

Environmental Degradation in the Context of Growing Urbanization: A Focus on the Metropolitan Cities of India*

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ABSTRACT Using the available data on relevant issues, the study concentrate on some of the important environmental problems caused by over population growth and rapid urbanization process in the metropolitan cities of India. Total urban population in India has increased more than ten times surpassing India's total population growth, which has increased less than five times during 1901 to 2001. Also, there was about three-fold increase in the percentage of total urban population in Class-I city followed by almost a fifty-fold increase in the total population in the million plus cities in India from 1901 to 2001. Despite several Government housing policies, 41% of the total slum population of India is residing in million plus city alone (Census 2001). A three-fold increase in the number of motor vehicles has been found in India in the last decade. In all the four metro cities SPM was found highest along with the problem of solid wastes. The noise pollution was noticed more than the prescribed standard in all the four metro cities. Five and more person residing in a room, was faced by more than one fourth population of Mumbai followed by a little less than one fifth population of Kolkata and about 10% population of Delhi and Chennai both. Also there is an acute shortage of piped drinking water in these metro cities. India's urban future is grave. Therefore there is an urgent need to tackle the urban environmental problem in a rational manner giving attention to the need for improving urban strategies.

INTRODUCTION

India's population has very rapidly grown since the demographic watershed of 1921, when medical treatment, sanitary improvement, etc., started reducing mortality drastically and led to concomitant population. The population is growing at the rate of about 17 million annually which means a staggering 45, 000 births per day and 31 births per minutes. If the current trend continues, by the year 2050, India would have 1620 million populations. Population explosion is one of the most threatening issues facing contemporary India particularly by the Indian cities. One of the most important reasons for population explosion in the cities of India is the large scale rural to urban migration and rapid urbanization.

Due to uncontrolled urbanization in India,

environmental degradation has been occurring very rapidly and causing shortages of housing, worsening water quality, excessive air pollution, noise, dust and heat, and the problems of disposal of solid wastes and hazardous wastes. The large and metropolitan cities present a particularly depressing picture today. The situations in metropolises like Mumbai, Kolkata, Chennai, Delhi, Bangalore, Kanpur, Hyderabad etc., is becoming worse year by year. The problems of finding space and housing for all have been intensified. Slums have become an inevitable part of the major Indian metropolises.

Environmental pollution in India can broadly be attributed to rapid industrialization, energy production, urbanization, commercialization, and an increase in the number of motorized vehicles (Maitra, 1993). Vehicles are a major source of pollutants in cities and towns. The concentration of ambient air pollutants in the metropolitan cities of India as well as many of the Indian cities are high enough to cause increased mortality. The rate of generation of solid waste in urban centers has outpaced population growth in recent years with the wastes normally disposed in low-lying areas of the city's outskirts (India: State of the Environment 2001).

In the above context, using the available data

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from existing literatures on relevant issues, the present study concentrate on some of the important aspects of India's population growth and urbanization process and also highlights some of the environmental issues caused by over population growth and rapid urbanization process in the metropolitan cities of India.

URBANIZATION IN INDIA AND METROPOLITAN CITIES

Urbanization is a process whereby increasing proportions of the population of a region or a country live in urban areas. Urbanisation has become a major demographic issue in the 21st Century not only in India but also all over the world. There has always been great academic interest in the Indian urbanization process and a number of scholars have analyzed India's urban experience, particularly in the post independence period (Bose, 1978; NIUA, 1988; Mohan, 1996). The level of urbanization in terms of the proportion of urban population to the total is low in India but the urban population in absolute terms is high. Since the first regular census of India was taken in 1881, almost all census reports have commented on the urban growth. During the last three decades in India, the link between urbanization and environment and the threat to the quality of life have emerged as a major issue.

Table 1: Pattern and trend of urbanization in India, 1901-2001¹

Cen- sus Years	Number of Towns ²	Urban Population (in millions)	Percent Urban	Annual Expo- nential Growth Rate	Rate of Urban- ization
1901	1916	25.9	10.8	-	-
1911	1908	25.9	10.3	0.0	-0.46
1921	2048	28.1	11.2	0.8	0.87
1931	2220	33.5	12.0	1.7	0.71
1941	2422	44.2	13.8	2.8	1.50
1951	3060	62.4	17.3	3.5	2.54
1961	2700	78.9	18.0	2.3	0.40
1971	3126	109.1	19.9	3.2	1.06
1981	4029	159.5	23.3	3.8	1.72
1991	4689	217.6	25.7	3.1	1.02
2001	5161	284.5 ³	27.8	2.7	0.82

¹Excluding Assam in 1981 and Jammu and Kashmir in 1991

²Constituents of cities and towns of urban agglomerations have been counted as separate units

³ Provisional Figures of 2001 Census

Source: Census of India, 1991, Series-1, India, General Population Tables, Part-II-A (i)

- (i) *Pattern and Trend of Urbanization in India during 1901-2001:* The pattern and trend of urban population and number of towns in India during 1901 to 2001 shows that (Table 1 and Fig. 1) total urban population has increased more than ten times from 26 million to 285 million whereas total population has increased less than five times from 238 million to 1027 million from 1901 to 2001. A continuous increase has been noticed in the percentage of urban population from 11% in 1901 to 17% in 1951 to further 28% in 2001. In the same fashion the number of towns had also increased from 1916 in 1901 to 2422 in 1951 and then to 4689 in 1991. This reveals the rapid urbanization process in India.
- (ii) *Percentage of Urban Population in India by Size-Class of Urban Centers, 1961-1991:* Table 2 and Figure 2 shows percentage growth of urban population in India by size-class of town during 1901 to 1991. The process of urbanization in India reflects a certain degree of abnormality because of the fact that more than 60% of the urban population of the country lives in Class I town alone and remaining below 40% urban population lives in the smaller sized towns. An unremitting increase has been noticed for percentage of total urban population in Class-I city over the decades (1901 to 1991), while class IV, V and VI towns have experienced a continuous decline. However, class II and III towns have almost constant percent of total urban population over the decades. About three-fold increase has been found in the percentage of total urban population in class one city, from 23% in 1901 to 65% in 1991. This depicts a huge concentration of urban population in large

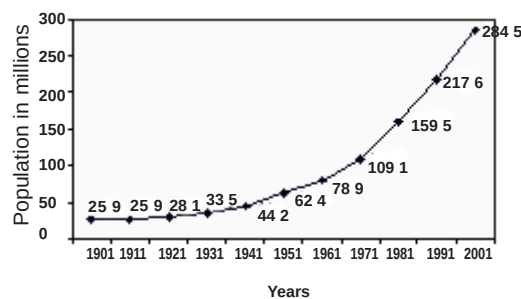


Fig. 1. Growth in the size of urban population in India, 1901-2001

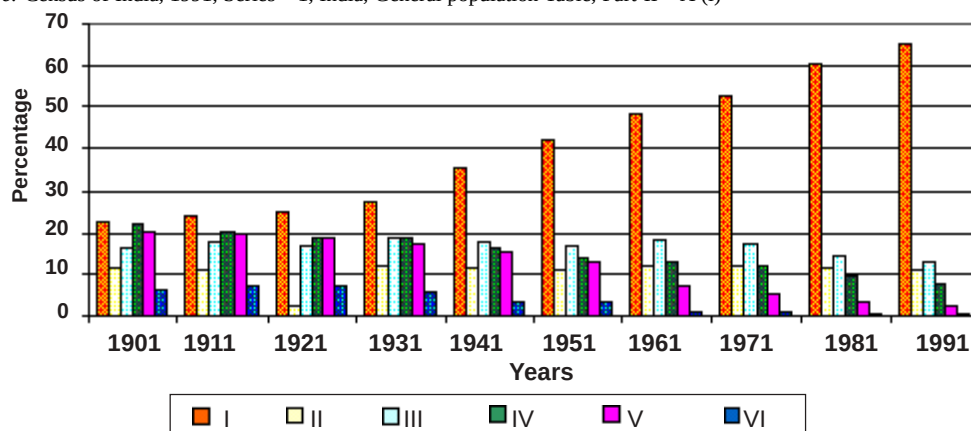
Table 2: Percentage of urban population in India by size-class of urban centers, 1961-1991¹

Size Class	1961	1971	1981	1991
Class I (100 000+)	51.4 (102)	57.2 (148)	60.4 (216)	65.2 (296)
Class II (50000-100000)	11.2 (129)	10.9 (173)	11.6 (270)	11.0 (341)
Class III (20 000-50 000)	16.9 (437)	18.0 (558)	14.4 (738)	13.2 (927)
Class IV (10 000-20 000)	12.8 (719)	10.9 (827)	9.5 (1053)	7.8 (1135)
Class V (5000-10 000)	6.9 (711)	4.5 (623)	3.6 (739)	2.6 (725)
Class VI (< 5000)	0.8 (172)	0.4 (147)	0.5 (229)	0.3 (185)
Total	100 (2270)	100 (2476)	100 (3245)	100 (3690)

¹ Excludes Assam in 1981 and Jammu and Kashmir in 1991

Figures in the parenthesis are the number of towns in each class category. Constituents towns of urban agglomerations are not counted as separate units

Source: Census of India, 1991, Series – 1, India, General population Table, Part-II – A (i)

**Fig. 2. Percentage growth of urban population by size-class of Towns in India, 1901-1991**

cities. The urbanization in India shows the pattern of 'inverted triangle' where majority of the urban population resides in the Class I cities.

- (iii) *Growth in the Number of Million Plus (1,000,000 Population or More) Cities in India during 1901-2001:* Table 3 shows the growth in the number and population of million plus cities in India during 1901 to 2001. There was only one million plus city (Kolkata) in 1901 in India. It became two in 1911 (Mumbai added) and was constant during 1911 to 1941. Million plus cities increases to five in 1951 and continuously increased after this decade and became 23 in 1991 and currently it is 35 in 2001 census. Total population also increased in the million plus cities from 1.51 million in 1901 to 107.88 million in 2001, almost a fifty fold increase. The percentage decadal growth rate in the total population of million plus city was noticed highest (121%) during 1941

Table 3: Growth in the number of million plus (1,000,000 population or more) cities in India 1901-2001¹

Cen- sus years	Number of cities with popu- lation more than one million	Popu- lation (in million)	Percent increase	Population of million cities as percent of India's	
				Total Popu- lation (in million)	Urban popu- lation (in million)
1901	1	1.51	-	0.6	5.8
1911	2	2.76	82.8	1.1	10.7
1921	2	3.13	13.4	1.3	11.1
1931	2	3.41	8.95	1.2	10.2
1941	2	5.31	5.71	1.7	12.0
1951	5	11.75	21.3	3.3	18.8
1961	7	18.10	54.0	4.1	22.9
1971	9	27.83	53.8	5.1	25.5
1981	12	42.12	51.3	5.2	26.4
1991	23	70.67	67.8	8.4	32.5
2001	35	107.88	52.8	10.50	37.8

¹ Excludes Assam in 1981 and Jammu and Kashmir in 1991
Source: Calculated from Censuses of different years

to 1951, because of the incidence of partition. After independence also, the decadal growth rate was more than 50% in each decades. This illustrates the realistic situation of exhausted growth in the million plus cities.

Looking at the percentage of total population of India residing in million plus cities, it reveals that it has increased drastically from less than 1% in 1901 to 3% in 1951 and further to 8% in 1991. Again, the percentage of total urban population of India residing in million plus cities has also increased drastically from 6% in 1901 to 19% in 1951 and further to 33% in 1991.

(iv) *Trend in Total Population and Annual Growth Rate in the Four Metropolitan Cities of India During 1901-2001*: More than thirty fold increase has been noticed in the population of Delhi in 100 years, from 0.41 million in 1901 to 12.8 million in 2001, whereas, there has been 20 fold increase in Mumbai's population, from 0.8 million to 16.4 million from 1901 to 2001. However, Chennai has experienced more than 10 fold increase (0.59 million to 6.4 million) in its total population during last 100 years whereas, Kolkata has experienced the lowest increase (less than 9 fold) in its total population among the metropolitan cities in last ten decades.

The maximum growth rate has been noticed during 1941 to 1951, highest in Delhi (90%) followed by Mumbai (76%) and Chennai (66%). However, Kolkata has noticed comparative low growth rate (29%) during the same period. This was the era of partition in India when a huge influx

of migration has taken place to big cities because of the Hindu Muslims communal riot. A large numbers of population joined the big cities after the insurrection. After independence, Delhi experienced the highest decadal growth rate (close to 50%) in its total population in all the censuses (1951 to 2001), followed by Mumbai where growth rate was about 40% during those Census years. However, Kolkata experienced continuous declining decadal growth rate from 1951 to 2001. On the other hand, Chennai has experienced a mixed pattern of high and low decadal growth rate during last 50 years.

Initially Kolkata was the most populous city of India till 1981, but Mumbai surpassed it in 1991 Census. Again, Delhi is expected to cross the population of Kolkata in the next Census of 2011 if both cities will experience same growth rate pattern. Thus it is evident with the table that Mumbai and Delhi metropolis are experiencing profuse growth in their population.

Impact of Urbanization on the Environmental Quality in the Metropolitan Cities of India

Urbanisation and its allied process have made a profound impact on the environment of the metropolitan cities of India. It has been accepted by the United Nations that it is quite impossible for developing countries to provide in advance the urban planning and design because it is not possible to accurately project the urban growth.

(i) *Slum Situation in India and its Metropolitan Cities*: The Govt. of India Slum Areas (Improvement and Clearance) Act of 1954 defines a slum 'as any predominantly

Table 4: Trend in total population (in 10,000s) and annual growth rate (in percent) in the four Metropolitan Cities of India, 1901-2001

<i>Census years</i>	<i>Mumbai</i>	<i>Growth rate</i>	<i>Kolkata</i>	<i>Growth rate</i>	<i>Delhi</i>	<i>Growth rate</i>	<i>Chennai</i>	<i>Growth rate</i>	<i>India</i>	<i>Growth rate</i>
1901	81.3	-	151.0	-	40.6	-	59.4	-	2384	-
1911	101.8	25.2	174.5	15.6	41.4	2.0	60.4	1.7	2521	5.7
1921	124.5	22.3	188.5	8.0	48.8	17.9	62.8	4.0	2513	-0.3
1931	126.8	1.8	213.9	13.5	63.6	30.3	77.5	23.4	2786	11.0
1941	168.6	33.0	362.1	69.3	91.8	44.3	92.1	18.8	3187	14.2
1951	296.7	76.0	467.0	29.0	174.4	90.0	153.1	66.2	3611	13.3
1961	415.2	39.9	598.4	28.1	265.9	52.5	192.4	25.7	4392	21.6
1971	597.1	43.8	742.0	24.0	406.6	52.9	305.8	58.9	5482	24.8
1981	891.7	49.3	919.4	23.9	622.0	53.0	428.9	40.3	6833	24.7
1991	1259.6	41.3	1102.2	19.9	942.1	51.5	542.2	26.4	8463	23.8
2001	1636.8	29.9	1321.7	19.9	1297.1	37.7	642.5	18.5	10270	21.4

Source: Census of India, 1991

Table 5: Total slum population in India according to size/class of towns, 1991

Size class category of cities /towns (population)	No of cities and towns	Total population (in 00000)	Percentage to total population	Slum population (in 00000)	Percentage to population total slum
More than 10,00000	23	710	26.6	189	41.3
5,00000-10,00000	31	215	19.8	43	9.3
3,00000-4,99999	39	151	18.9	29	6.3
1,00000-2,99999	207	325	16.8	54	11.9
50,000 to 99,999	345	236	20	47	10.3
Less than 50,000	3052	521	18.3	95	20.9
Total	3697	2158	21.2	457	100.0

Source: A Compendium on Indian Slums, 1996, Town and Country Planning Organization

residential areas, in which light or sanitary facilities or any combination of these factors are detrimental to the safety, health or morals'. The vast majority of the people who migrated to the city were attracted by opportunity and comforts offered by modernization. They belonged to the working class and found it difficult to secure accommodation within their means. So, they squatted on every open space available, as near their workplaces as possible and put up huts with cheap building materials. In this way slums grew in number and population. Total and slum population in India according to size/class of towns during 1991 shows that 41% of the total slum population was residing in million plus cities, where 27% of total population of India resides (Table 5). However, cities with population between 0.5 million to 1 million have only 9% of total slum population where 20% of total population was residing. Further, cities with population between 0.3 million to 0.5 million have only 6% of total slum population where 19% of total population was residing. This shows that cities with population between 0.5 to 1 million and city with population between 0.3 to 0.5 million have very less percentage of slum population whereas million plus cities have more percentage of slum population. It reveals that the opportunity in the medium city is less than the million cities. Therefore the unskilled population is more attracted towards the million cities and thus joins the slums for their residence. On the other hand, the towns with population less than 50,000 shows little more percentage of total slum population (21%) than its share of total

population (18%). It shows the poor housing quality in the small towns and also may be because the *semi-pucca* and *kachcha* houses may be identified as slum.

Slum population is a serious problem of the mega-cities of India. A large population of Mumbai, Kolkata and Delhi lives in slum, despite of several Government housing policies. Table 6 shows the percentage of slum population in the four metropolitan cities of India during 1981 to 2001. A continuous increase has been found in the percentage of slum population over the last three decades in the four metropolitan cities of India in which Mumbai was highest. In 1981, 31% population of Mumbai were residing in slum, and in 2001 nearly half of Mumbai's population (49%) was living in slums. However, Kolkata and Delhi had not shown as severe condition as Mumbai. The proportion of slum population was 30% and 18% in 1981 in Kolkata and Delhi, which increased to 36% and 23% respectively. On the other hand, it is little bit comfortable sign for Kolkata and Delhi that in 2001 the proportion of slum population has decreased to 33% and 19%, respectively. Although Chennai has lowest slum population among the four metropolitan cities yet it has experienced continuous increase in the slum population over the three decades. There were 14% slum population in Chennai in

Table 6: Percentage of slum population in the four Metropolitan Cities of India, 1981-2001

Metropolitan Cities	1981	1991	2001
Greater Mumbai (UA)	30.8	43.2	48.9
Kolkata (UA)	30.3	36.3	32.6
Delhi Municipal Corp. (UA)	18.0	22.5	18.9
Chennai (UA)	13.8	15.3	17.7

Sources: Census of India 1981, 1991 and 2001

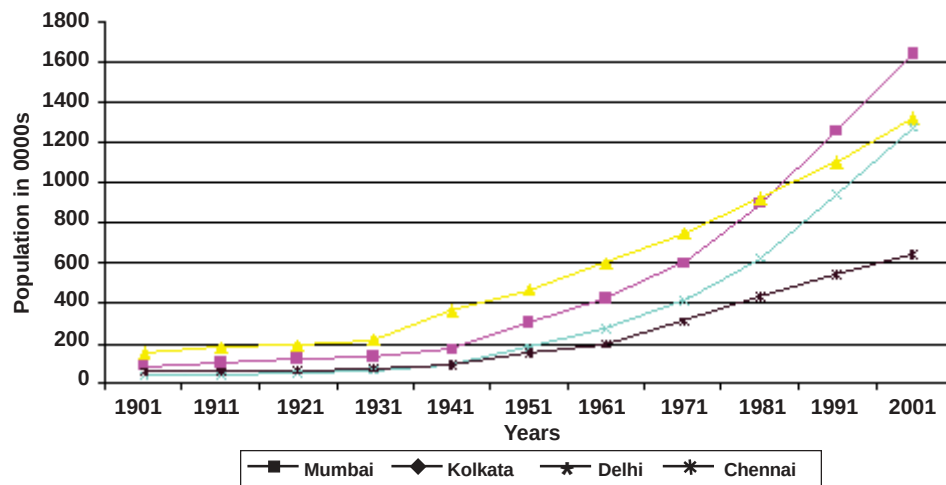


Fig. 3. Trend in total population in the Four Metropolitan cities of India, 1901-2001

1981, which increased to 15% in 1991 and further 18% in 2001.

(ii) *Composition of Solid Wastes in the Four Metropolitan Cities of India:* Table 7 shows the composition of solid wastes generated by four metropolitan cities in India. Among the different solid wastes generated like paper, textiles, leather, plastics, metal, glass, ash etc. and other compostable matters the percentage of ash etc. is the highest. Delhi exhibits the highest percentage of ash, which is about 52% of the weight of all the solid waste, followed by Mumbai, Kolkata and Chennai. The reason that Delhi has the highest percentage of ash as solid waste may lie in the fact that Delhi is a large industrial center with mainly metal industry, which uses coal as a source of power and the number of industries is growing day by day because of the growing urbanization. About 10% of all the solid waste generated in the metropolitan cities is paper. Textile waste generation ranges between 3 to 5%. Leather

waste is generated mostly by Chennai and generated lowest in Mumbai. Kolkata generates the largest amount of plastics among all the metros, which accounts for 8% of all the weight of the solid waste materials. This is a serious problem and will increase in future because of increase in packaging of consumer's goods, if proper management will be not available. Also this has an irreversible health hazards.

(iii) *Status of Municipal solid waste generation and collection in Metropolitan Cities of India:* Mumbai generates the largest amount of Municipal solid waste in 1996, which is 5355 tonnes/day followed by Delhi (4000 tonnes/day), Kolkata (tonnes/day) and Chennai, which is 3124 tonnes/day (Table 8). But if we consider the per capita generation of solid waste, it is largest in Chennai, which is about 700 gms/day. The lowest per capita waste generation is in Kolkata, which is about 350 gms/day. Again about 90% of the generated Municipal solid

Table 7: Composition of solid wastes in the four Metropolitan cities of India, 1998

Metropolitan cities	Characteristics (in percent by weight)						Ash, etc.	Comostable matter
	Paper	Textile	Leather	Plastic	Metal	Glass		
Mumbai	10.0	3.6	0.2	2.00	-	0.2	44.0	40.00
Kolkata	10.0	3.0	1.0	8.00	-	3.0	35.0	40.00
Delhi	06.6	4.0	0.6	1.50	2.50	1.2	51.5	31.78
Chennai	10.0	5.0	5.0	3.00	-	-	33.0	44.00

Source: Central Pollution Control Board, Status of Solid Waste Management in Metro Cities India, 1998

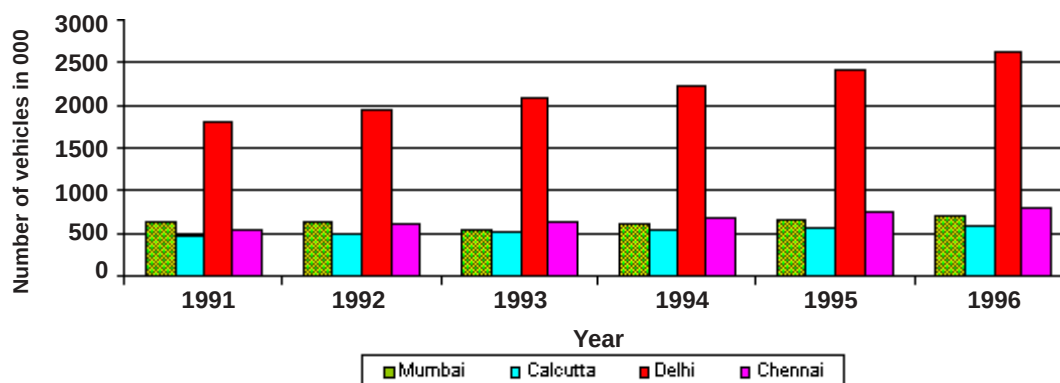


Fig. 4. Growth (in numbers) in motor vehicles in four Metropolitan cities of India, 1991-1996

Table 8: Status of Municipal solid waste generation and collection in Metropolitan Cities of India, 1996

Metro-politan cities	Municipal Solid Waste ¹ (tones/day)	Per capita Generation ¹ (Kg/day)	Collection in percent ²
Mumbai	5355	0.436	90
Kolkata	3692	0.347	-
Delhi	4000	0.475	77
Chennai	3124	0.657	90

Source: ¹Central Pollution Control Board, Status of Solid Waste Management in Metro Cities India, 1998

² World Resources, 1996-97

Table 9: Growth in motor vehicles in India, 1990-2000

Years	Number of vehicles (in thousands)	Percent increase
1990	19152	-
1991	21374	11.6
1992	23507	10.0
1993	25505	8.5
1994	27660	8.4
1995	30287	9.5
1996	33850	11.8
1997	37231	10.0
1998	43159	15.9
1999	48240	11.8
2000	53100	10.1

Source: Center for Pollution Control Board, Ministry of Environment and Forests, Government of India, New Delhi, 2000

waste in Mumbai and Chennai are being collected. However, in Delhi there is a not adequate system of collection as only 77% of the generated Municipal solid wastes are collected.

- (iv) *Growth in motor vehicles in India and in Metropolitan Cities:* Motor vehicles, which are the main source of vehicular pollution, are constantly increasing in number since the year 1990 (Table 9). With in 10 years from 1990 to 2000 there has been almost a

Table 10: Growth in Motor Vehicles in Metropolitan Cities in India during 1991-96 as on 31st March (in 000s)

Metro-politan cities	1991	1992	1992	1994	1995	1996
Mumbai	629	647	546	608	667	724
Calcutta	475	497	517	545	561	588
Delhi	1813	1963	2097	2239	2432	2630
Chennai	544	604	641	689	768	812

Source: Transport Research Wing, Motor Transport Statistics of India, 1997, M/o Surface Transport, GOI, New Delhi.

Table 11: Estimated vehicular emission load in 1994 (tones per day)

Emission load	Delhi	Mumbai	Kolkata
Particulates	10.30	5.59	3.25
Sulphur Dioxide (SO ₂)	8.96	4.03	3.65
Nitrogen Oxide (NO ₂)	126.46	70.82	54.69
Hydro Carbons (HC)	249.57	108.20	43.88
Carbon Monoxide (CO)	651.01	496.6	188.24
Total	1046.3	659.57	293.71

Source: Center for Science and Environment, Slow Murder, 1996

three-fold increase in the number motor vehicles in India. On an average 10% increase has been found in each year, which is a serious concern for air pollution.

Again, the number of vehicles in Delhi has increased from 1813 thousand in 1991 to 2630 thousand in 1996, a one and half times increase in 6 years followed by Chennai. This is because of lack of the sub-urban train facility in Delhi with a huge number of commuting population. On the other hand, increase in the number of

Table 12: State of ambient air quality in four Metropolitan Cities of India, 1991-1995

<i>Metro-politan cities/ years</i>	<i>Sulphur dioxide (SO₂) (mg/cu.m)</i>	<i>Nitrogen dioxide (NO₂) (mg/cu.m)</i>	<i>Suspended Particulate matter (SPM) (mg/cu.m)</i>
<i>Mumbai</i>			
1991	28	29	244
1992	18	33	238
1993	22	35	232
1994	33	34	231
1995	31	26	209
<i>Kolkata</i>			
1991	63	40	391
1992	36	27	307
1993	40	40	460
1994	48	34	375
1995	35	29	354
<i>Delhi</i>			
1991	20	34	390
1992	18	30	364
1993	19	30	424
1994	25	43	446
1995	23	47	410
<i>Chennai</i>			
1991	14	01	130
1992	07	03	074
1993	14	00	100
1994	16	00	128
1995	21	00	127

Source: Anon 1997, Ambient Air Quality Status & Statistics 1995, NAAQMS / 8 1996-96, Central Pollution Control Board, Delhi

vehicles was quite less in Mumbai and Calcutta compared to Delhi and Chennai (Table 10 and Fig. 4).

- (v) *Vehicular Emission Load*: Table 11 shows the estimated vehicular emission load in tones per day in the three metropolitan cities of Delhi, Kolkata and Chennai in 1994. Among all the vehicular emission loads, the amount of Carbon monoxide (CO) was

found highest followed by Hydro Carbon and Nitrogen Oxide in all the three metropolitan cities. The total amount of all type of vehicular emission load was found highest in the sky of Delhi (1046 tonnes / day) followed by Mumbai (660 tonnes /day) and Calcutta (294 tonnes /day). Carbon monoxide contributes to more than 65% in all the three metro cities, which is 651 tonnes/day in Delhi followed by Mumbai (497 tonnes/day) and Kolkata (188 tonnes/day). The amount of Suspended Particulate Matter (SPM) in the air is highest in Delhi (10.3 tonnes/day) followed by Mumbai (5.6 tonnes/day) and Kolkata (3.3 tonnes/day). As the previous table shows that in Delhi the numbers of registered vehicles are highest, the vehicular emission load also substantiates it, as all the elements were found highest in Delhi. The ingredient of vehicular emission load affects the health of the people and deteriorates the quality of life of the residence of metro cities.

- (vi) *State of Ambient Air Quality in Four Metropolitan Cities of India*: Although air pollution is only one of the many environmental hazards in urban centers of the world, along with water contamination, hazardous wastes, overcrowding, congestion, and so on, it is a unique problem as it affects every resident, it is seen by every resident, and is caused by every resident (Maitra, 2000). Table 12 shows the state of ambient air quality in the four metropolitan cities of India during 1991 to 1995. Here air quality has been measured by the presence of SO₂ (Sulphur dioxide), NO₂ (Nitrogen dioxide) and SPM (suspended particulate matters) in mg/cu.m in the air, which causes air

Table 13: Waste water generation, collection and treatment in Metropolitan Cities of India, 1997-98

<i>Metropolitan cities</i>	<i>Volume of wastewater generated (mld)</i>			<i>Wastewater collected</i>			<i>Treatment</i>		<i>Mode of disposal</i>
	<i>Domestic</i>	<i>Industrial</i>	<i>Total</i>	<i>Volume (mld)</i>	<i>Percent</i>	<i>Capacity (mld)</i>	<i>Pri-ary</i>	<i>Sec-ndary</i>	
Mumbai	2228.1	227.9	2456.0	2210.0	90.0	109.0	Y	Y	Sea
Kolkata	1383.8	48.4	1432.0	1074.9	75.1	-	-	-	Hugli river
Delhi	1270.0	-	1270.0	1016.0	80.0	981.0	Y	Y	Fish farm
Chennai	276.0	-	276.0	257.0	93.1	257.0	Y	Y	Agriculture
									Yamuna river
									Agriculture Sea

Note: Y-Yes Source: Control of Urban Pollution Series: Cups/42/1997-98, CPCB, 1997

pollution. One good sign is that the presence of SPM in the air of the metro cities has been declining over the years but only exception is Delhi where the presence of suspended particulate matter has been increased from 390 to 410 mg/cu.m from 1991-95. The concentration of SO₂ has increased from in Mumbai over the five years but in Kolkata it has declined significantly.

(vii) *Waste Water Generation, Collection and Treatment in Metropolitan Cities:* Like air pollution, water pollution is also one of the increasing problem due to the growing population. Water resources are diminishing not just because of large population numbers but also because of wasteful consumption and neglect of conservation. With rapid urbanization and industrialization, huge quantities of wastewater enter rivers. Table 13 shows the volume of wastewater generated (in milliliter per day) from different domestic and industrial sources, the volume ultimately collected and the amount of waste water treated before it is ultimately disposed off, in the four metropolitan cities of India. The volume of domestic wastewater generation is highest in the metropolitan city of Mumbai, which is 2228.1 ml/d followed by Kolkata (1383 ml/d) and Delhi (1270 ml/d) and the lowest is in Chennai (only 276 ml/d). The generation of industrial wastewater is also highest in Mumbai. Again looking at the percentage of wastewater collection from the four metropolitan cities, Chennai and Mumbai performs better than Delhi and Kolkata. Regarding the treatment of the collected wastewater in all the metro cities, the water is disposed only after primary and secondary treatment. Again the collected wastewater in Mumbai is mainly disposed off in the Arabian Sea and in Kolkata some amount is disposed in the Hugli river and the rest is used in the fish farming. However, in Delhi and Chennai the waste-water is mainly used for agricultural works and the remaining water is disposed in the Yamuna river in Delhi and in the Bay of Bengal in Chennai.

(viii) *Noise Levels in the Metropolitan Cities:* Table 14 shows the average noise levels in various metropolitan cities of India both during the day and night in the industrial area, commercial area, residential area and

as well as in the silence area during 1997. The noise pollution was noticed above than the prescribed standard in all the metro cities. Kolkata experienced the highest noise pollution level in all the areas like residential, commercial, and Industrial in both during day and night. Mumbai was in better situation than Kolkata but worse than Delhi in respect of noise pollution in all areas.

Table 14: Average noise levels in the Metropolitan Cities, 1997

Metro-politan cities	Day/night	Industrial area	Commercial area	Residential area	Silence area
Mumbai	Day	76	75	70	66
	Night	65	66	62	52
Kolkata	Day	78	82	79	79
	Night	67	75	65	65
Chennai	Day	71	78	66	63
	Night	66	71	48	49

Source: State of the Environment, 1995, MOEF and Compendium of Environment Statistics, 1997 - Central Statistical Organization, Department of Statistics, Ministry of Planning and Programme Implementation, GOI

Living Condition in the Metropolitan Cities in India

Table 15 shows housing characteristics of the four Metropolitan Cities and urban India in 1998-99. In Mumbai 34% of the household lived in semi-pucca and 3% in kachcha houses followed by 33% and 9% respectively in Chennai. However, in Delhi, 11% household resides in semi-pucca and less than 1% in kachcha houses. It is a good sign for Kolkata that there were only 5% semi-pucca houses and almost negligible kachcha houses. This shows that in Mumbai and Chennai housing situation is poorer than Kolkata and Delhi.

On the other hand, the houses in these metros are very much overcrowded. More than three people residing in a single room, is condition for 56% of the population of Mumbai followed by 43% population of Kolkata, 30% population of Chennai and one-fourth population of Delhi. Further, five and more person residing in a room, such miserable condition, was faced by 28% population of Mumbai followed by 17% of the population of Kolkata and about 10% population of Delhi and Chennai both.

Looking at the sanitation condition of the

Table 15: Housing characteristics of the four metropolitan cities and urban India, 1988-99

<i>Household Characteristics</i>	<i>Mumbai</i>	<i>Kolkata</i>	<i>Delhi</i>	<i>Chennai</i>	<i>All India urban</i>
<i>Types of House</i>					
Pucca	62.8	94.1	88.2	57.5	66.0
Semi-pucca	34.1	5.2	10.7	32.8	24.4
Kachcha	2.8	0.2	0.9	9.2	9.4
<i>Sanitation Facilities</i>					
Flush Toilet	97.4	89.5	85.5	89.1	63.9
Owned	29.4	-	-	-	-
Shared	15.2	-	-	-	-
Public	52.8	-	-	-	-
Pit Toilet	0.1	8.9	8.9	1.6	16.8
No Facility	2.5	1.6	5.6	9.3	19.3
<i>Sources of Drinking Water</i>					
Piped	99.6	64.0	86.7	63.3	74.5
Hand Pump	0.2	34.5	12.0	30.6	18.1
Others	0.2	1.5	1.3	6.1	7.4
<i>Methods of Purifying Drinking Water</i>					
Stains water by cloths	54.1	1.0	3.9	14.7	25.1
Uses water filter	10.2	17.0	18.8	15.1	14.8
Boils water	18.2	5.7	14.4	38.2	13.6
Uses electronic purifier	2.5	2.7	3.8	3.0	1.2
Other methods	0.7	1.5	1.0	0.7	2.0
Does not purify water	27.1	74.2	62.4	42.8	50.4
<i>Electricity</i>					
Yes	99.5	93.8	97.7	89.6	91.3
No	0.5	6.2	2.3	10.4	8.7
<i>Main Type of Fuel Used for Cooking</i>					
Kerosene	39.5	50.3	16.3	54.0	21.5
LPG	58.9	39.9	17.0	37.3	46.9
Biomass fuel and others	1.4	14.6	3.7	8.7	31.6
<i>Persons Per Room</i>					
<3	43.9	57.4	75.2	69.9	68.6
3-4	27.6	25.3	15.1	19.8	19.5
5-6	20.1	11.9	6.7	8.8	8.3
7+	8.3	5.5	3.0	1.1	3.5

metro cities, it is apparent that, almost universal flush toilet facility is available in Mumbai followed by 90% in Kolkata and 89% in Delhi. However, the matter-of-fact is that more than half of this facility in Mumbai is available in public place and not in house premises. Kolkata and Delhi might have the similar situation. Again it is unfortunate to note that about 9% population of Kolkata and Delhi uses pit toilet. Further what is the worst situation that 9% of Chennai's population does not have toilet facility at all

followed by 6% in Delhi. This shows the inadequate planning of Municipal Corporation because of unprecedented population pressure.

As regard to the sources of safe drinking water, the situation is best in Mumbai where almost the entire population has access to piped drinking water. However, a substantial population is dependent on hand pump in Kolkata (35%) followed by Chennai (31%) and Delhi (13%). On the other hand, in Chennai, 6% of population is dependent on the sources other than hand pump and taped/piped water.

Considering the methods of purification of drinking water, again it is a very deplorable fact that, half of the urban population in India does not purify drinking water at all. In Kolkata three-fourth population do not purify drinking water followed by 62% of population of Delhi. However, the situation is little bit better in Mumbai and Chennai where 27% and 43% population respectively, do not purify drinking water. But at the same time, majority of the Mumbai population purify drinking water by straining by cloths only. The situation reveals the danger of diseases related to water born. This may cause serious health problems especially to the slum dwellers and low-income population.

Electricity facility is almost universal to Mumbai's population whereas 10% population of Chennai and 6% population of Kolkata do not have the electricity facility. Main type of fuel used for cooking in urban India is LPG followed by biomass fuel and kerosene. However, in Kolkata and Chennai more than 50% population uses kerosene. There is very less percentage (less than 9%) of user of biomass fuel and others in all the four metro cities, except Kolkata where 15% population uses it. This enhances the problem of indoor pollution in the metro cities.

CONCLUSION

It is evident from the study that, each and every environmental and social parameter of the Indian metropolitan cities are very much deprived. In case adequate steps are not taken to prevent pollution and to improve the quality of life by providing more social amenities, the life of the urban dwellers of India may become more miserable which may be the cause of health hazards and worst devastation. To achieve this, the urban population must be controlled. Also the number of people living in the metropolitan city

demanding the resources land, air and water apart from other biological resources must be limited. Vehicular pollution control in metropolitan cities and other cities deserves top priority. Urgent attention should be given to reduce the generation of solid waste at the sources through mandatory standards and regulation fee and tax incentives, and education and voluntary compliance. Improved technologies should be developed for waste collection, treatment, and disposal in order to ensure proper solid waste management.

Evidences from the present study indicates that the maintenance of high quality of life in metropolitan cities requires the innovative economic growth potential as well as our urban population in the metro cities should be stabilized at sufficient level in lieu with the resources available and the protection of environmental quality leading towards sustainable development. Serious attention should be given to the need for impro-

ving urban strategies, which promote efficiency in resource use. There is an urgent need to tackle the problem of population growth in the metropolitan cities in a rational manner.

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