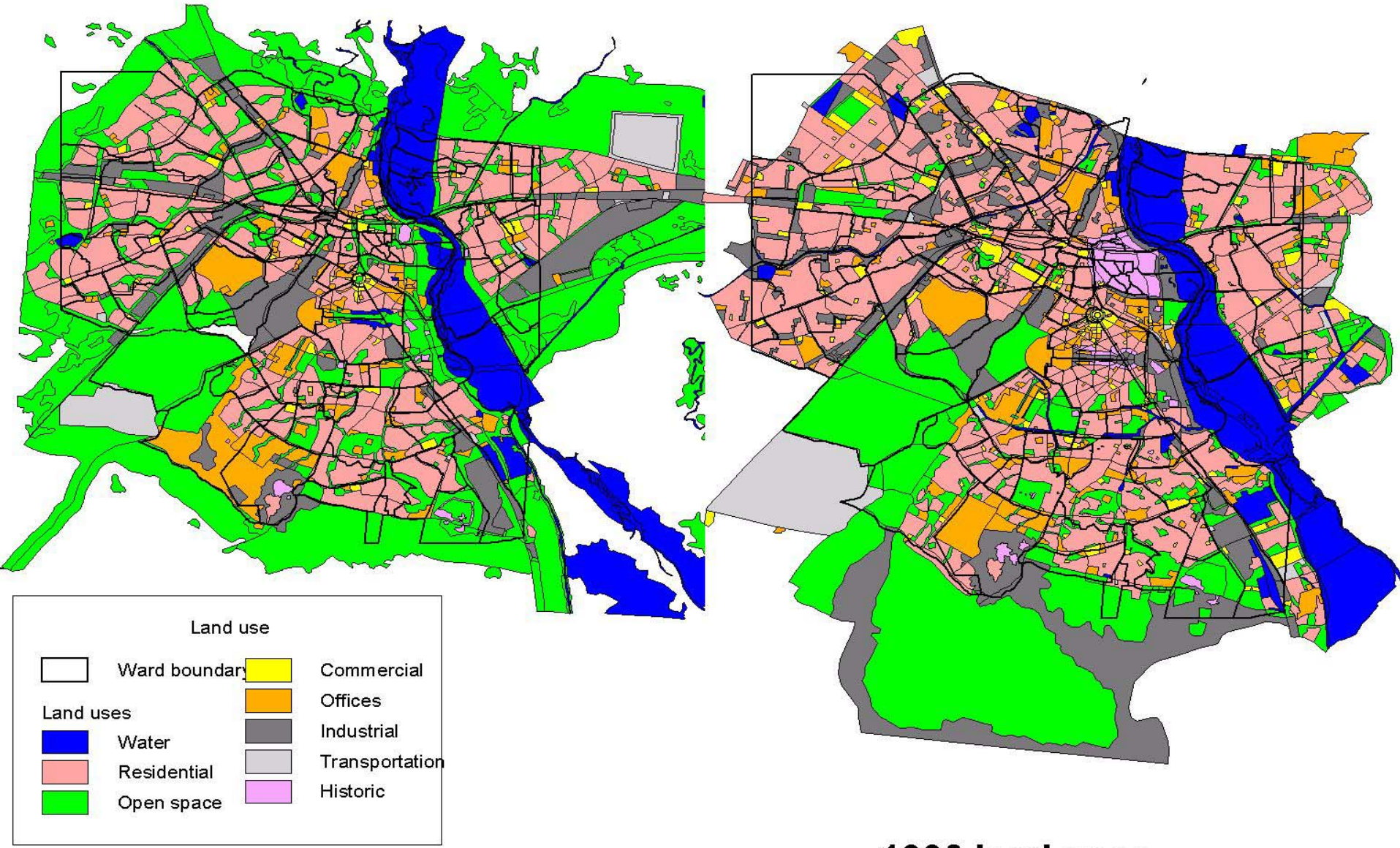
Accidents

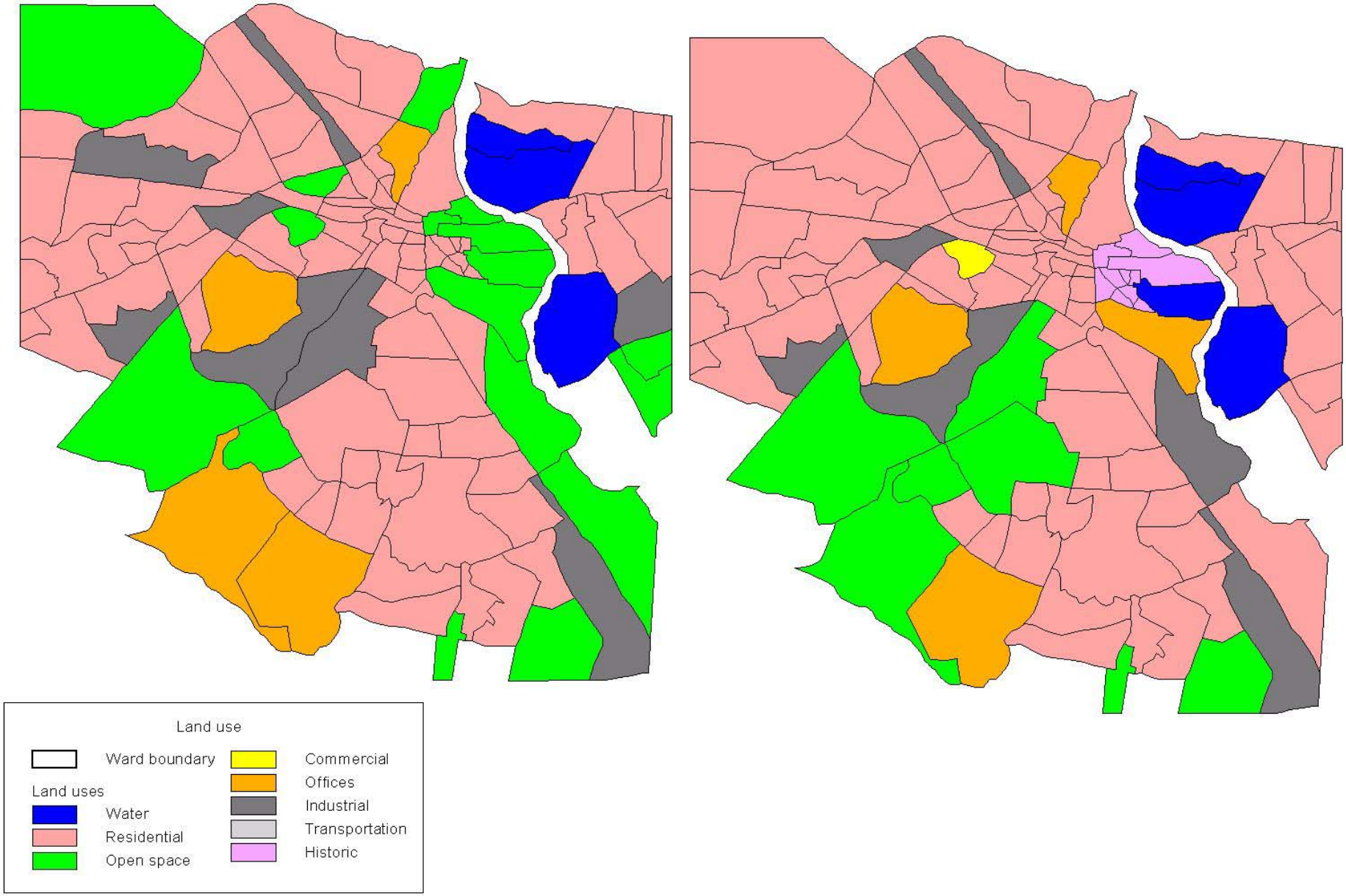
	1992	1993
Total	7496	7462
Simple	5842	5823
Fatal	1654	1639
Deaths	1680	1730

Total Deaths in 1993 (%)

Padestrians	35
Motorcyclists	15
Cyclists	10
Busses	8
Other Vehicles	8
Hit and Run	22

Source: www.isl.uni-karlsruhe.de/vrl/resp/delhi/respdww w/coverpage.html


Land use
Ward boundary
Land uses
Water
Residential
Open space
Commercial
Offices
Industrial
Transportation
Historic
1962 land uses
1990 land uses
N
2 0 2 4 6 Kilometers



Major land use (1962)

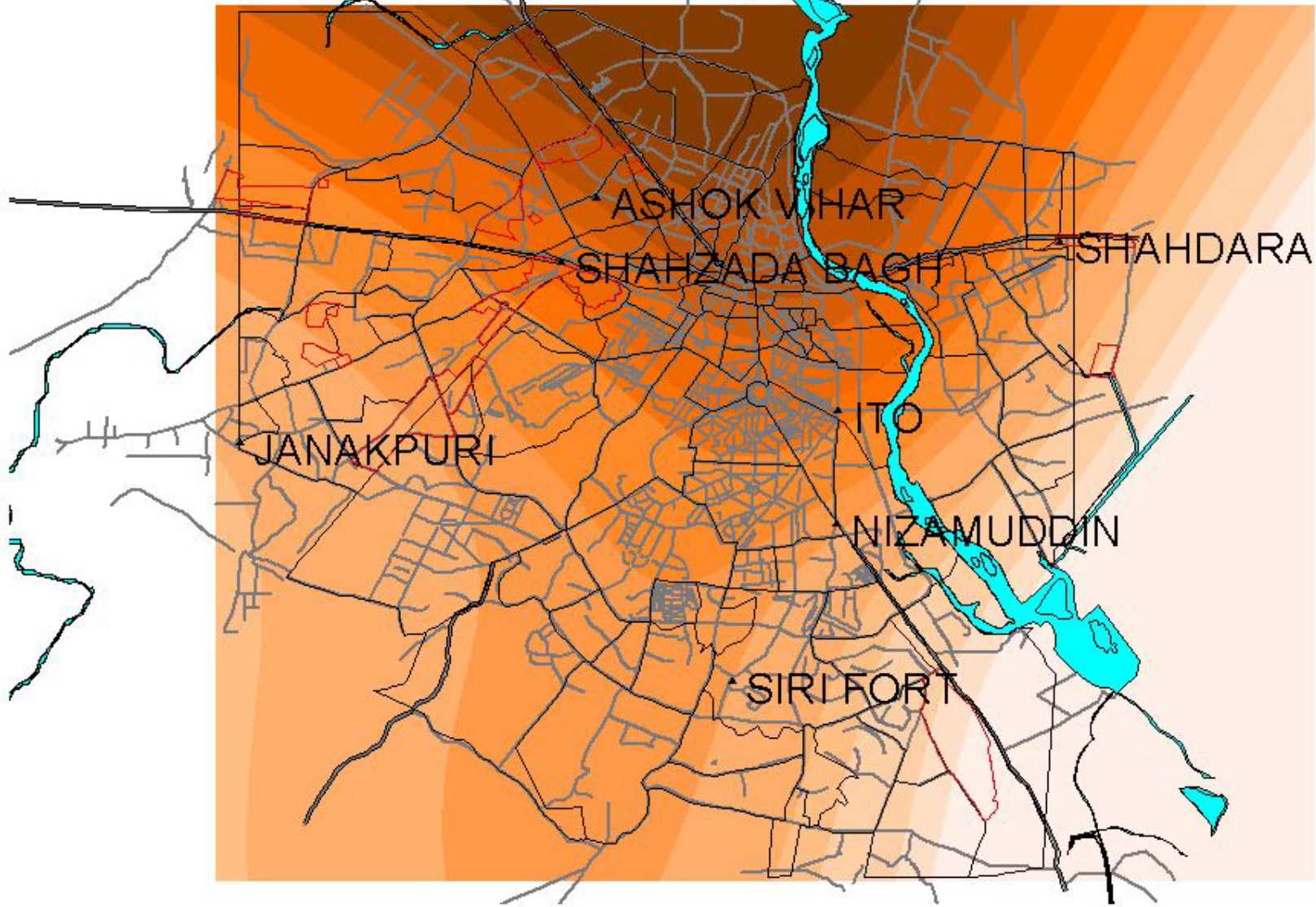
Major land use (1990)

N

1 0 1 2 3 Kilometers

Air quality in New Delhi

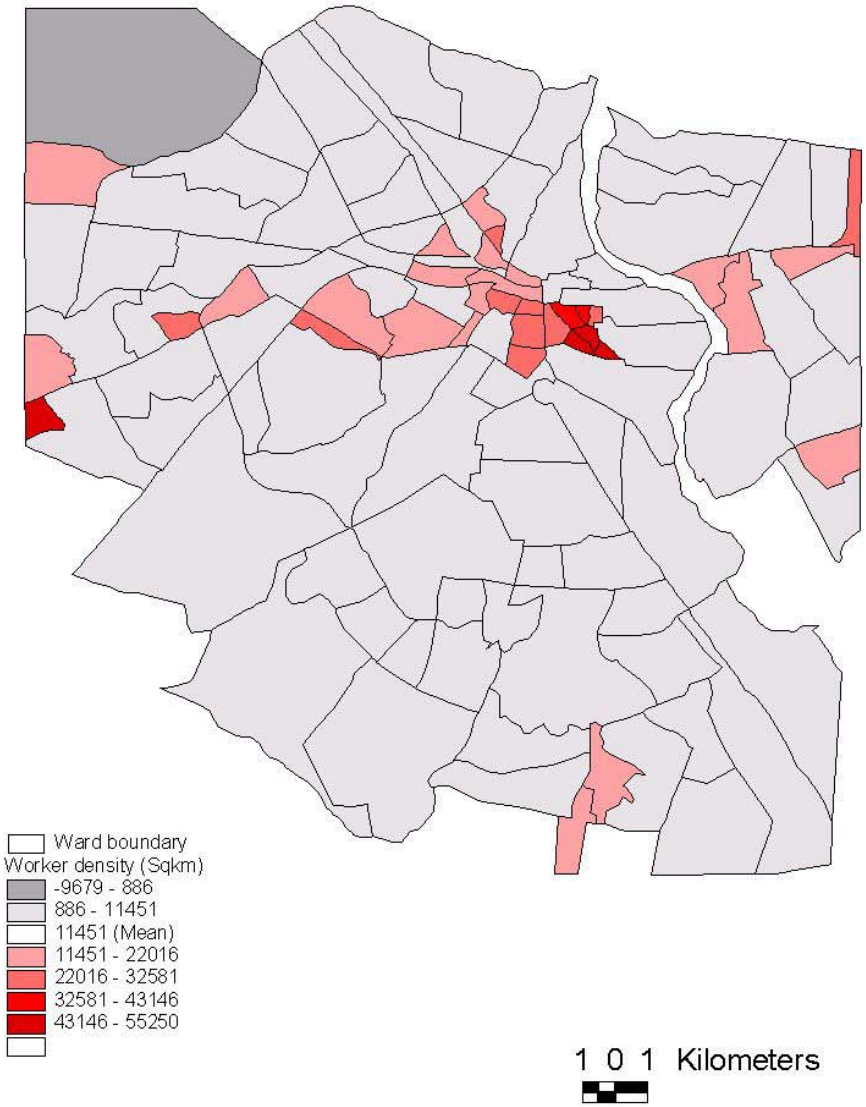
- A view of changes in SPM over 22 months
  Jan 1999 - Oct 2000
- Note that SPM values tend to always exceed the NAAQS
- However, SO_2 and NO_x values tend to stay below NAAQS



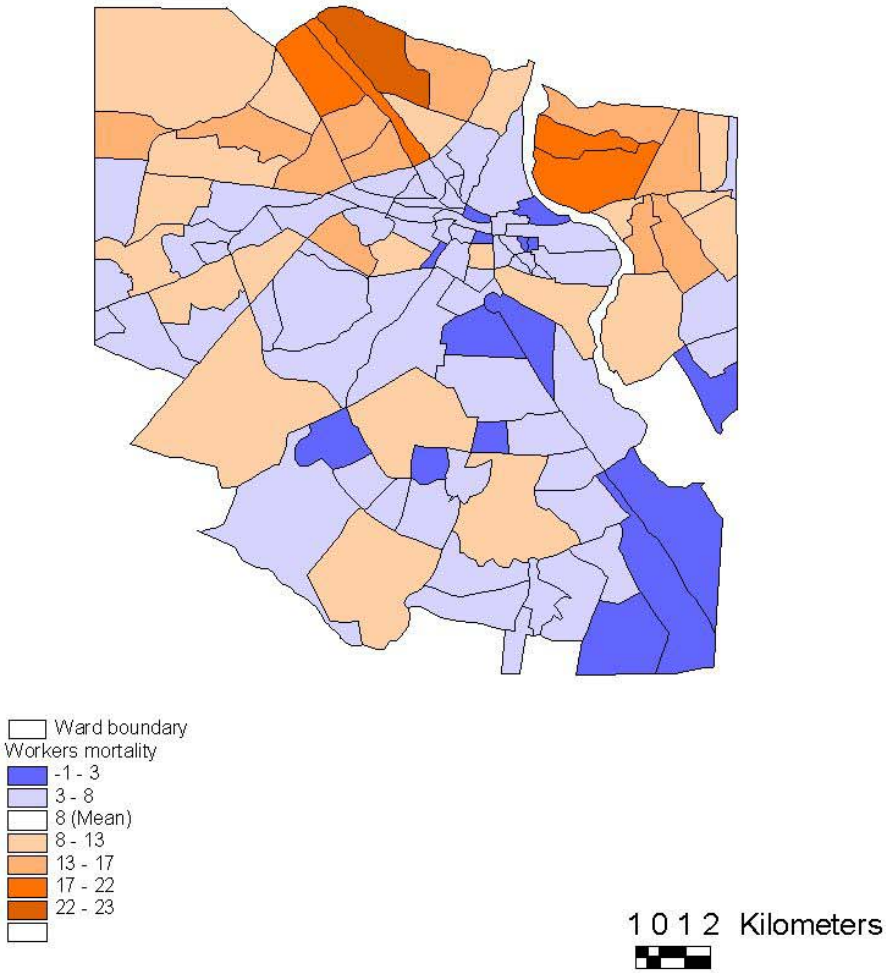
SPM Interpolation for October 2000

Health and Mortality risks

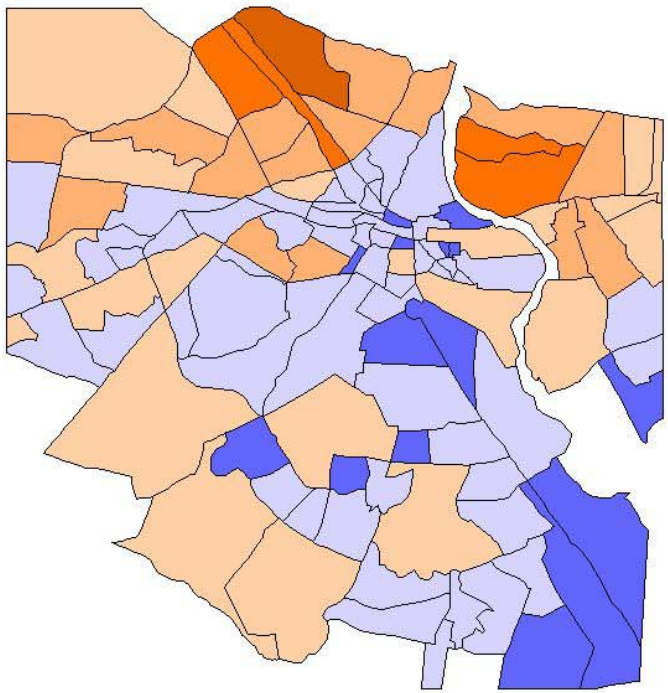
- High worker, population and children densities in the central wards and in West Delhi
- High mortality and health risks occur in the North (Modeltown, etc) and East Delhi (Gautampuri, etc) due to high concentration of SPM in these locations
- Low SPM related risks in South Delhi



Worker density (Census 1991)

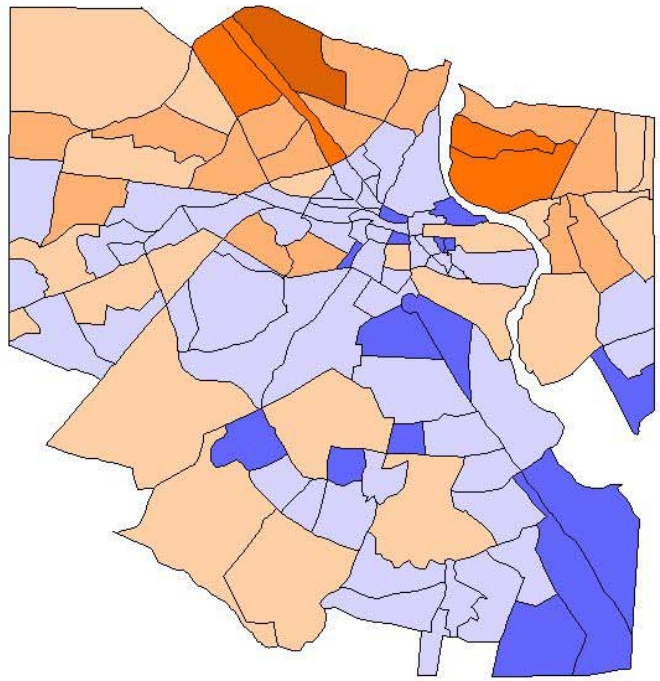


Worker mortality (based on Oct 2000 air quality data)



Ward boundary
Workers RAD
-2 - -1 Std. Dev.
-1 - 0 Std. Dev.
27916 (Mean)
0 - 1 Std. Dev.
1 - 2 Std. Dev.
2 - 3 Std. Dev.
> 3 Std. Dev.
No Data

Adult Restricted Activity days October 2000

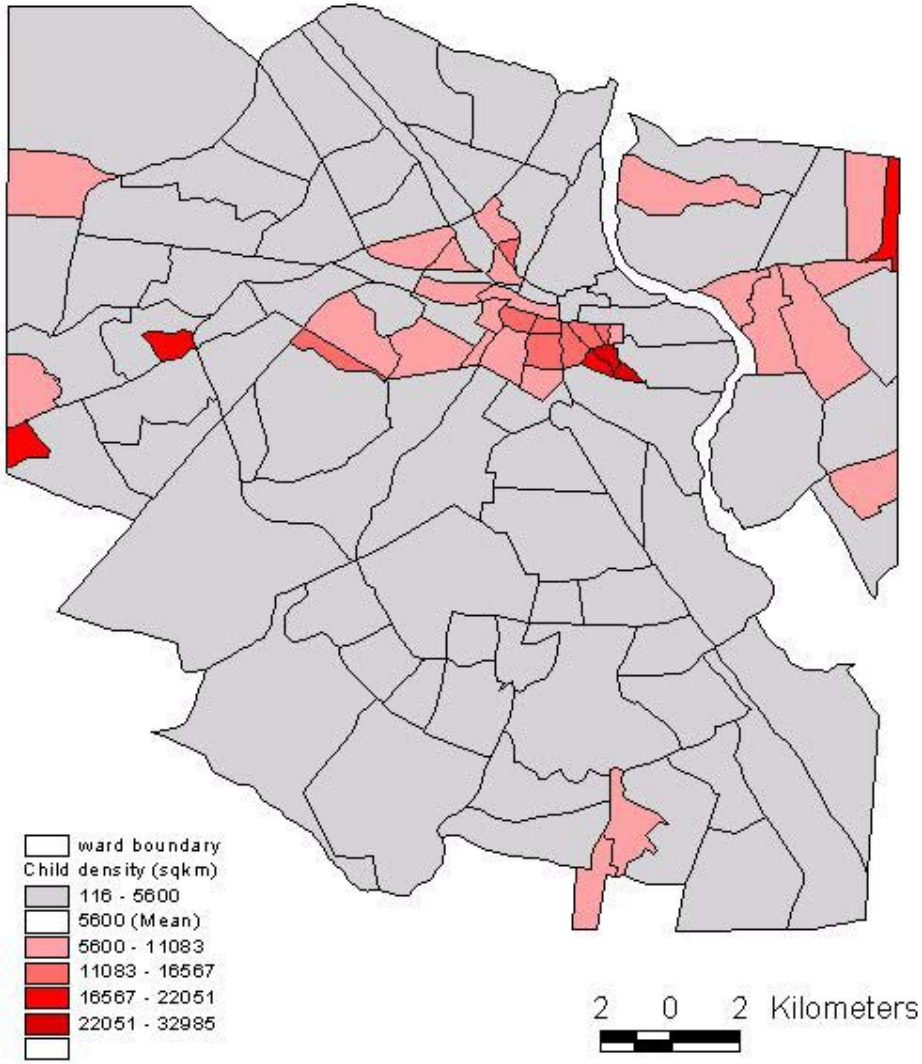


Ward boundary
Workers RS
-2 - -1 Std. Dev.
-1 - 0 Std. Dev. (50000)
88844 (Mean)
0 - 1 Std. Dev.
1 - 2 Std. Dev.
2 - 3 Std. Dev.
> 3 Std. Dev.

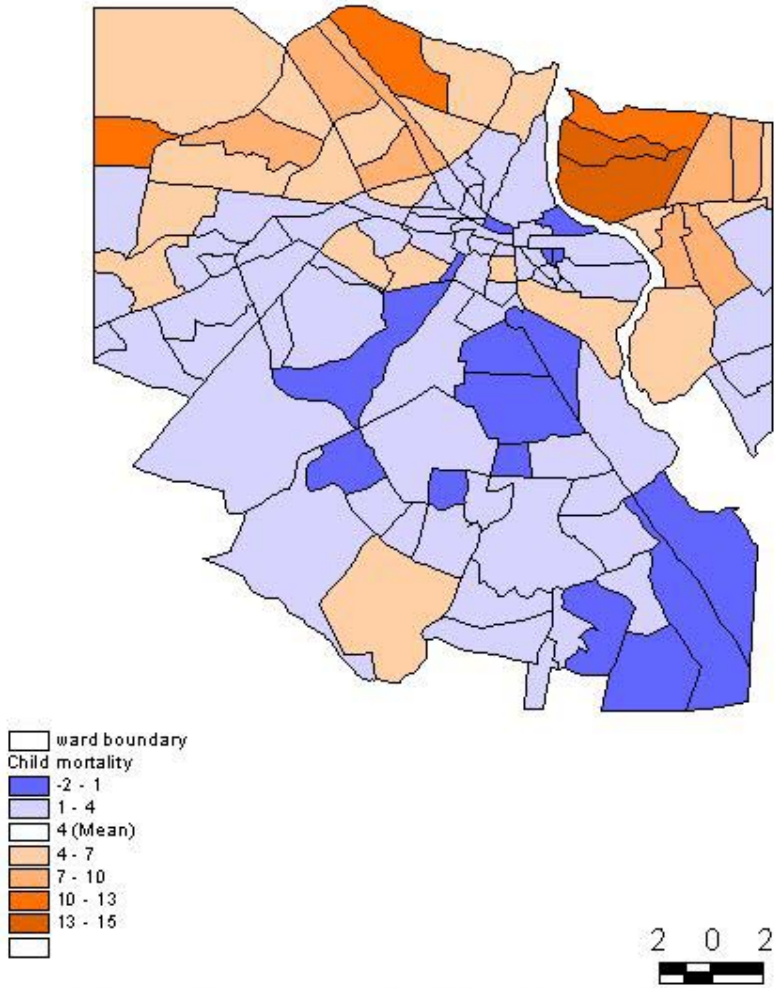
1 0 1 Kilometers

Adults with respiratory symptoms October 2000

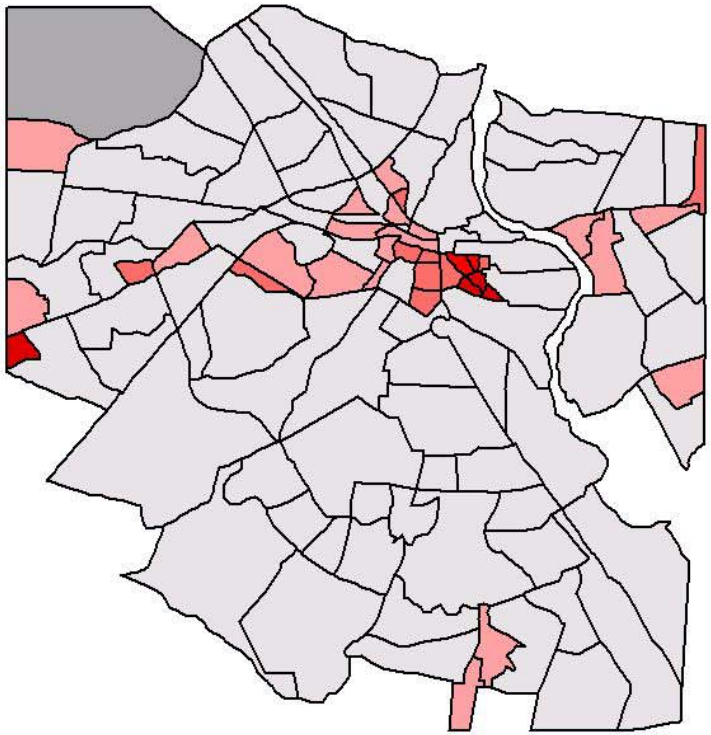
N



Density of children below age 6
Source: 1991 Census

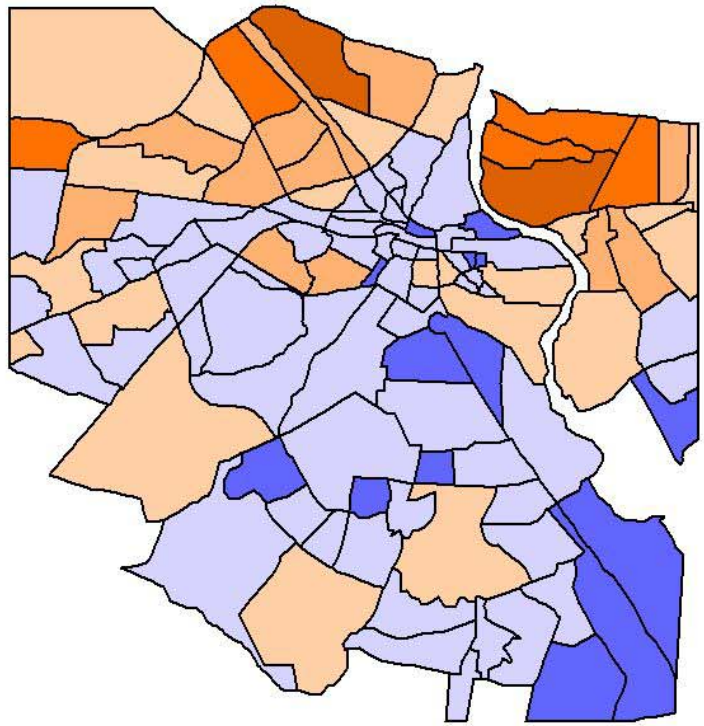


Monthly mortality for children
October 2000



Ward boundary
Population density (sqkm)
0 - 886
886 - 11451
11451 (Mean)
11451 - 22016
22016 - 32581
32581 - 43146
43146 - 55250

Density of population
Source: 1991 Census



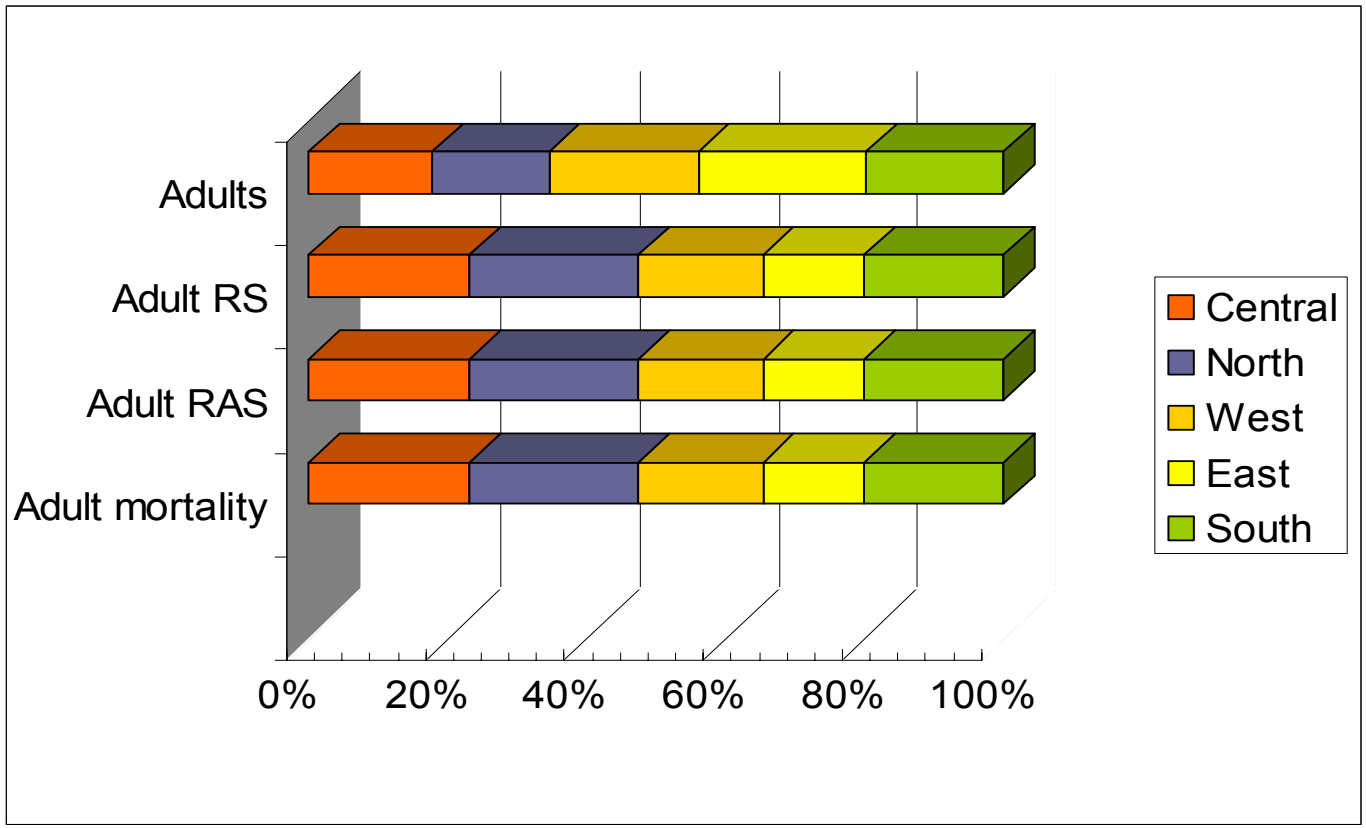
Ward boundary
Population asthmatic attacks
0 - 2289
2289 - 5992
5592 (Mean)
5992 - 9694
9694 - 13397
13397 - 17099
17099 - 18308

2 0 2 4 Kilometers

Asthma attacks in population
October 2000

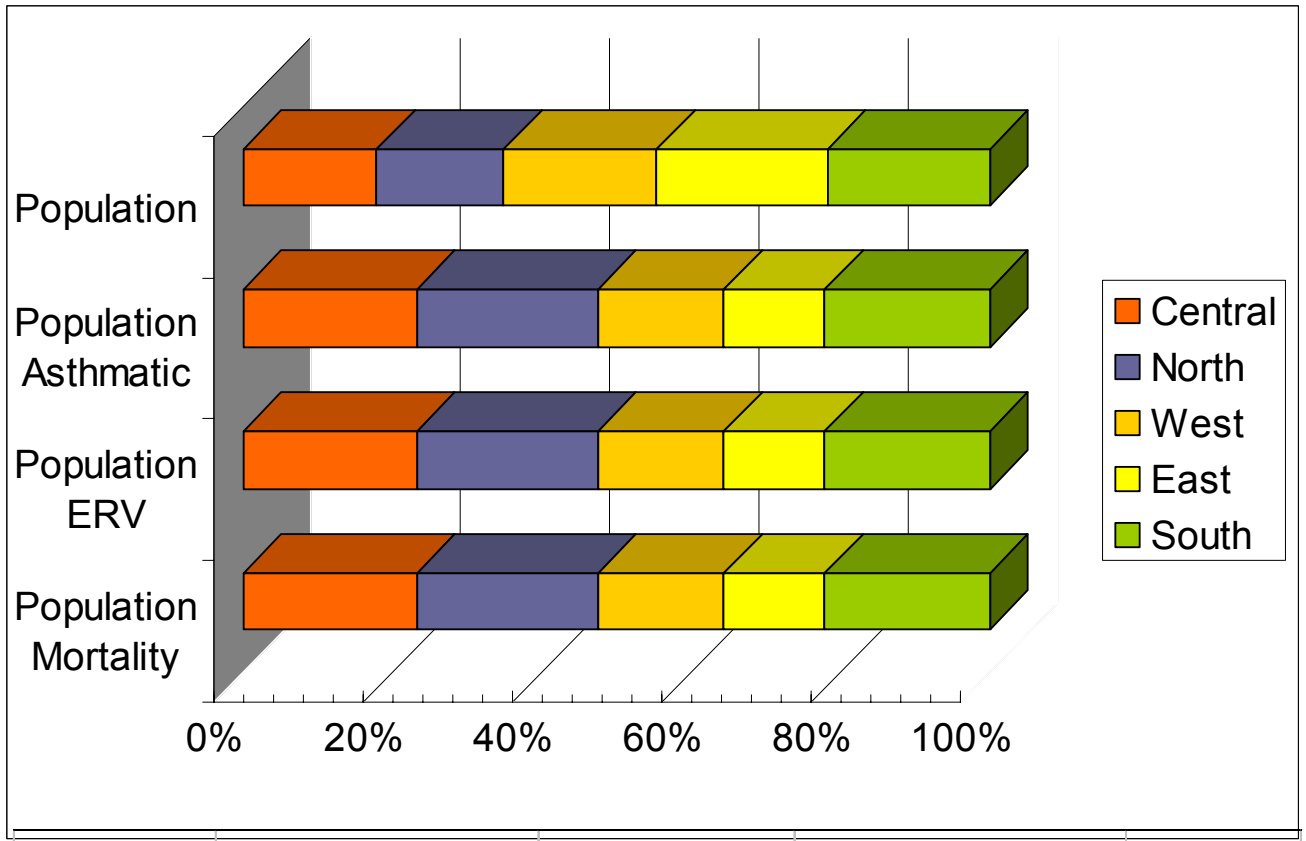
N

Adult exposure effects to PM10 by location in New Delhi



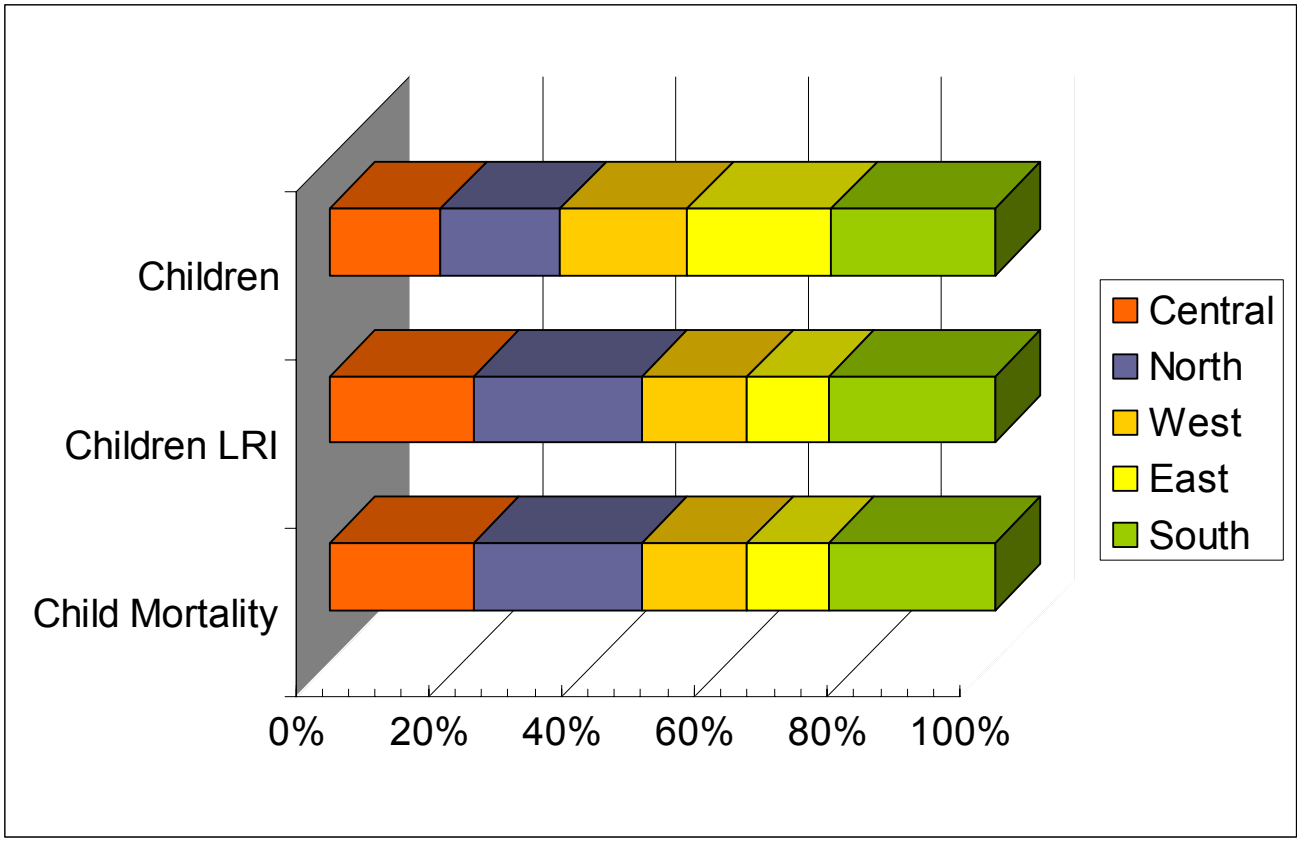
LOCATION	Adult mortality	Adult RAS	Adult RS	Adults
Central	209	723,368	2,302,196	413,229
North	220	761,515	2,423,605	392,350
West	161	558,666	1,778,016	499,460
East	132	456,717	1,453,552	565,068
South	181	626,278	1,993,197	461,034

Population exposure effects to PM10 by location in New Delhi



LOCATION	Population Mortality	Population ERV	Population Asthmatic	Population
Central	654	9,255	155,953	1,290,955
North	681	9,647	162,563	1,225,496
West	476	6,735	113,495	1,474,126
East	381	5,395	90,905	1,637,494

Childrens' exposure effects to PM10 by location in New Delhi



LOCATION	Child Mortality	Children LRI	Children
Central	97.56	9988.54	193025
North	114.27	11701.97	207110
West	71.6	7331.54	220810
East	55.67	5702.45	251104
South	112.72	11543.01	283148

Transportation planning - New Delhi

- Who is responsible for transportation planning?
  - DDA
  - Traffic Police
  - DTC
  - TCPO
- The need for data in the context of traffic management
  - Origin Destination survey
  - Bus route studies to study high density routes
  - Trip generation models to study location of work and non work trips
  - Viability of light or heavy rail in high density locations

Delhi's Vehicle Fleet

- Average ownership of private vehicles: 178 vehicles/1000 people in 1995-1996. Total # of motor vehicles per 1000 people was 205 in 1993 (and 238 in 1998).
- Delhi has the highest road length in India: 1284km/100km^2 area (26,379km of total length in 1998/99)
- Car ownership (1995): 52 vehicles/1000 people

•Delhi has one of the highest per capita road lengths and lowest number of vehicles per unit road length when compared with large cities around the world.

• Delhi's roads, if good traffic management is applied, can accommodate 2-3 times the existing number of vehicles.

• Source: Indian Institute of Technology, May 1997

Congestion & Traffic Accidents in Delhi

Delhi	1972	1981	1991	1997	1999	2001	2011
road length (km)	8,380	14,320	21,670	25,949	26,379		
# of vehicles (millions)	0.214			2.848	3.21	3.924	6

- Average speeds go down from 31km/hr in 1995 to 21.2km/hr in 2000.
- Road length increased by 3 times from 1972 to 1997 in Delhi while # of vehicles increased by 13 times!
- TERI 1996: Delhi is the most congested city in India.
- Average speeds during peak hour range from 10 to 15 km/hr in central areas and from 25-40 km/hr in arterial streets.
- Delhi's traffic fatalities in 1993 were more than double those of all other major Indian cities combined.
- The # of accidents in 1995 were 10,138 which ended up with 2,074 deaths.

Current (2000) Road Accidents in Delhi:

Average No. of Persons Killed / Day - 5

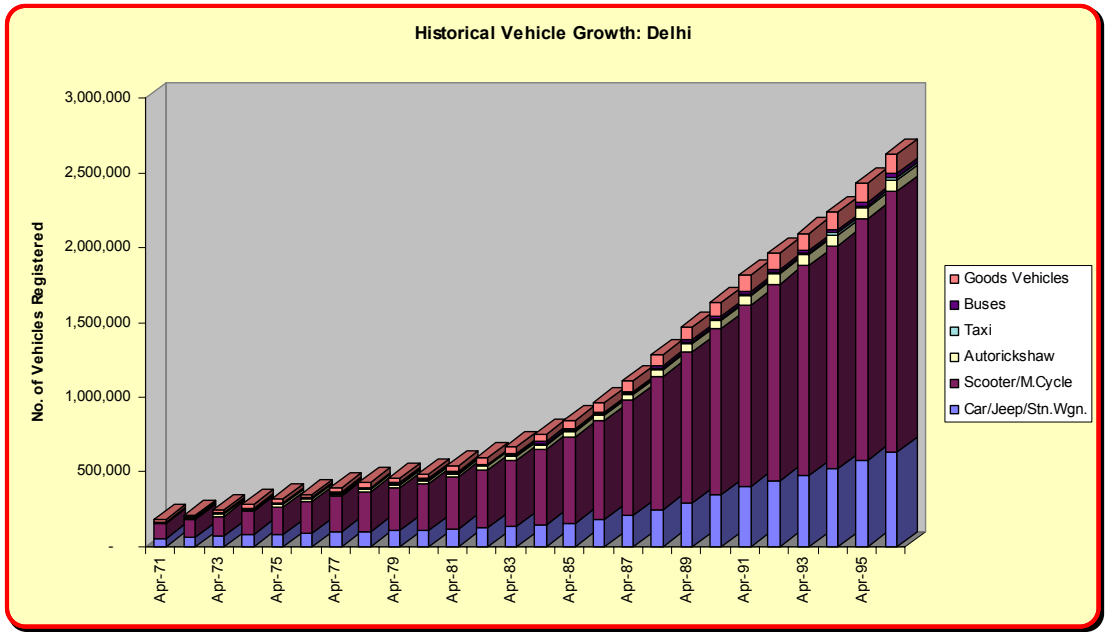
Average No. of persons injured - 13

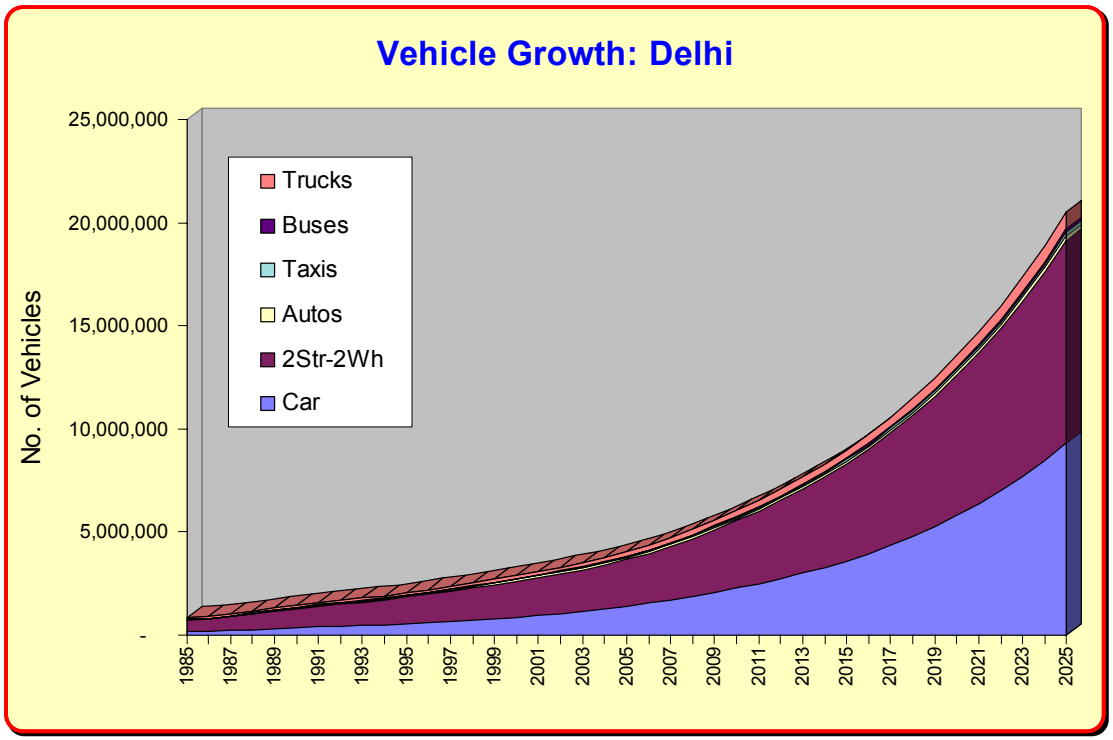
Buses contribute to the majority of the accidents

Source: http://www.delhimetrorail.com

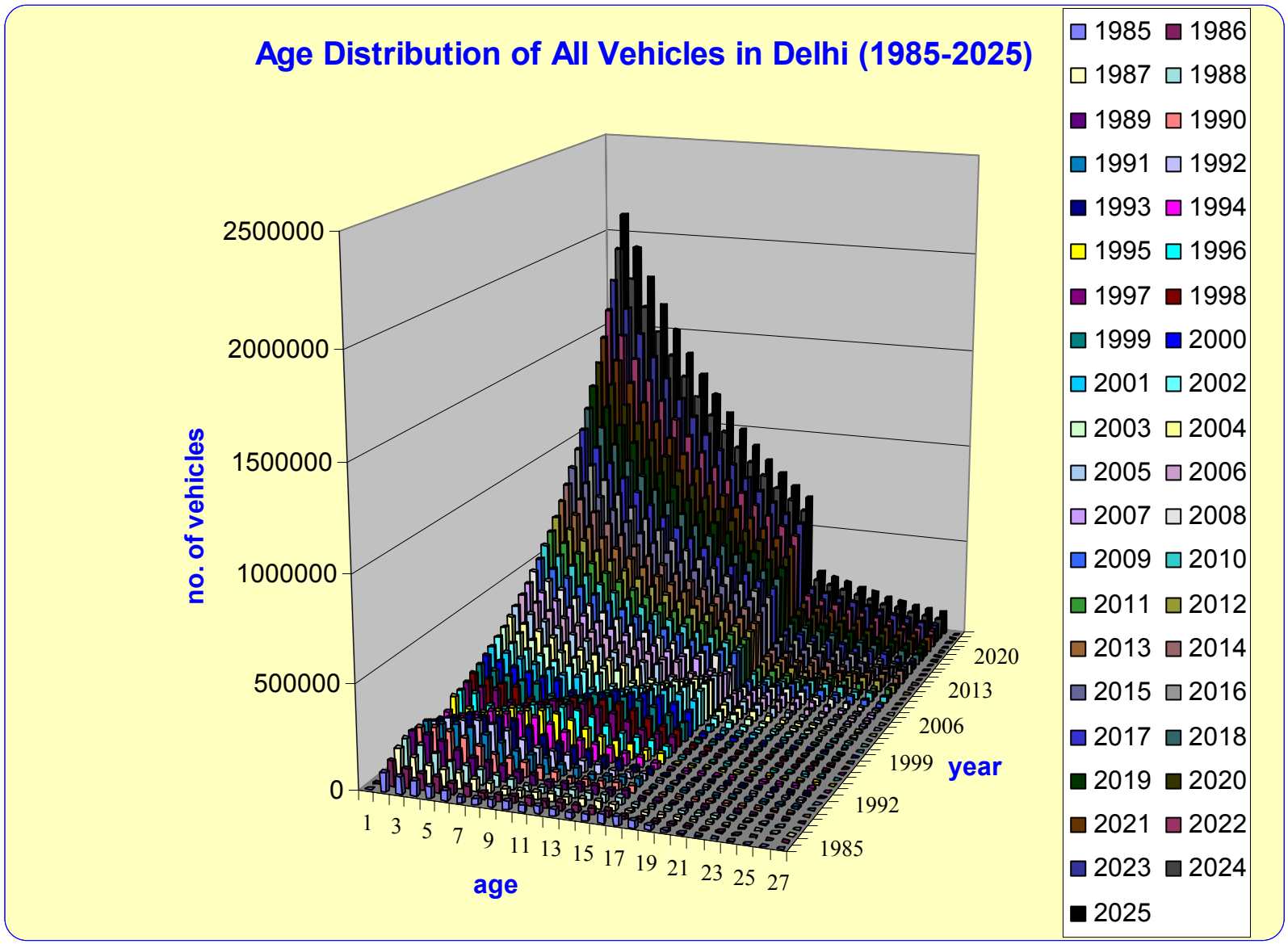
- On average a car in India weighs 800kg!
- On average cars in Delhi emit the following amounts of gases in 1 year:

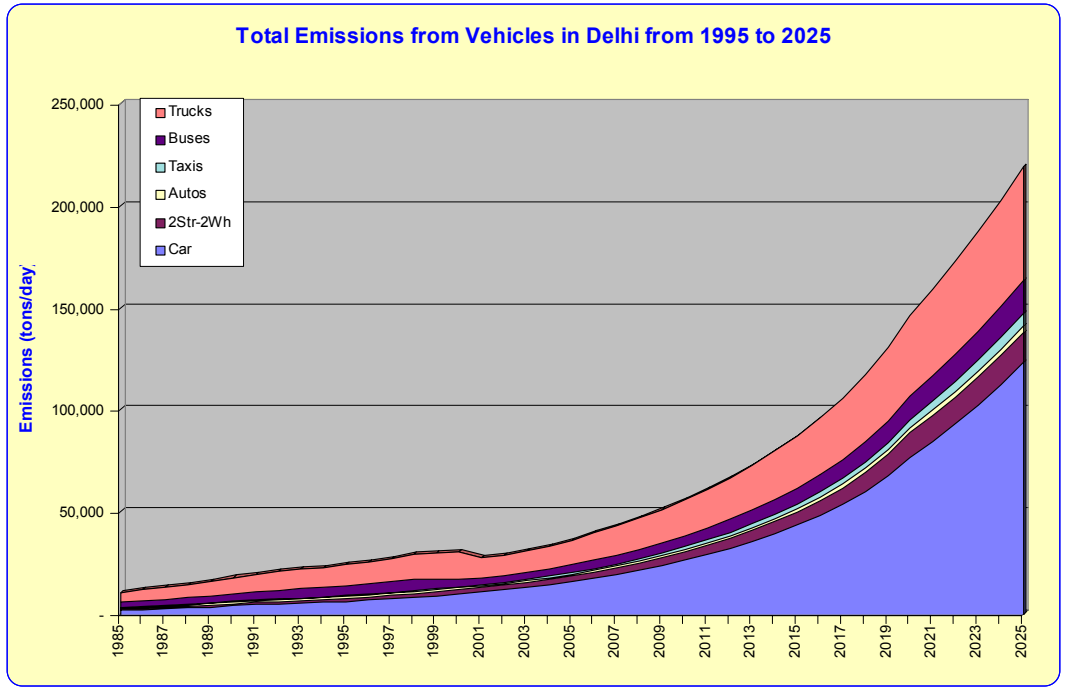
1999	CO	NOx	SO2	HC
kg/car/year	160.2	16.26	0.4928	28.88
% gas weight of car weight	20.03%	2.03%	0.06%	3.61%
1999	Pb	TSP	PM10	CO2
kg/car/year	0.1971	1.577	1.281	3932
% gas weight of car weight	0.02%	0.20%	0.16%	491.52%

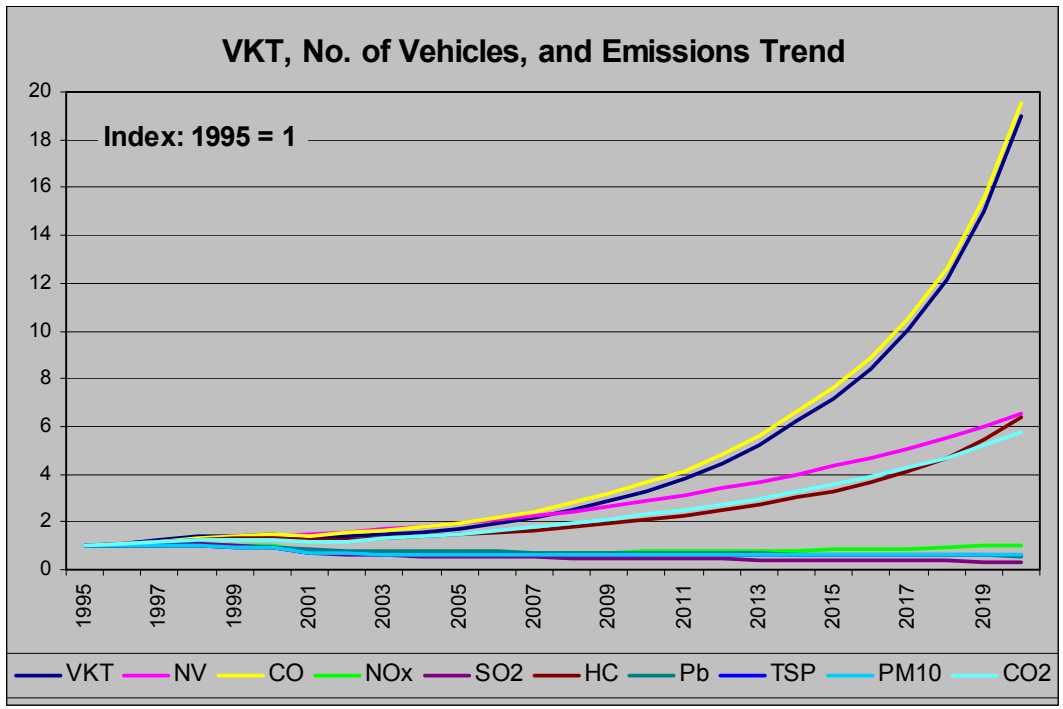

Historical Vehicle Growth: Delhi
No. of Vehicles Registered
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
Apr-71
Apr-73
Apr-75
Apr-77
Apr-79
Apr-81
Apr-83
Apr-85
Apr-87
Apr-89
Apr-91
Apr-93
Apr-95
Goods Vehicles
Buses
Taxi
Autorickshaw
Scooter/M.Cycle
Car/Jeep/Stn.Wgn.


Vehicle Growth: Delhi
No. of Vehicles
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
-
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025
Trucks
Buses
Taxis
Autos
2Str-2Wh
Car

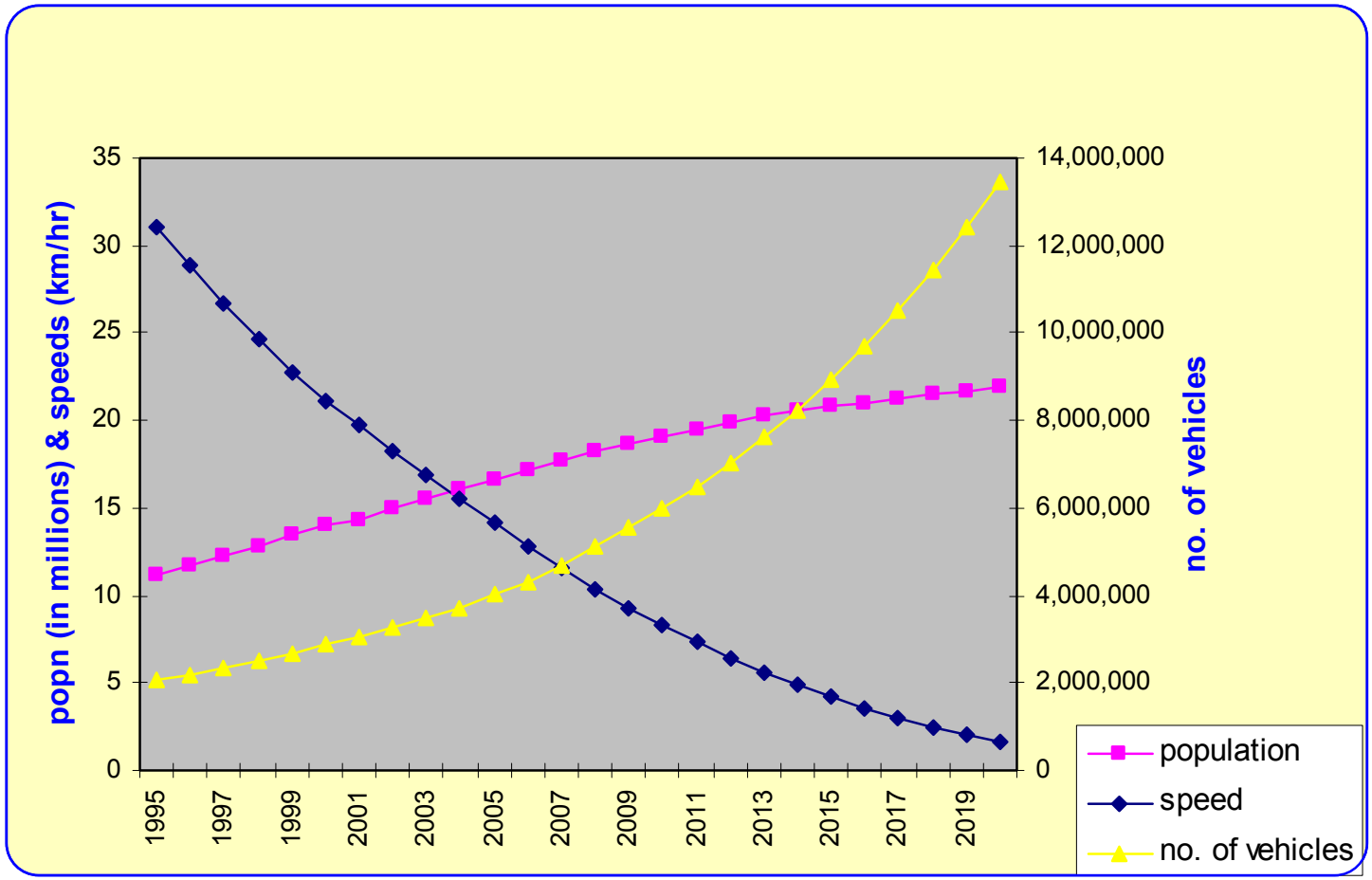
Vehicular Air Pollution Information System, Delhi (3)




Total Emissions from Vehicles in Delhi from 1995 to 2025
Emissions (tons/day)
250,000
200,000
150,000
100,000
50,000
-
Trucks
Buses
Taxis
Autos
2Str-2Wh
Car
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025


VKT, No. of Vehicles, and Emissions Trend
Index: 1995 = 1
20
18
16
14
12
10
8
6
4
2
0
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
VKT
NV
CO
NOx
SO2
HC
Pb
TSP
PM10
CO2

Population, number of vehicles and speeds



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

million $	1995	2000	2020
Value of Time	142.34	314.88	13,939.38
Fuel Costs	662.36	1000.10	13,123.32
Health Costs	507.78	798.08	2,657.63

million tons of carbon per year	1995	2000	2020
	2.38	3.04	15.14

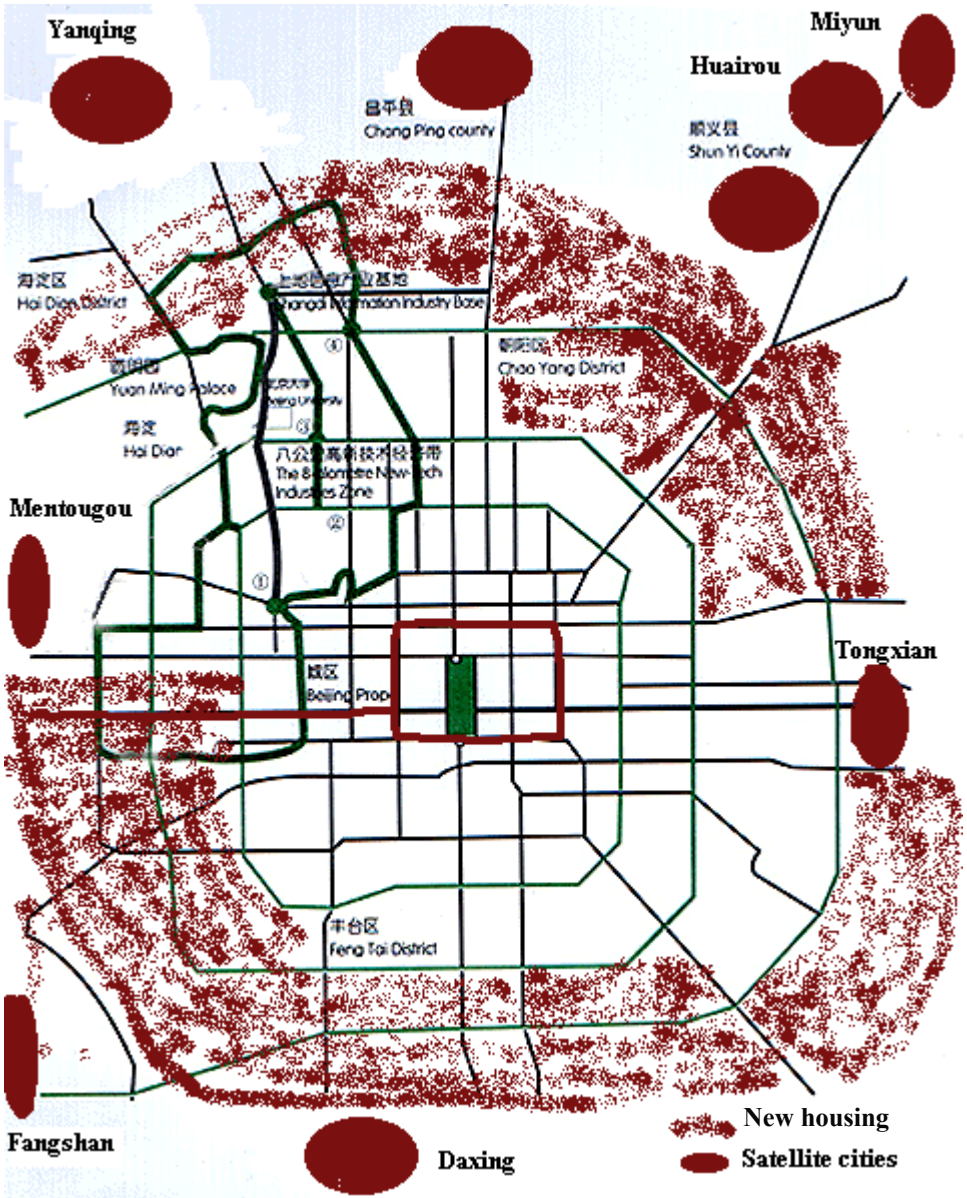
# of premature deaths per year due to air pollution	1995	2000	2020
	5,863	6,883	8,607

Traffic accidents / deaths	1995	2000	2020
	10,178/2,074	/1,956	na

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

Beijing

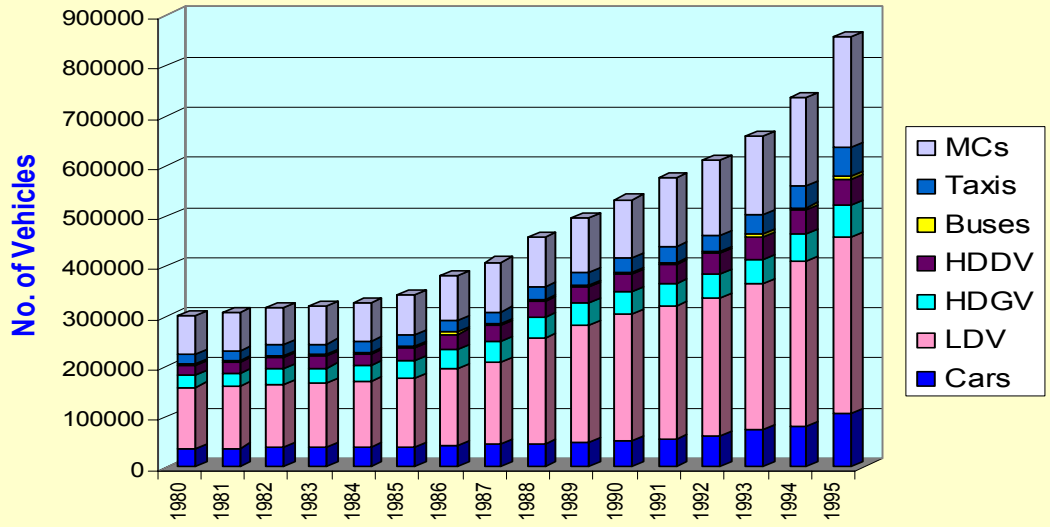


- 5 ring roads
- new housing under construction around the 5th ring road area
- 14 satellite cities being built in the suburban and rural areas
- This suburbanization and decentralization plan of Beijing will increase future pass-km demand and put more strain on the transportation system.
- 2000 population: 12,511,000
- Car ownership (1995): 9 vehicles/1000 people

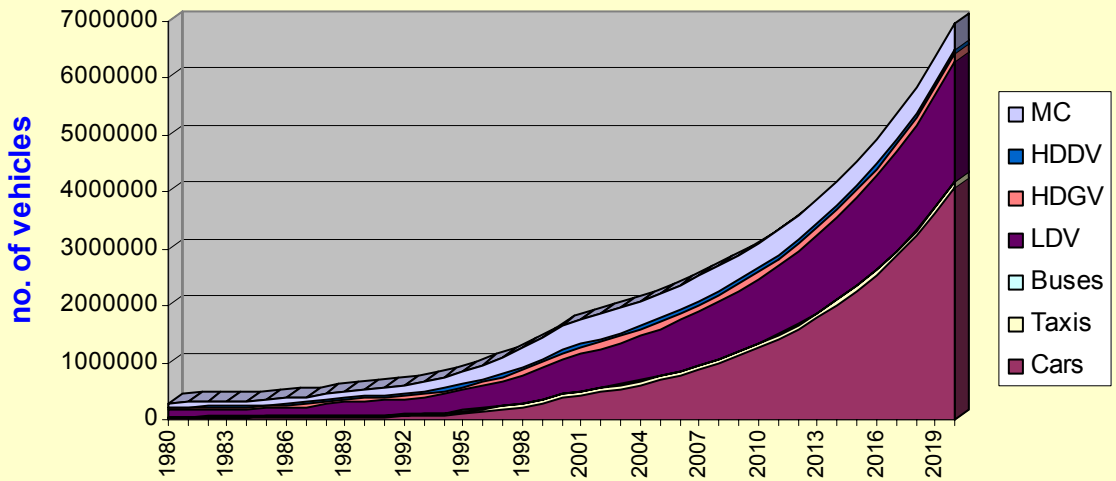
Beijing, China

- 1 meter resolution black-and-white image of the Forbidden City, Beijing.
- IKONOS satellite collected the image on October 20, 1999.

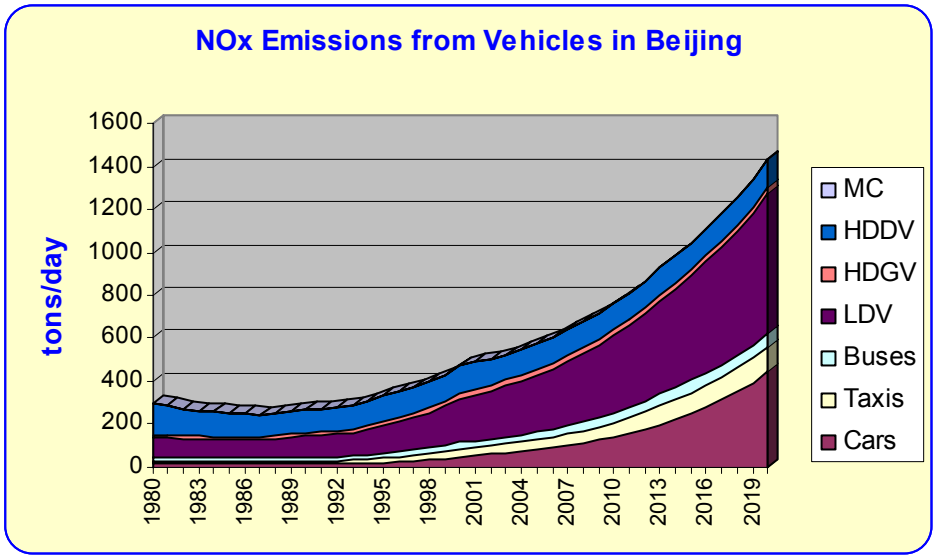
Historical Vehicle Growth in Beijing



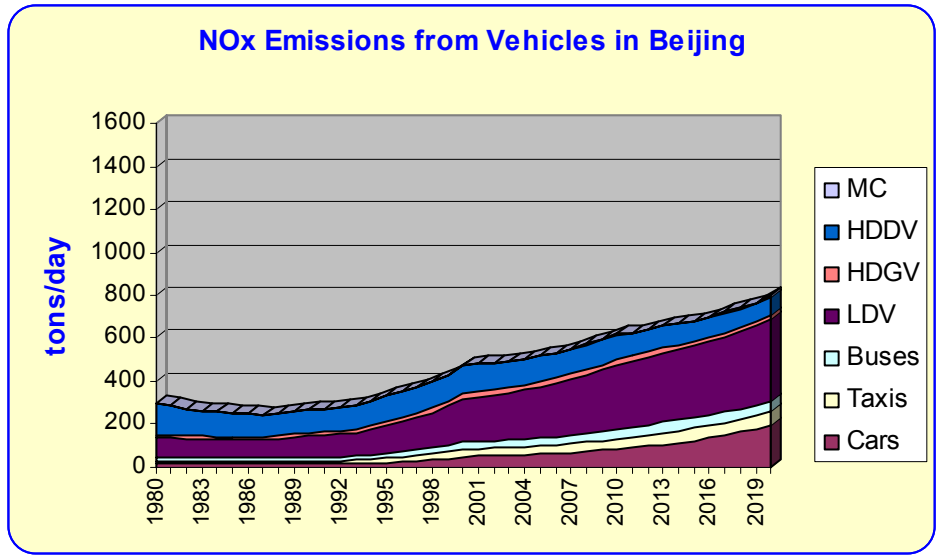
Vehicle Growth in Beijing

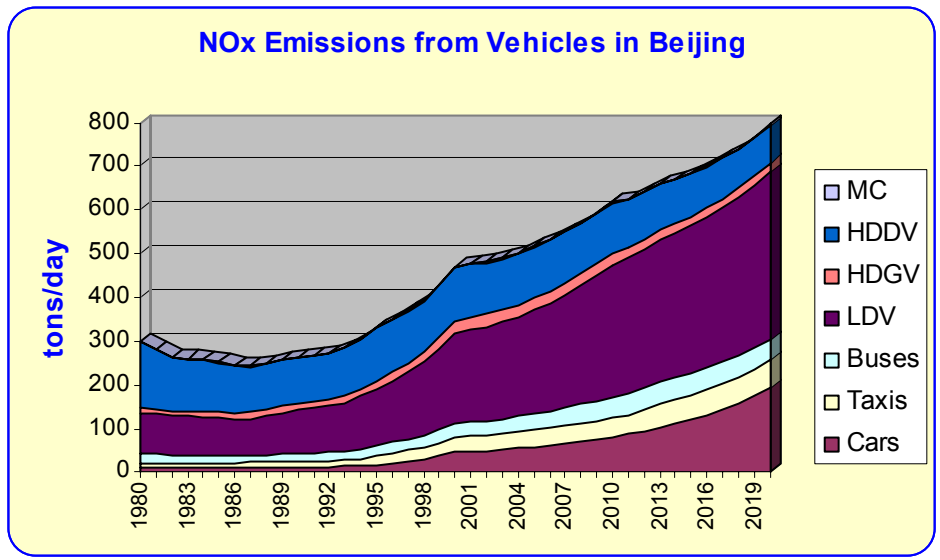


UNREGULATED



REGULATED





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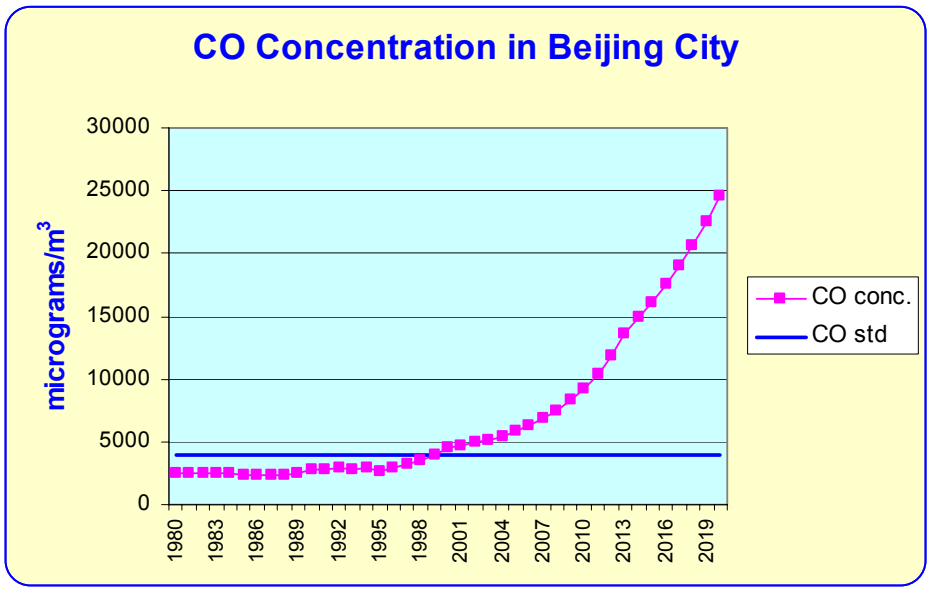

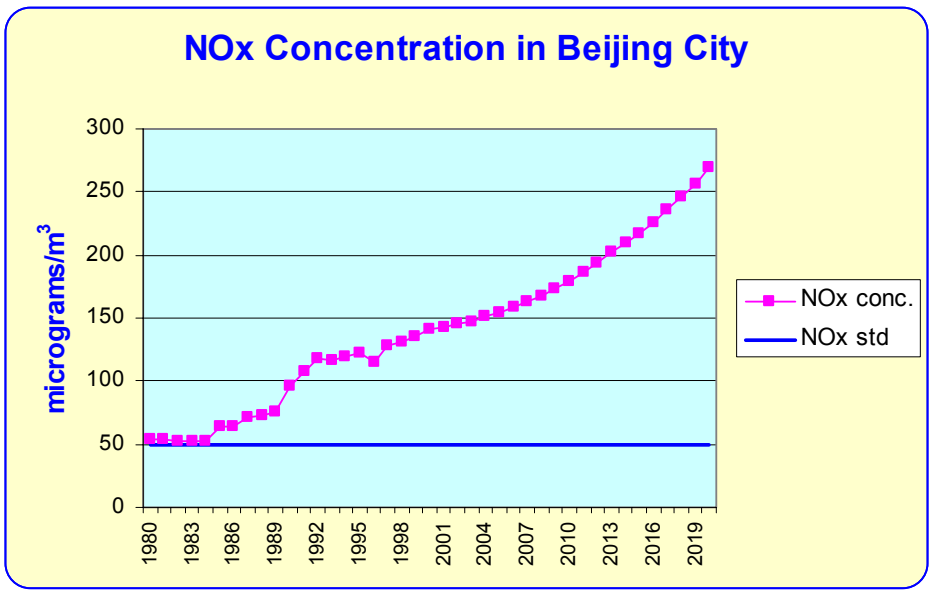

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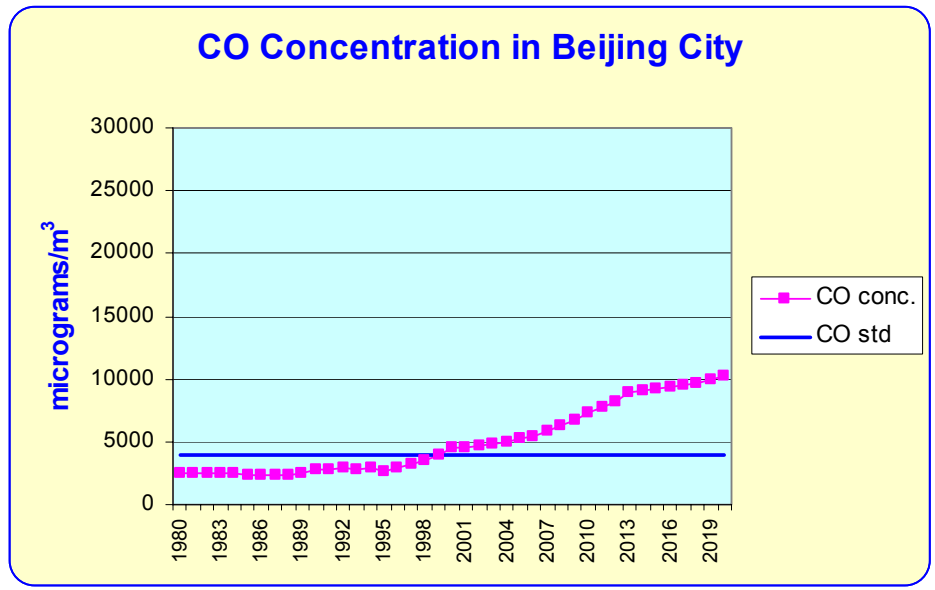
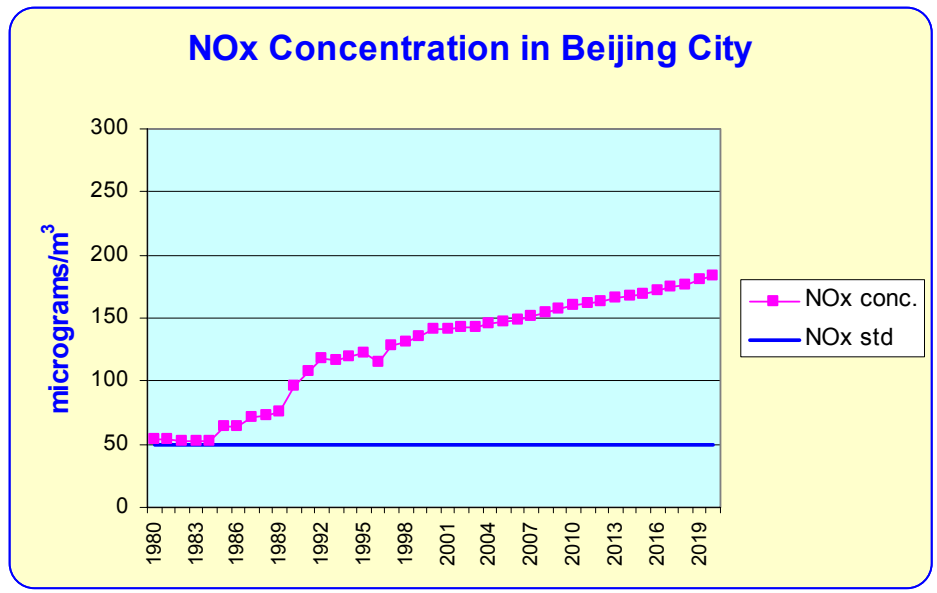




Value of Time, Fuel Costs, & Health Costs from Passenger Transport in Beijing

million $	1995	2000	2020
Value of Time	182.33	743.63	19,514.94
Fuel Costs	641.00	1,569.22	19,509.85
Health Costs	975.18	1,898.65	15,117.62

million tons of carbon per year	1995	2000	2020
	3.40	6.02	19.47

# of premature deaths per year due to air pollution	1995	2000	2020
	10,405	15,267	46,123

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

	At 6 km/hr	At 16km/hr	With Tokyo's pass-trip mix
million $	2020	2020	2020
Value of Time	19,514.94	9,348.51	8,631.77
Fuel Cost	19,509.85	15,281.42	17,879.25
Health Costs	15,117.62	11,794.00	8,635.45
Total	54,142.41	36,423.93	35,146.47

Comparison of Delhi and Beijing

Beijing's and Delhi's Population, Vehicle Fleet, and Their Projections for 2020

Delhi, June 1997	# of Vehicles	% Modal Share
Cars/Jeeps/Station Wagons	720,921	25%
MC/SC/MPD	1,906,232	66%
Taxis	15,362	1%
Autorickshaws	80,210	3%
Trucks	142,290	5%
Buses	39,344	1%

Beijing, 1997	# of Vehicles	% Modal Share
Cars	178,566	16%
MC	289,231	26%
Taxis	58,976	5%
LDV	438,157	40%
HDGV	77,053	7%
HDDV	57,088	5%
Buses	7,269	1%

		1995	2000	2020
Beijing	*# of vehicles*	858,482	1,669,447	6,951,405
	population	11,705,000	12,511,209	13,860,955
Delhi	*# of vehicles*	2,076,119	2,936,504	13,556,004
	population	11,232,000	13,964,000	21,937,000

- 2 to 3 times more # of vehicles in Delhi.
- Similar population in 1995 and 2000 in Delhi and Beijing but higher growth for Delhi resulting in a much larger population in 2020 in Delhi (due to controlled population growth in Beijing).

A comparison of three cities

	1995			2000			2020		
	Delhi	Beijing	NYC SMSA[5]	Delhi	Beijing	NYC	Delhi	Beijing	NYC
Population (millions)	11	12	18[1]	14	13	19[2]	22	14	NA
Vehicle Population (millions)	2	1	8	3	2		14	1	NA
Value of Time lost (million $)	142	182	22,253	315	744		13,939	19,515	NA
Fuel Costs (million $)	662	641	5,464	1,000	1,569		13,123	19,510	NA
Health Costs (million $)[3]	508	975	9,238	798	1,899		2,658	15,118	NA
Tons of Carbon (million)	2.4	3.4		3.0	6.0		15.1	19.5	NA
Number of premature deaths due to air pollution	5,863	10,405	5,727	6,883	15,267		8,607	46,123	NA

Notes:

1 1990 US Census

2 2000 US Census preliminary estimate

3 New York City SMSA health costs includes fixed and mobile sources

4 1990 US Census

5 Data for NY City SMSA calculations from International Energy Agency and Census 1990

6 New Delhi has strict fuel quality and emissions requirements in future years (corresponding to EURO norms for SO_2 and PM10)

7 Beijing's numbers are work in progress. Their fuel quality standards are not as strict as New Delhi

8 NY City figures come from International Energy Agency data for 1995, EPA data for 2000

Applicability of Decision Support Models

GIS MODELS

- Fundamental data handling tool for urban planning.
- Link to urban air transport and diffusion models.
- Map exposure and health impacts.
- Explore air/water/land interactions
- Aid trip generation models.

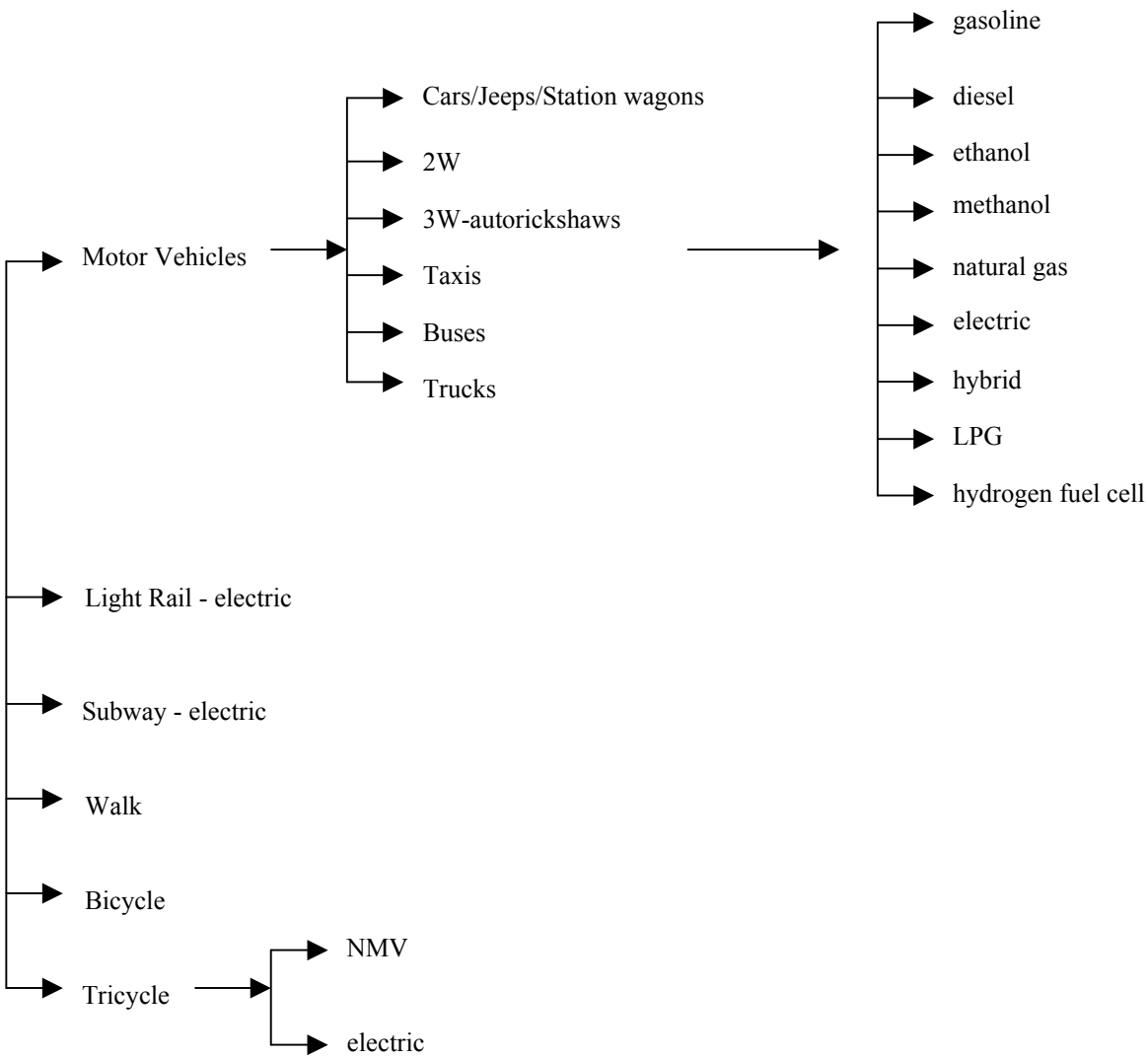
Simulation Models

- Quick and easy.
- Can test assumptions about future land use and environmental regulatory policies.
- Can be integrated into GIS system.
- Ease of use for citizen involvement in planning.

MATHEMATICAL MODEL

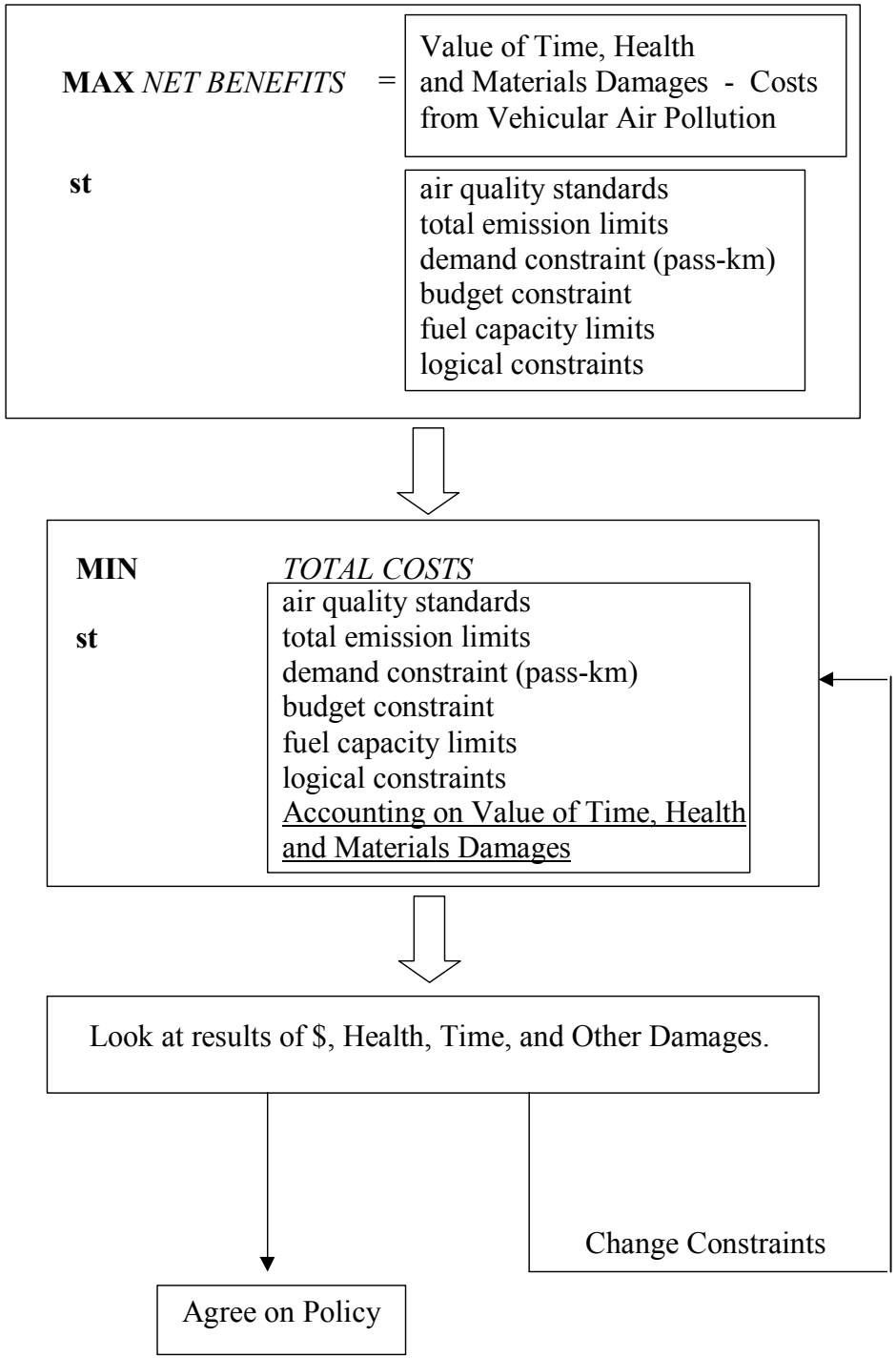
- Include all modes of transportation
- Include different types of fuels and technologies for each mode
- Include investment opportunities in infrastructure for all transportation modes
- Include different control options

TRANSPORTATION MODES FOR DELHI



Control Options To Be Considered in The Model

- Pricing Measures:
  - tax measures
  - subsidize transit services
  - subsidize clean fuels
- Incentive related and educational policy options
  - education and driver behavior
  - encourage air quality monitoring and research on health effects of pollutants
  - ride sharing
  - telecommuting
- Technical policy options
  - engine designs
  - improve fuel quality
  - catalytic converters
  - fuel switching
  - decrease scrappage rate
  - infrastructure investments
  - increase transit services
- TDM measures
  - I/M programs
  - traffic management
  - parking management
  - provide HOV and bus lanes


MAX NET BENEFITS =
Value of Time, Health and Materials Damages - Costs from Vehicular Air Pollution
st
air quality standards
total emission limits
demand constraint (pass-km)
budget constraint
fuel capacity limits
logical constraints
MIN
TOTAL COSTS
st
air quality standards
total emission limits
demand constraint (pass-km)
budget constraint
fuel capacity limits
logical constraints
Accounting on Value of Time, Health and Materials Damages
Look at results of $, Health, Time, and Other Damages.
Change Constraints
Agree on Policy

Some Conclusions

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.

1. Clean fuels, clean vehicle technologies (electronic fuel injection, catalytic converters), new vehicle emission standards

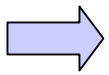
2. Infrastructure investments - build new roads to add more capacity

3. Traffic and demand management (manage existing street space to maximize available capacity and implement vehicle use controls)

4. I/M programs

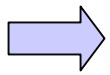
5. Improve public transit

6. Land-use planning



Effect on:

- speeds
- emission factors
- fuel efficiencies
- traffic flow
- driver behavior



1. Reduction of emissions per vehicle kilometers traveled

2. Reduction of the total number of vehicle kilometers traveled

• New capacity attracts new demand and so traffic congestion will continue as long as incomes, population, and vehicle ownership continue to grow.

• So while managing road space, also implement vehicle use controls (rather than vehicle ownership controls) and develop public transit!

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

And now a word from our sponsors….

Now a word from our sponsor...

India Inc

Ford, Harvard join hands to clean up Delhi

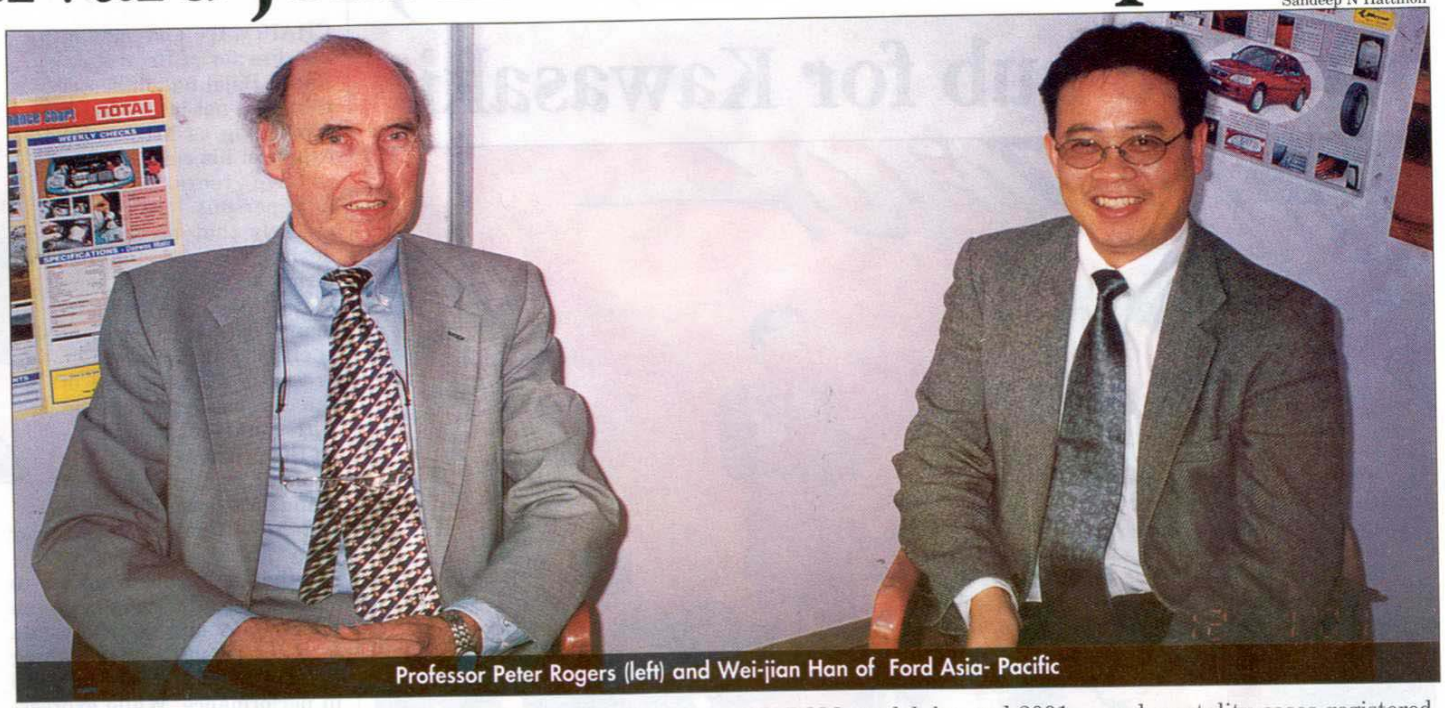
Sandeep N Hattiholi

Sandeep N Hattiholi

AM EXCLUSIVE

FORD India has teamed up with Harvard University to initiate a study on solving the bulging problem of traffic congestion and pollution in Delhi.

The objective of the exercise is to prepare models that will be given to relevant organisations concerned with traffic management. The recommendations could then be implemented on a case-to-case basis. A workshop on awareness of the study will be held in April.



Professor Peter Rogers (left) and Wei-jian Han of Ford Asia- Pacific

Foul air

In an exclusive meeting with *Auto Monitor* two key members -Peter Rogers of Harvard University and Wei-jian Han of Ford Asia Pacific -- said that quality of air in India was getting progressively worse. This was despite the government's efforts to curb pollution through imposition of stringent emission norms. The biggest hurdle has been the age of the existing fleet coupled with the growing number of vehicles entering the market.

Delhi in 2000

- $700 million yearly loss due to time wasted in congestion
- $1.2 billion in health damage owing to pollution
- $600 million yearly loss due to wastage of fuel
- Deaths exceeding 9,000 on roads
- Average speeds decrease to 35kmph

20 years later

- Average speeds down to 20kmph

"Though we have new cars fitted with better technology, the solution lies in reducing the ageing fleet, increasing speeds and decreasing congestion," said Rogers, who is professor of environmental engineering and city planning at Harvard University.

Little coordination

result of little coordination between government agencies on traffic, infrastructure and land management. Wei-jian Han, R&D programs manager of Ford Asia Pacific, said that the study would create awareness among the various institutions and non-government organisations (NGOs) which will implement the model.

The study will be based on a set of intersecting models that will relate to database and geographic information. These will project the after-effects of any

CD-ROM model by end-2001. The suggestions will then be implemented in various regions of Delhi.

Initial impact study

The study has roped in organisations like the Pune-based Central Institute of Road Transport (CIRT) which will implement similar models in other congested metros such as Mumbai, Hyderabad and Bangalore. The initial impact study will be out by 2003.

Ford and Harvard are

and mortality cases registered. Rogers said that the model would indicate which class of people will be the worst to affected by air quality.

The duo said that a similar project is being carried out in Beijing, China. According to them, on a direct comparison basis, though the average area is the same for both cities, Delhi still scores. This is because roads take up 30 percent of its land. However, Beijing observes greater traffic discipline with separate lanes/roads for two