

INDIA 2025 - Environment

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Introduction

The rapid increase in population and economic development has led to severe environmental degradation that undermines the environmental resource base upon which sustainable development depends. The economics of environmental pollution, depletion and degradation of resources has in fact been neglected as compared to the issues of growth and expansion. India has been no exception to this worldwide phenomenon, rather the trends of environmental deterioration in India, because of the substantial increase in its population, have been far more prominent as compared to other developing economies.

The country has indeed made substantial progress in most indicators of human development since independence when it was predominantly an agrarian economy with a stagnant national income. Encouraging achievements have been recorded in the age-specific mortality rates; expectation of life at birth; and aspects related to livelihood conditions like education, nutritional security and health. With the country's population having grown three-fold and the urban population itself quadrupling in four decades (1951-1991), the current infrastructure in most of the cases is not only over stretched but also inadequate. With a population of over a billion, India supports 16% of the world's population on 2.4% of the world's land resulting in a paucity of resources that jeopardises growth in the longer run.

Urban development in India is presently going through a very dynamic stage, the percentage of population in urban centres itself having increased from 14% in the 1940s to about 33% in 2000 (HSMI 2000). The unprecedented challenge of such an urban shift has resulted in Indian cities degenerating into slums and squatters camps. The rapid expansion of cities has brought to the fore acute problems of transport congestion, atmospheric pollution and unwise water and solid waste management resulting in the degradation of the quality of life. The deterioration of environmental quality in Indian cities is but one aspect of the threat to the quality of life, the other perhaps more pertinent issue being that of the sustainability of growth itself.

The much needed impetus to industrial development has resulted in huge residuals, having undesirable effects on the environment — air, water and land, disproportional to their contribution to overall economic growth. For instance, the iron and steel industry contributes 55% of the particulate matter load while adding 16% to the total industrial output. The industrial BOD load from chemicals and food processing industries is as much as 86% against the industry's contribution of 25% to the total industrial output.

These unsustainable growth trends increase the vulnerability of the economically weaker sections to environmental degradation and pollution, on account of their direct dependence on natural resources like land, forests and various common property sources for fuelwood, fodder, and water. In the absence of alternatives, the imbalanced competition for natural resources could significantly contribute to weakening the support base of the poor further and perpetuating poverty and a poor quality of life. Hence for a developing country like India, the key to poverty

elimination is the country's ability to regenerate its environment and assist its masses to retain control over their living conditions.

Based on studies done at TERI (Tata Energy Research Institute) – Looking Back to Think Ahead (TERI 1998) ; DISHA (Directions, Innovations and Strategies for Harnessing Actions for Sustainable Development) (TERI 2001) and State of Environment — India (UNEP 2001)¹ this chapter aims to highlight the key environmental concerns that have emerged in the country. Section I focuses on the prevalent status and causal factors of the major environmental concerns such as air, water resources and pollution, solid waste management and also touches briefly on the issues of land degradation and biodiversity. Baseline scenarios have been developed on how these trends are likely to unfold by the year 2025, considering the base year as 1997. Section 2 puts forward the strategies for a reform agenda that is more widespread and proposes its implementation at a considerably quicker pace. Alternative case projections for the year 2025 are presented accordingly, assuming that the proposed strategies are implemented in full within a well-defined time frame.

Growing environmental concerns — compulsions of economic development

This section focuses on the prevailing environmental concerns and the root causes of the degrading environment emphasising current effects on resource depletion and environmental degradation currently and expected future trends. Projections have been made as per BAU (business-as-usual) scenario for the year 2025 in view of the current socio-economic, policy and technological factors prevalent in India.

Air pollution

Air pollution in India has been aggravated over the years by developments that typically occur as economies become industrialised: growing cities, increasing traffic, rapid economic development and industrialisation, and higher levels of energy consumption. In India, air pollution is restricted mostly to urban areas, where automobiles are the major contributors, and to a few other areas with a concentration of industries and thermal power plants. The major sources of air pollution in the country are industries (toxic gases), thermal power plants (fly ash and sulphur dioxide), and motor vehicles (carbon monoxide, particulate matter, hydrocarbons and oxides of nitrogen). Major polluting industries and automobiles emit tonnes of pollutants every day, putting citizens, at great health risk. The national capital — Delhi, is already among the most polluted cities in the world.

The incidence of respiratory diseases in most of the major cities in India has also increased considerably over the years. In a study of 2031 children and adults in five major cities of India, of the 1852 children tested, 51.4% had levels of lead in their blood above 10 µg/dl. The percentage of children having 10 µg/dl or higher lead levels ranged from 39.9% in Bangalore to 61.8% in Mumbai. Among the adults, 40.2% had lead levels of about 10 µg/dl (George Foundation 1999, cited in CPCB 2000 a).

Box 1 below lists the principal sources and environmental effects of some of the major air pollutants.

¹ Currently under publication

Box 1 Principal sources and environmental effects of selected atmospheric pollutants

<i>Pollutant</i>	<i>Principal sources related to human activity</i>	<i>Effects</i>	<i>Remarks</i>
Carbon monoxide	Incomplete fuel combustion (as in motor vehicles)	Deprives tissues of oxygen. People with cardio-respiratory diseases more sensitive.	CO is one of the most widely distributed of all air pollutants – global emissions probably exceed the combined emissions of all other major air pollutants. Contribution of natural sources is small. The largest source is petrol-driven motor vehicles.
Sulphur dioxide	Burning of sulphur-containing fuels like coal and oil	Combined with smoke, increases risk and effects of respiratory diseases. Causes suffocation and irritation of throat and eyes. Combines with atmospheric water vapour to produce acid rain. Leads to acidification of lakes and soils. Corrodes buildings.	
Suspended particulate matter	Smoke from domestic, industrial, and vehicular sources	Possible toxic effects depend on specific composition. Aggravates effects of sulphur dioxide. Reduces sunlight and visibility. Increases corrosion.	Chemically, a most diverse group of substances. Natural sources include dust-storms and volcanic eruptions.
Oxides of nitrogen	Fuel combustion in motor vehicles, power stations, and furnaces	Possible increase in acute respiratory infections and bronchitis morbidity in children. Produce brown haze in city air. Causes corrosion.	Combustion oxidizes both the nitrogen in the fuel and some of the nitrogen present in the air, producing several oxides of nitrogen. However, only NO and NO ₂ are known to have adverse environmental or biological effects.
Volatile hydrocarbons	Partial combustion of carbonaceous fuels, industrial processes, disposal of solid wastes.	React with other pollutants to produce eye irritants (acrolein, aldehydes). Ethylene is harmful to plants. Aerosol particles reduce visibility. May produce unpleasant odours.	
Oxidants and ozone	Emissions from motor vehicles. Photochemical reactions of nitrogen oxides and reactive hydrocarbons.	Cause eyes irritation and impaired pulmonary function in diseased persons. Corrode materials and reduces visibility. Ozone is one of the most damaging pollutants for plants.	Mainly derivative: products of atmospheric reactions between other pollutants. Ozone is a natural and essential constituent of the upper atmosphere.
Lead	Main source is emission from motor vehicles. Other sources include smelting and refining lead, producing batteries, paints, etc.	Adversely affects blood and human nervous system. Causes anaemia, brain dysfunctions and kidney damage.	Alkyl lead, used as an anti-knock agent in petrol, is released into the atmosphere as fine particles when petrol is burnt.

Sources: United National Environment Programme (1991), Centre for Science and Environment (1982)

It is an issue of prime concern since these emissions are from ground level sources and thus have the greatest impact on the health of the population exposed to it. The increase in the number of vehicles contributes significantly to the total air pollution load in many urban areas. The number of motor vehicles in India has increased from 0.3 million in 1951 to 40.94 million in 1998 (MoST 2000). CO (Carbon monoxide)

and HC (hydrocarbons) respectively account for 64% and 23% of the total emission load due to vehicles in all cities considered together (CPCB 1995).

Table 1 highlights the types of pollutants from different sectors in Delhi (CPCB 1995) and reflects the significant share of the transport sector in the same.

Table 1 Sectoral contribution to emissions in Delhi (tonnes/day)

Pollutant	Transport	Power	Industries	Domestic	Total
TSP	13 (10%)	50 (37%)	60 (44%)	12 (9%)	138
SO ₂	11 (6%)	121 (68%)	35 (20%)	12 (6%)	179
NO _x	157 (49%)	143 (44%)	20 (6%)	3 (1%)	323
HC	810 (76%)	8 (1%)	128 (12%)	117 (11%)	1063
CO	310 (97%)	2 (<1%)	6 (2%)	2 (<1%)	320

Source. CPCB 1995

Apart from the concentration of vehicles in urban areas, other reasons for increasing vehicular pollution include the types of engines used, age of vehicles, poor road conditions, outdated automotive technologies, poor fuel quality and traffic congestion resulting from clumsy traffic management systems.

Air quality profile

In order to determine the air quality status and trends, assess health hazards, disseminate air quality data, and to control and regulate pollution, the CPCB (Central Pollution Control Board) initiated a nationwide framework of NAAQM (National Ambient Air Quality Monitoring) in 1984 with 28 stations at 7 cities. Presently, the network has 290 monitoring stations in 92 cities and towns throughout the country (CPCB 1998). The pollutants being monitored are mainly SPM (suspended particulate matter), SO₂ (sulphur dioxide) and NO_x oxides of nitrogen. SPM is one of the most critical pollutants in terms of its impact on air quality and is also the most common pollutant across all sectors. The ranges of SPM concentration (annual average) in the major metropolitan cities in India are shown in Table 2.

Table 2 Range of annual averages of SPM in major Indian cities

S. No.	City	Area land use	Range of annual average of SPM ($\mu\text{g}/\text{m}^3$) 1990-98		Mean of annual averages ($\mu\text{g}/\text{m}^3$)
			Minimum	Maximum	
1.	Delhi	Residential	300	409	355
		Industrial	314	431	381
2.	Mumbai	Residential	196	327	230
		Industrial	150	276	224
3.	Calcutta	Residential	205	491	327
		Industrial	286	640	434
4.	Chennai	Residential	72	118	99
		Industrial	53	147	123
5.	Bangalore	Residential	60	239	158
		Industrial	99	153	125
6.	Ahmedabad	Residential	198	316	261
		Industrial	201	306	243
7.	Hyderabad	Residential	135	184	158
		Industrial	72	259	153

Source. CPCB 2000a

As against to the maximum permissible limits laid down by CPCB for annual average concentration of SPM in ambient air - $70 \mu\text{g}/\text{m}^3$ in sensitive areas, $140 \mu\text{g}/\text{m}^3$ in residential areas and $360 \mu\text{g}/\text{m}^3$ in industrial areas, it is clearly evident that the SPM levels are high in most of the metropolitan cities in India.

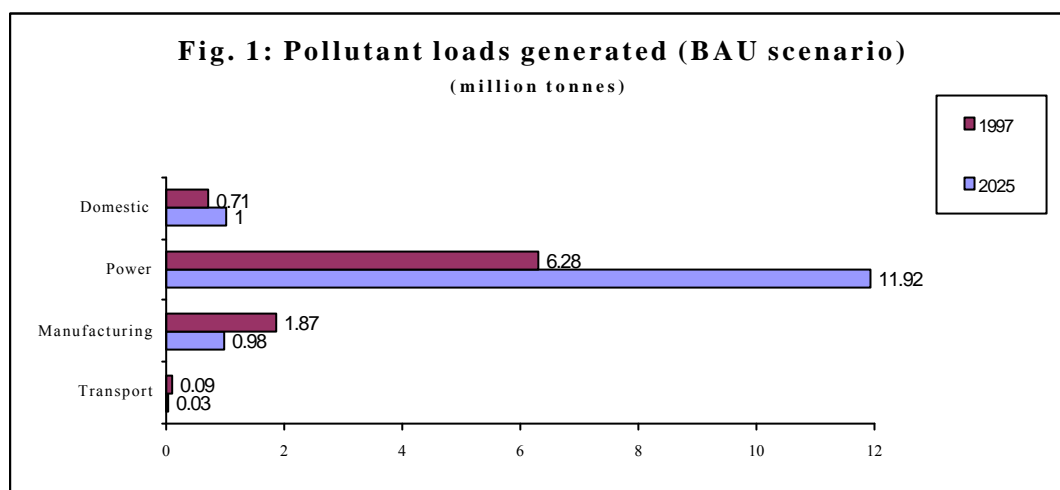
Projections for integrated air pollution loads — BAU (business as usual) scenario

The future scenario of air pollution in India has been calculated considering the integrated impact from major contributing sectors, i.e. domestic, transport, manufacturing industries and power. In the absence of a comprehensive emission inventory, projections have been made only for SPM, which is the most common pollutant across all sectors and is critical for air quality in many cities.

- Emissions from the transport sector have been calculated based on projections for a count of vehicles, in line with the projections for growth in population and economic activity.
- Air pollution from the manufacturing sector has been worked out on the basis of emission load per unit of output for some of the resource intensive and highly polluting industries- copper, aluminium, steel, cement, fertilisers, textiles and PVC (poly-vinyl chloride).

- Projections for pollutant loads from power generation have been arrived at, considering a continued reliance of the power sector on coal-based generation, resulting a higher SPM load. It is further assumed that all coal-based power plants will have installed ESPs (electro-static precipitators) to limit SPM emissions.
- The SPM contribution of the domestic sector takes into account a shift towards cleaner gaseous fuel and fewer emissions from the residential sector.

Figure 1 highlights the projections for the pollutant load generated from each of the



sectors.

Projections indicate that the overall SPM load is likely to get reduced in the time frame 1997-2025 at around 2% per annum, although a bulk of the load would continue to emanate from power generation (66% in 2025). The drop in pollution loads from the domestic sector is on account of a likely shift to commercial fuels in rural India.

Water

Water resources

India receives an average annual rainfall equivalent of about 4000 cubic kilometres. This is unevenly distributed across different parts of the country and most of the rainfall is confined to the monsoon season, from June to September. Thus, while India is considered to be rich in terms of annual rainfall and total water resources, water is spatially and temporally very unevenly distributed. Based on per capita water availability², some river basins fall in the category of water scarce³ and water stressed regions, and several others suffer from absolute scarcity. Though water resource availability is estimated to be 1085.9 billion cubic metres, annual average utilisable

² Per capita water availability is calculated on the basis of total resource availability of 1085 billion cubic metres and a population of 1 billion

³ When the annual per capita availability, in cubic metres, falls below 1700, it is held to be a situation of water stress, availability of less than 1000 is labeled as water scarcity, and of less than 500 is termed absolute scarcity (Engelman and Roy 1993)

per capita water resources vary considerably from as high as 3020 in the Narmada basin to as low as about 180 cubic metres and less in the Sabarmati basin, as against a desired availability of 1700 per capita per year. The estimated per capita water availability has also declined from 6008 cubic metres a year in 1947 to 2266 cubic metres in 1997, as per TERI's 'Green India 2047' study (TERI 1998). This declining figure gives a broad indication of the growing water scarcity in the country in the last fifty years since independence.

The growing gap between demand and supply has led to overdevelopment of groundwater, making its overuse emerge as a major concern in a few states. Against a critical level of 80%, the level of exploitation is over 98% in Punjab and about 80% in Haryana. The problem is also becoming increasingly serious in Tamil Nadu, where the level of exploitation exceeds 60%, and in Rajasthan, where it is 53% (Central Groundwater Board 1994). Between 1984/85 and 1994/95, the number of dark blocks with groundwater exploitation greater than 85% increased on an average by over threefold in a few states (Table 3).

Table 3 Blocks with intensive exploitation of groundwater (utilization exceeds 85% of the annual utilisable potential)

State	<i>% of blocks using groundwater intensively</i>	
	<i>1984/85</i>	<i>1994</i>
Gujarat	3	25
Punjab	54	62
Rajasthan	9	29
Tamil Nadu	14	26

Source. Saleth 1996

Water pollution

The problem of fresh water pollution in India came to the forefront towards the beginning of 1970's with the domestic sewage and industrial waste discharges being the most critical sources of pollution in cities. This resulted in the promulgation of the Water (Prevention and Control of Pollution) Act, 1974 and establishment of the National Water Quality Network in 1979. The sources of water pollution include point and non-point sources like discharges from industries and storm water respectively. While pollution from point sources can be controlled, it is difficult to control pollution from non-point sources such as agriculture run-off, leaching from waste disposal sites and storm water.

The total wastewater generation from domestic sources in class I towns is 16.27 billion litres and of this a mere 25% is treated. The increase in treatment capacities have also not shown a commensurate increase as the share of waste water which is untreated and disposed into our surface water bodies, has increased from 61% in 1978-79 to 76% in 1994-95 (CPCB 2000).

Water pollution, in the industrial sector is concentrated within a few subsectors mainly in the form of toxic wastes and organic pollutants. Of the total

pollution load generated by industrial subsectors, 40%–45% is contributed by the processing of industrial chemicals. In terms of the total organic pollution, expressed as BOD, nearly 40% arises from the food industries followed by industrial chemicals and the pulp and paper industry (World Bank 1996). Other major sector of concern is that of small-scale industries with more than 2 million units where pollution abatement has been neglected so far. Depending on the traditional crafts and culture of the area, small-scale industries like chemical, textiles, food processing and tanneries are found in large clusters in different states. States with over a lakh registered small-scale industries include Andhra Pradesh, Gujarat, Madhya Pradesh, Punjab, Tamil Nadu, Uttar Pradesh, and West Bengal. Of these very few of the clusters have opted for CETPs (Common Effluent Treatment Plants) to control water pollution but most of these CETPs either do not function at all or do not treat effluents to the desired quality.

Presently the institutional mechanisms to address pollution in the agriculture sector are also missing, as the sector is out of the ambit of the pollution control boards. The problem is acute in the riparian states of Punjab, Haryana, Uttar Pradesh and Tamil Nadu. Excessive use of fertilizers has led to an increase in the levels of nitrates in the shallow groundwater sources. The nitrate content of well water in a few districts of Uttar Pradesh, Haryana, and Punjab is far beyond the standard prescribed safe limit of 45 mg/litre (Kansal, Grewal, and Dhaliwal 1994). Severe degradation of ground water sources is also resulting from dumped solid wastes and human waste in dug wells.

Water quality profile

Pressures due to inadequate collection and inefficient treatment of domestic wastewater, discharge of highly complex wastes from industries and the polluted runoff from agricultural fields, have resulted in considerable degradation in the quality of water sources. Indicators of this deterioration include depletion of oxygen, excessive presence of pathogens, settling of suspended material during lean flow conditions, and bad odour.

The quality of river water is monitored at 480 stations under different programmes such as MINARS (monitoring of Indian national aquatic resources), GEMS (global environmental monitoring systems), and GAP (ganga action plan). A number of physical, chemical, biological and bacteriological parameters are being measured under the programme, but the important ones include BOD (biochemical oxygen demand), DO (dissolved oxygen), and TC (total coliform) count. Heavy metals are however not included under the monitoring programme. Some of the polluted river stretches, their critical parameters and possible sources of pollution are listed in the Table 4 below.

Table 4 List of polluted river stretches ^a

River	Polluted stretch	Desired class	Existing class	Critical parameters	Possible source of pollution
Sabarmati	Immediate upstream of Ahmedabad upto Sabarmati Ashram	B	E	DO, BOD, Coliform	Domestic and industrial waste from Ahmedabad
	Sabarmati Ashram to Vautha	D	E	DO, BOD, Coliform	Domestic and industrial waste from Ahmedabad
Subarnarekh a	Hatia dam to Bharagora	C	D/E	-do-	Domestic and industrial waste from Ranchi and Jamshedpur
Godavari	Downstream of Nasik and Nanded	C	D/E	BOD	Wastes from sugar industries, distilleries and food processing industries
Krishna	Karad to Sangli	C	D/E	BOD	Wastes from sugar industries and distilleries
Sutlej	Downstream of Ludhiana to Haike	C	D/E	DO, BOD	Industrial wastes from hosieries, tanneries, electro-plating and engineering industries and domestic waste from Ludhiana and Jalandhar
	Downstream of Nangal	C	D/E	Ammonia	Wastes from fertilizer and chloralkali mills from Nangal
Yamuna	Delhi to confluence with Chambal	C	D/E	DO, BOD, Coliform	Domestic and industrial wastes from Delhi, Mathura and Agra
	In the city limits of Delhi, Mathura and Agra	B	D/E	DO, BOD, Coliform	Domestic and industrial wastes from Delhi, Mathura and Agra
Hindon	Saharanpur to confluence with Yamuna	C	D	DO, BOD, Toxicity	Industrial and domestic wastes from Saharanpur and Ghaziabad
Chambal	Downstream of Nagda and downstream of Kota	C	D/E	BOD, DO	Domestic and industrial waste from Nagda and Kota
Damodar	Downstream of Dhanbad	C	D/E	BOD, Toxicity	Industrial wastes from Dhanbad, Durgapur, Asansol, Haldia and Burnpur
Gomti	Lucknow to confluence with Ganges	C	D/E	DO, BOD, Coliform	Industrial wastes from distilleries and domestic wastes from Lucknow
Kali	Downstream of Modinagar to confluence with Ganges	C	D/E	BOD, Coliform	Industrial and domestic wastes from Modinagar

Source. CPCB 1999

^a Water quality and the desired water quality is expressed in classes A, B, C, D, and E, which reflect the best use of that water. Class A indicates that water is fit for drinking without conventional treatment but after disinfection; Class B that it is suitable for outdoor bathing; and Class C, that it is suitable for drinking after conventional

treatment. Class D water is suitable for propagation of wildlife and fisheries and Class E water can be used for irrigation, industrial cooling, and controlled waste disposal.

Projections for water requirements — BAU scenario

Demand for fresh water will continue to grow from all sectors, due to additional requirements from agriculture and increased migration to urban areas. To project the water requirement by the year 2025 under a baseline scenario, four major water-consuming sectors have been considered and the cumulative water requirement has been estimated based on:

- *Agricultural* cropping intensity of 157% with 60% of the gross cropped area under irrigation.
- Per capita *domestic* supply of 135 litres a day in the urban areas and 40 litres per day in rural areas.
- An estimated 3% increase in water consumption by the *industrial sector* in line with the projections for growth in economic activity.
- Projections for water requirements in the *power sector* assume an increase in dry collection practices and better process operations for fly ash collection and steam generation respectively.

Based on the above, total water demand under the BAU scenario is as Table 5.

Table 5 Total water demand projections: base case (**billion cubic metres**)

Year	<i>Irrigation</i>	<i>Domestic</i>	<i>Manufacturing</i>	<i>Power</i>	<i>Total requirements</i>
1997	528.85	23.52	1.6	1.39	555.36
2025	789.50	39.76	4.79	3.75	837.80

These projections for water demand when compared to the estimated availability of 1085.9 billion cubic metres indicate an overall net marginal positive balance of only 248.1 billion cubic metres by the year 2025. However, given the uneven distribution of the resource, as discussed, it is projected that the country will go, from the present state of water stress, to a state of water scarcity, with an average annual per capita availability of 750 cubic metres by 2025. Further, due to wide inequality in the consumption patterns of different sectors, competition for water from different sectors may trigger disputes among these sectors as well.

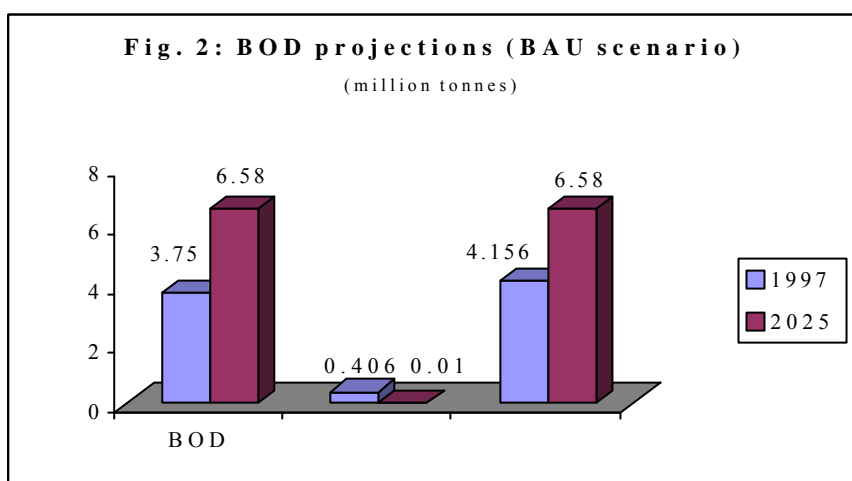
Projections for water pollution loads – BAU scenario

The current state of infrastructure marked with inadequate collection networks and treatment capacities forces discharge of untreated or partly treated waste water into natural drains joining the rivers, lakes, and sea. The polluted rivers and other water bodies is a direct consequence of the inadequate level of collection and treatment in Indian cities.

BOD projections from the urban domestic sector assume an overall wastewater collection efficiency of about 70% in 2025. It is also assumed that all

production units would have facilities to control pollution in accordance with the CPCB's year wise analysis of the polluting units and strict compliance due to stringent environmental regulations. The estimated pollutant load, in terms of BOD, from the untreated wastewater from the domestic sector (urban and rural areas) and industrial sector under the base case is presented in Figure 2.

Annual discharge of the order of 6.58 million tonnes from the domestic sector, as projected is beyond the self-cleansing capacity of the water bodies, rendering them unfit for several beneficial uses.



Solid waste management

Municipal solid waste

The growth in MSW (municipal solid waste) generation in India has outpaced the growth in population in the recent years. The daily per capita generation of municipal solid waste in India ranges from about 100 g in small towns to 500 g in large towns. The recyclable content of waste ranges from 13% to 20% (CPCB 1994/95). The survey conducted by CPCB puts total municipal waste generation from Class I and II cities to around 18 million tonnes in 1997 (CPCB 2000b). The reason for this escalating trend is a mix of the changing lifestyles, food habits and changes in standard of living.

The TERI 'Green India 2047' study made the following observations on the situation of municipal solid waste management in the country (TERI 1998):

- increasing urbanisation and changing lifestyles has led to, the solid waste generated in Indian cities having increased from 6 million tonnes in 1947 to 47.8million tonnes in 1997.
- The production and consumption of plastic increased over 70 times between 1960 and 1995.
- The collection of municipal solid waste is inefficient (more than 25% of the total is not collected at all), its transport is inadequate, and its disposal is unscientific.
- More than one-fourth of the municipal solid waste is not collected at all, and the landfills to dispose of the waste are neither well equipped nor managed efficiently.

The characteristics of MSW collected from any area depends on a number of factors such as food habits, cultural traditions of inhabitants, lifestyles, climate, etc. Table 6 below presents the changes in the characteristics of waste in past two decades. The changes in the relative shares of different constituents of waste in the past several decades, as shown by the data, can be attributed largely to changing lifestyles and increasing consumerism.

Table 6 Physico-chemical characteristics of MSW

Component	% of wet weight	
	1971-73† (40 cities)	1995‡ (23 cities)
Paper	4.14	5.78
Plastics	0.69	3.90
Metals	0.50	1.90
Glass	0.40	2.10
Rags	3.83	3.50
Ash and fine earth	49.20	40.30
Total	41.24	41.80
compostable matter		
Calorific value (kcal/kg)	800-1100	<1500
Carbon-nitrogen ratio	20-30	25-40

Source. † Bhide and Sundaresan 1983, ‡ EPTRI 1995

Disposal of waste is a major issue of concern in India. Respective municipalities collect MSW in cities and transport it to the designated disposal sites, which is normally a low-lying area on the outskirts of a city. The choice of a disposal site is more a matter of what is available than what is suitable. Only a few cities follow good practices such as organized dumping of wastes, using mechanized equipment for leveling and compacting the wastes, and covering the top layer with earth before compacting it further. Of late, some cities have also started to practice composting the organic fraction of waste.

Management of biomedical waste is another issue of concern for municipalities. This waste produced in hospitals generally has high contamination of pathogens, making it hazardous. It also includes scalpels, needles, bandages, and other wastes from operating theatres and laboratories as well as infectious items, e.g. amputated body-parts, body fluids, cultures of contagious viruses, excreta from patients with highly contagious diseases, etc. Though waste from hospitals and nursing homes are required to be collected and treated separately, in most cities and towns such waste continues to form a part of the MSW in absence of any dedicated disposal facilities for hospital waste. The MoEF, Government of India has issued the

Municipal Solid Wastes (management and handling) Rules in the year 2000, which identify the CPCB (Central Pollution Control Board) as the agency to monitor the implementation of these rules. For the management of bio-medical waste, the MoEF has notified Bio-Medical Waste (management and handling) Rules in 1998 under sections 6, 8 and 25 of the Environment (Protection) Act of 1986.

Industrial solid waste

Industries can be broadly classified into those that produce non-hazardous waste and those that produce hazardous waste. Non-hazardous waste can be either biodegradable or non-biodegradable. The major industries in urban areas that generate substantial amounts of biodegradable solid waste are fruit processing, cotton mills, paper mills, sugar mills, and textile factories. The major generators of non-biodegradable industrial solid waste are thermal power plants producing coal ash, integrated iron and steel mills producing blast furnace slag and steel melting slag, such non-ferrous industries as aluminum, zinc, and copper, which produce red mud and tailings, and fertilizer and allied industries which produce gypsum.

Some of the wastes generated by industries are deemed to be hazardous wastes because they contain substances that are toxic to plants and animals or are flammable, corrosive, explosive or highly reactive, chemically. Box 2 lists the categories of hazardous waste as specified under the Hazardous Wastes (management and handling) Rules.

Box 2	Types of hazardous waste
Waste Category Nos	Types of waste
No. 1	Cyanide waste
No. 2	Metal finishing, waste
No. 3	Waste containing water soluble chemical compounds of lead, copper, zinc, chromium, nickel, selenium, barium, and antimony
No. 4	Mercury, Arsenic, Thallium and Cadmium-bearing wastes
No. 5	Non-halogenated hydrocarbons including solvents
No. 6	Halogenated hydrocarbons including solvents
No. 7	Waste from paints, pigments, glue, varnish and printing ink
No. 8	Wastes from dyes and dye-intermediates containing inorganic chemical compounds
No. 9	Wastes from dyes and dye-intermediates containing organic chemical compounds
No. 10	Waste oil and oil emulsions
No. 11	Tarry wastes from refining and tar residues from distillation or pyrolytic treatment
No. 12	Sludge arising from treatment of wastewaters containing heavy metals, toxic organics, oils emulsion and spent chemicals and incineration ash
No. 13	Phenols
No. 14	Asbestos
No. 15	Wastes from manufacturing of pesticides and herbicides and residues from pesticides and herbicides formulation units
No. 16	Acids/ alkalies / slurry
No. 17	Off-specification and discarded products
No. 18	Discarded containers and container-liners of hazardous and toxic waste

Source CPCB 1998

The major industries that produce hazardous wastes include metals, chemicals, drugs and pharmaceuticals, leather, pulp and paper, electroplating, refining, pesticides, dyes, rubber goods and so on. In total, at present around 7.2 million tonnes of hazardous waste is generated in the country of which 1.4 million metric tonnes is recyclable, 0.1 million metric tonnes is incinerable and 5.2 million metric tonnes are destined for disposal on land (MoEF 2000). Improper storage, handling, transportation, treatment and disposal of hazardous waste has an adverse impact on ecosystems including the human environment. When discharged on land, heavy metals and certain organic compounds are phytotoxic and can adversely affect soil productivity for extended period of times at relatively low levels of concentration. For example, uncontrolled release of chromium contaminated wastewater and sludge resulted in contamination of aquifers in the North Arcot area in Tamil Nadu. These aquifers can no longer be used as sources of freshwater. Box 3 highlights a case study on the adverse impact of hazardous wastes in Maharashtra.

Reliable data on the quantity of solid wastes generated by small-scale industries are

Box 3 Case Study from Maharashtra illustrating adverse impact of hazardous wastes

The Thane-Belapur industrial area, in Maharashtra where about 1200 industrial units are housed on a 20 km stretch close to New Mumbai produces more than 100 tonnes of solid waste every day. About 85% of this waste is either acidic or alkaline in nature. The area also produces 5 tonnes of waste every day, which is difficult to treat because of its halogen content. The bulk of hazardous waste in this area is co-disposed with municipal waste in municipal waste dumpsites. The water bodies in the vicinity of this industrial area are polluted. The sediment in the Ulhas river has registered high levels of mercury and arsenic. The river empties into the Thane Creek at its northern end. As a result, the Thane Creek is one of the most polluted parts of the sea in the country.

Source (Shankar, Martin, Bhatt and Erkman 1994)

scarce as these industries have mushroomed widely; it is however assumed that they generate as much industrial waste as that generated by medium- and large-sized industries.

Projections for solid waste — BAU scenario

Waste generation trends. The per capita quantity of waste generation tends to increase with time due to factors as increased commercial activities and higher standard of living. In India, the amount of waste generated per capita is estimated to increase at a rate of 1%–1.33% annually (Shekdar 1999). The projected quantities of municipal solid waste for 2025 have been estimated and the scenario under the base case appears that the total waste generation in 2025 will exceed 140 million tonnes—three times the present level (Figure 3).