Status of Wastewater Generation and Treatment in India

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ABSTRACT: Urban centers in India lack infrastructure for sanitation, and the wastewaters generated are not managed appropriately. Inadequate treatment facilities for sewage have deteriorated the water quality of aquatic resources. Deterioration of the water quality results in health problems for the public at large. The rapidly increasing population and resultant wastewater generation may make all perennial aquatic resources unfit for their desired uses in the years to come, if wastewater generated in urban centers is not treated completely.
The Central Pollution Control Board carried out studies to assess the status of wastewater generation and treatment in Class I cities (population > 100,000) and Class II towns (population between 50,000 and 100,000) during 1978-79, 1989-90, 1994-95 and 2003-04.
The latest study indicates that about 26 254 million litres per day (Ml/d) of wastewater are generated in the 921 Class I cities and Class II towns in India (housing more than 70% of urban population). The municipal wastewater treatment capacity developed so far in India is about 7044 Ml/d - accounting for 27% of wastewater generation in these two classes of urban centers. An attempt is made to estimate the urban population and resultant wastewater generation for 2051.
There is urgent need to plan strategies and give thrust to policies giving equal weighting to augmentation of water supplied and development of wastewater treatment facilities. The future of urban water supplies for potable uses will grossly depend on efficient wastewater treatment systems, as the treated wastewater of upstream urban centers will be the source of water for downstream cities.

1. Introduction

The unregulated growth of urbanisation has led to an alarming deterioration in the quality of life in the urban centres in India. Indian cities suffer from infrastructure deficiencies, poor sanitation, water shortages and polluted natural watercourses. The aggregate impact of the distress is debilitating to manage daily lives and chores in this environment. One of the significant environmental problem and threat to public health in both rural and urban India is inadequate access to clean drinking water and sanitation facilities. Almost all the surface water sources are contaminated to some extent by Coliform Group of Bacteria that make it unfit for human consumption unless disinfected. As per the estimates of Department of Drinking Water, about 67% population does not have access to sanitation facilities in rural India.

2. Urbanisation in India

The process of urbanisation in India from the beginning of last century reveals a steady increase in the size of its urban population, number of urban centres, and level of urbanisation since 1911 and a rapid rise after 1951. From a modest base of 25.8 million persons in 1901, the number of urban dwellers has risen to 285 million, signalling a phenomenal eleven fold increase in urban population over the period 1901-2001. However,

India continues to be among the least urbanised countries as far as the share of urban population to the total is concerned. A majority of the developing countries are more urbanised than India besides the developed nations, which have reasonably high level of urbanization than India. The present annual rate of growth of urban population in India is 3.09%.. In 1901, the percentage of settlements with over 100,000 population was just 26.0 %; it has risen to 60% by 2001, heralding what would seem to be one of the most significant changes in the pattern of habitation in the country.

Table 1: Distribution of Cities/Towns of various population ranges in different States/Union Territories-2001

State	Number of Cities/Towns (Ranges of Population in 100,000)							
	Class I Cities							Class II Towns
	1-2	2-5	5-10	10-20	20-50	>50	All Cities	0.5-1
Andaman & Nicobar Islands	1	0	0	0	0	0	1	0
Andhra Pradesh	27	14	2	2	1	0	46	52
Arunachal Pradesh	0	0	0	0	0	0	0	0
Assam	3	0	1	0	0	0	4	9
Bihar	12	6	0	1	0	0	19	18
Chandigarh	0	0	1	0	0	0	1	0
Chhattisgarh	2	3	2	0	0	0	7	7
Dadra & Nagar Haveli	0	0	0	0	0	0	0	0
Daman & Diu	0	0	0	0	0	0	0	0
Delhi	8	0	1	0	0	1	10	9
Goa	0	0	0	0	0	0	0	3
Gujarat	17	1	1	2	2	0	23	36
Haryana	14	5	0	1	0	0	20	7
Himachal Pradesh	1	0	0	0	0	0	1	0
Jammu & Kashmir	0	1	1	0	0	0	2	4
Jharkhand	4	0	1	2	0	0	7	17
Karnataka	14	11	2	0	1	0	28	30
Kerala	2	3	1	1	0	0	7	24
Lakshadweep	0	0	0	0	0	0	0	0
Madhya Pradesh	14	5	1	3	0	0	23	25
Maharashtra	12	15	6	4	2	1	40	44
Manipur	0	1	0	0	0	0	1	0
Meghalaya	1	0	0	0	0	0	1	1
Mizoram	0	1	0	0	0	0	1	0
Nagaland	1	0	0	0	0	0	1	1
Orissa	3	3	2	0	0	0	8	15
Pondicherry	0	2	0	0	0	0	2	1
Punjab	8	2	1	2	0	0	13	20
Rajasthan	7	6	3	0	1	0	17	28
Sikkim	0	0	0	0	0	0	0	0
Tamil Nadu	13	8	2	2	1	0	26	57
Tripura	1	0	0	0	0	0	1	0
Uttar Pradesh	28	13	5	4	2	0	52	57
Uttaranchal	2	1	0	0	0	0	3	4
West Bengal	37	18	0	2	1	0	58	29
Total	**232**	**119**	**33**	**26**	**11**	**2**	**423**	**498**

With this change, India is no longer a country that lives in villages and small towns; rather, it has acquired an intricacy of a country that has an extensive network of large urban agglomerations.

India has entered the 21st century with a total population of 1020 million and an urban population of 285 million. The numbers of Class-I cities (population more than 100,000) are 423 and Class II Towns (Population between 50,000 and 100,000) are 498 as per the census of India 2001, which accounts for about 72% of urban population of India. The distribution of Class I Cities in various population ranges and Class II Towns as per 2001 census is given in Table 1 above.

The urban India has become a massive and perhaps a frightening reality as far as waste management is concerned. This country can no longer afford to allow urban areas constituting cities and towns of varying magnitude to take care of themselves, they need the full and undivided attention of our planners and decision makers for protection of environment, aquatic resources and ultimately for better management of health aspects.

3. Methodology for Questionnaire Survey

Questionnaires were prepared and circulated to the Chief Executives of the Class I cities and Class II towns Municipalities/Municipal Committees/Municipal Corporations in all the States and Union Territories of India. The Engineers-in-Chief, Chief Engineers and Managing Directors of the respective State Public Health Engineering Departments/ City Water Board/Water Supply and Sewerage Board were also requested to provide information as detailed in Questionnaire. Simultaneously the State Governments at the level of Chief Secretary and Secretary Urban Development; and State Pollution Control Boards were requested to persuade the municipal authorities in their States/Union Territory to provide the requisite information. Information in this context, were also collected from the Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development. A copy of the Questionnaire is placed at the end of this paper as Annexure. The data is compiled based on the information received through filled in questionnaires and other sources. Data validated through personal visits to the Cities/Town and through telephonic interaction. The data were processed to obtain Statewise, Basinwise and National status of water supply, wastewater collection, treatment and disposal in the Class I cities and Class II Towns. Though identifying class I cities were based on a particular year census report, in the calculation of per capita water supply and wastewater generation, projected population for the year of study for each city were calculated.

Limitations of the study

- Population has been estimated for the year of study on the basis of growth rate of the previous decade.
- Some of the municipal authorities did not report the volume of wastewater generation, collection and sewered population that has been estimated after visits to the concerned urban center.
- The urban centers are associated with outer growth, which is not accounted under municipal population. The water supply to these areas is managed privately or through cooperative society however the wastewater finds its way to the drainage system of urban center. In such situation information needs further validation for wastewater generation.

4. Status of Water Supply, wastewater generation and treatment in Class I Cities and Class II Towns

The Central Pollution Control Board (CPCB) realised the gravity of water quality deterioration in water bodies and instituted studies on the wastewater management in India with changing urban pattern during last three decades and highlighted the need for urban wastewater management. The studies on watersheds for assessment of water quality and wastewater management formed the basis for River Action Plans on many of rivers and their tributaries. The comparison of water supply, wastewater generation and treatment in Class I Cities and Class II Towns during 1978-79, 1989-90, 1994-95 and 2003-04 is given in table 2. Data collected in these studies indicates that the wastewater generation has increased three fold i.e from 8233 million litres per day (mld) in 1978-79 to 26254 mld in 2003-04 putting together the figures of both categories of urban centres. Although, the treatment capacity has also increased by two and half times from 2823 mld in 1978-79 to 7044 mld in 2003-04 but the gap of untreated volume has increased drastically. The trend of water supply and wastewater generation and treatment in Class I Cities and Class II towns is summarised in Table 2.

Table 2: Trend of water supply, wastewater generation and treatment in Class I Cities/ Class II towns

Parameters	**Class I Cities**				**Class II Towns**			
	1978-79	**1989-90**	**1994-95**	**2003-04**	**1978-79**	**1989-90**	**1994-95**	**2003-04**
Number	142	212	299	423	190	241	345	498
Population (millions)	60	102	128	187	12.8	20.7	23.6	37.5
Water Supply (mld)	8,638	15,191	20,607	29782	1533	1622	1936	3035
Water Supply (lpcd)	144	149	161	160	120	78	82	81
Wastewater generated (mld)	7,007	12,145	16,662	23826	1226	1280	1650	2428
Wastewater generation (lpcd)	117	119	130	127	96	62	70	65
Wastewater treated (mld)	2,756 (39%)	2,485 (20.5%)	4,037 (24%)	6955 (29%)	67 (5.44%)	27 (2.12%)	62 (3.73%)	89 (3.67%)
Wastewater untreated (mld)	4,251 (61%)	9,660 (79.5%)	12,625 (76%)	16871 (71%)	1160 (94.56%)	1252 (97.88%)	1588 (96.27%)	2339 (96.33%)

The data on wastewater generation and treatment in Class I cities and Class II towns in India during 2003-04 is compiled for each State and Union Territory and the ranking of States (worked out on the basis of discharge of untreated wastewater) is presented in Table 3.

Table 3: Ranking of States based on discharge of untreated wastewater in Class I cities and Class II towns - 2003-04

Rank	State	Wastewater generation (mld)	Wastewater Treatment (mld)	Discharge of untreated wastewater (mld)
1	Maharashtra	5247	653	4594
2	West Bengal	2363	385	1978
3	Delhi	3663	2230	1433
4	Bihar (incl. Jharkhand)	1524	135	1389
5	Uttar Pradesh (incl. Uttaranchal)	2563	1215	1348
6	Andhra Pradesh	1421	208	1213
7	Rajasthan	1180	27	1153
8	Gujarat	1911	807	1104
9	Madhya Pradesh (incl. Chattisgarh)	1296	241	1055
10	Tamil Nadu	1223	338	885
11	Karnataka	1158	397	761
12	Punjab	689	5	684
13	Kerala	479	0	479
14	Orissa	418	0	418
15	Assam	248	0	248
16	Chandigarh	304	91	213
17	Haryana	369	309	60
18	Pondicherry	40	0	40
19	Meghalaya	34	0	34
20	Manipur	27	0	27
21	Tripura	25	0	25
22	Goa	22	0	22
23	Nagaland	22	0	22
24	Himachal Pradesh	15	3	12
25	Andaman	9	0	9
26	Mizoram	4	0	4
	Total	26254	7044	19210

5. Future Scenario

The Population of India is likely to be stabilized by 2050 at the level of 1700 million people. The urban population projection for the year 2051 is likely to be of the magnitude of 850 million when about 50% population will live in cities. The per capita wastewater generation shall be around 98 lpcd (by the conservative estimate and putting together the figures of both the classes studied) based on the average wastewater generation observed during the four studies carried out by CPCB. However the actual measurement of drains carried out in National Capital Territory of Delhi on monthly basis indicates the per capita wastewater generation over 220 lpcd.The development process has gain momentum and the basic infrastructure is the priority that includes piped water supply and sewerage system for management of wastewater. In these circumstances wastewater generation from urban population will be enormous.

Based on the projected population for the year 2051 the wastewater generation is going to be around 83,300 mld by conservative estimates however if the wastewater generation figures of Delhi are taken into account the figures of wastewater generation projected for 2051 may be doubled. As the water availability is going to reduce due to increase in population the wastewater generation in any urban centre is going to be the source of water supply for the

downstream located urban centres. In view of such situation there is a need to attain 100% wastewater treatment in each city with more stringent standard. The projected population and respectively wastewater generation is given in Table 4

Table 4: Projected population and respectively wastewater generation for 2051

Year	Urban Population (million)	Wastewater Generation (lpcd)	Gross Wastewater Generation (mld)
1977-78	72.8	106	8,233
1989-90	122.7	90	13,425
1994-95	151.6	100	18,312
2003-04	224.5	96	26,254
2051	850 (Projected)	98 (Assumed)	83,300 (Projected)

6. Experience of River Action Plan

The water quality monitoring of CPCB resulted in identification of the water bodies in need of restoration. The first such restoration program was formulated for the Ganga river known as Ganga Action Plan, which was launched in 1985. Subsequently, other rivers were taken in the program under National River Action Plan. In each case the major polluting sources were identified. Interception, diversion and treatment of wastewater was taken up in the major towns located along the rivers. Presently such action plan is being implemented in 157 Cities/ towns all over the country.

During operational phase, several problems are being faced. Apart from the administrative problem of operation and maintenance, there are technical problems. Amongst others, inadequacy in the design of treatment plants leads to a host of problems that are being faced in construction, operation and maintenance. This is due to the fact that the characteristics of sewage actually reaching the plant are much different than the design criteria. The plant designs are based on population based estimated BOD load, which is much higher than the BOD actually reaching to the plants. Thus the plants were over-designed.

7. Conclusion

With fast urbanization & industrialization the generation of wastewater has taken a phenomenal growth. Due to paucity of resources the wastewater is not being treated adequately before disposal leading to pollution of surface & groundwater resources. Many water bodies are already in alarming situation. Treatment of wastewater requires enormous resources, which cannot be provided without public support. A large number of small-scale industries located in urban residential areas are compounding the problem by discharging industrial effluent in sewer line. Since wastewater contains large amount of organic matter & nutrients, it is worth to convert into energy & fertilizer. Keeping in view of future scenario of wastewater generation for the year 2050 a definite road map is needs to be prepared by all concerns. Effort needs to focus on use of wastewater for agriculture & recover energy from it as far as possible.

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ANNEX

Questionnaire on Status of Water supply, Wastewater Generation, Collection and Treatment in Class I Cities & Class II Towns in India

(A) Municipal Body

1) Name of Town/City :
2) Population (2001 census) :
3) District :
4) State :
5) PIN Code :
6) Name of river basin :

(B) Water Supply

1) Source of piped Water Supply : a)River/Lake……mld
(Specify name:)
b)Ground water…….. mld
c)Other ……mld

2) Percentage population covered by piped water supply: ……%

3) Specify type of treatment given before community water supply (For multiple source, information on treatment may be indicated separately) : Conventional treatment system/only chlorination

4) Source of private Water Supply: a)River/Lake……mld
(Specify name:)
b)Ground water…….. mld
c)Other ……mld

(C) Wastewater (sewage) generation and collection

1) Total Wastewater generation (Sewered + Unsewered) : a) Domestic …… mld
: b) Industrial …… mld

2) Percentage population covered by underground sewerage : ……%

3) Volume of wastewater collected (Sewered) : a) Domestic …… mld
: b) Industrial …… mld

4) Are there separate sewers for domestic and industrial wastewaters? : Yes/No

5) Are there separate storm water drains ? : Yes/No

(D) Wastewater (sewage) treatment and disposal

1) Total installed Sewage Treatment Capacity : …… mld

Details of treatment technology in existing STPs

Process	Capacity (mld)	Capital Cost	Year of Commissioning
Activated Sludge Process			
Trickling Filter Process			
UASB Process			
Other Anaerobic Process			
Oxidation Pond			
Only Primary Settling			
Other Process(Specify)			

2) Under construction or proposed : …… mld
Sewage Treatment capacity

Details of treatment technology in under construction or proposed STPs

Process	Capacity (mld)	Stage of construction
Activated Sludge Process		
Trickling Filter Process		
UASB Process		
Other Anaerobic Process		
Oxidation Pond		
Only Primary Settling		
Other Process(Specify)		

3) Mode of disposal of Sewage :

	Treated sewage	Untreated sewage
a)Disposal into River	…… mld	…….. mld
(Name of receiving River:…….River distance:		…….)
b)Disposal into Lake	…… mld	…….. mld
(Name of receiving Lake:…….Lake distance:		…….)
c)Disposal into Estuary	…… mld	……. mld
(Name of receiving Estuary:	Estuary distance:	……)
d)Disposal into Sea	…… mld	…….. mld
(Name of receiving Sea: ……	Sea distance:	……)
e)Disposal on land for irrigation/farming	…… mld	…… mld
f) Disposal on land predominantly for percolation	…… mld	…… mld

4) If any sewage water cost charged from the farmers using sewage for farming : Rs…….per KL

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