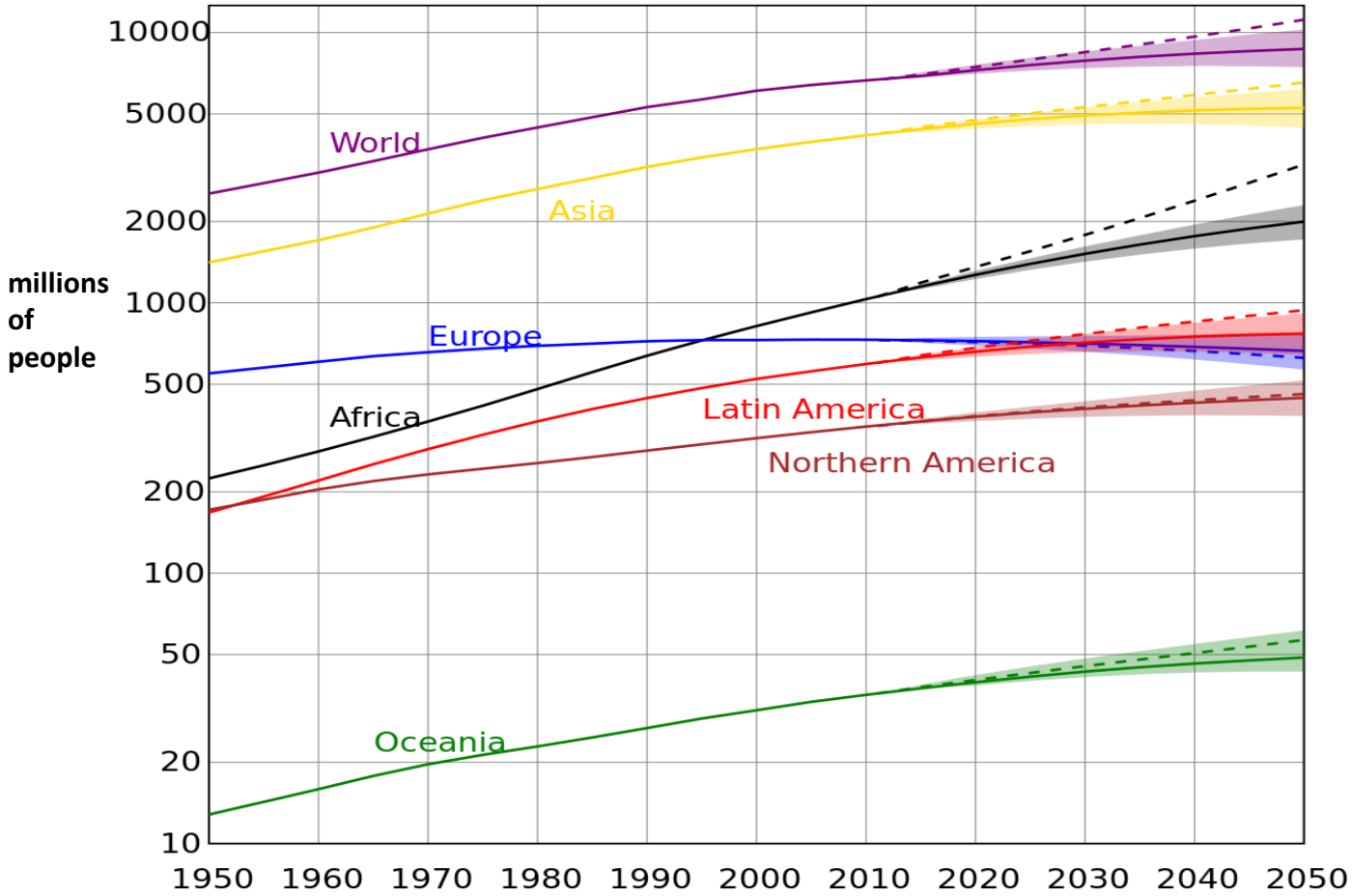
Human and Environment

Impact of Human Activity on the Environment

$I = P \times A \times T$

Impact on the environment = **P**opulation x **A**ctivity x **T**echnology

World Population



https://en.wikipedia.org/wiki/World_population#/media/File:World_population_(UN).svg

How does population growth affect the environment?

Adverse effects:

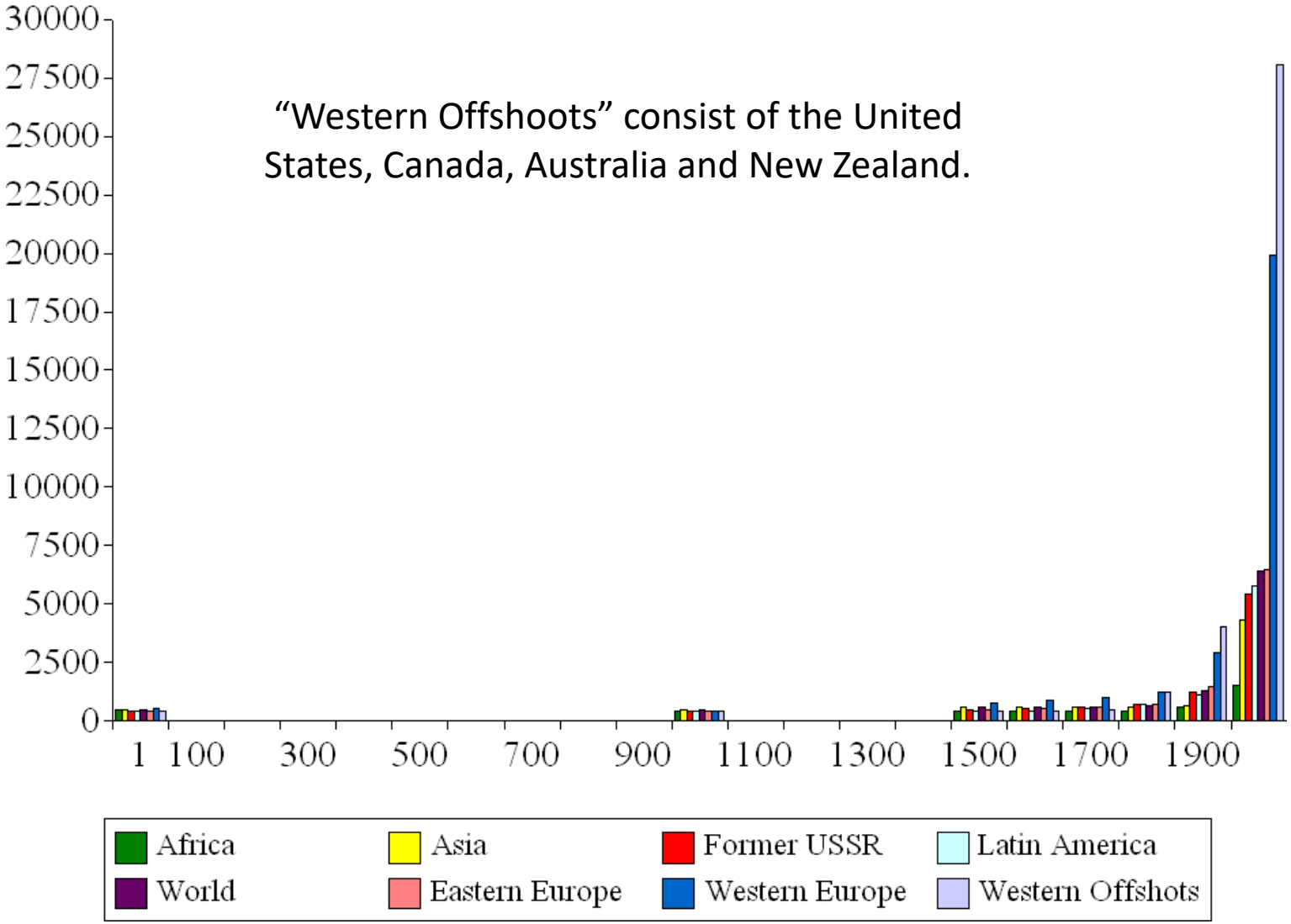
- Increased land use: Decreased habitat for other species
- Resource depletion
  - Changes in land cover
  - Deforestation and loss of carbon sinks
  - Extinction of prey species
- Pollution
  - Nitrogen from fertilizers and wastes
  - Sulfur from combustion

Affluence (A)

- Represents the average consumption of each person in the population

- A common proxy for measuring consumption is through GDP per capita.

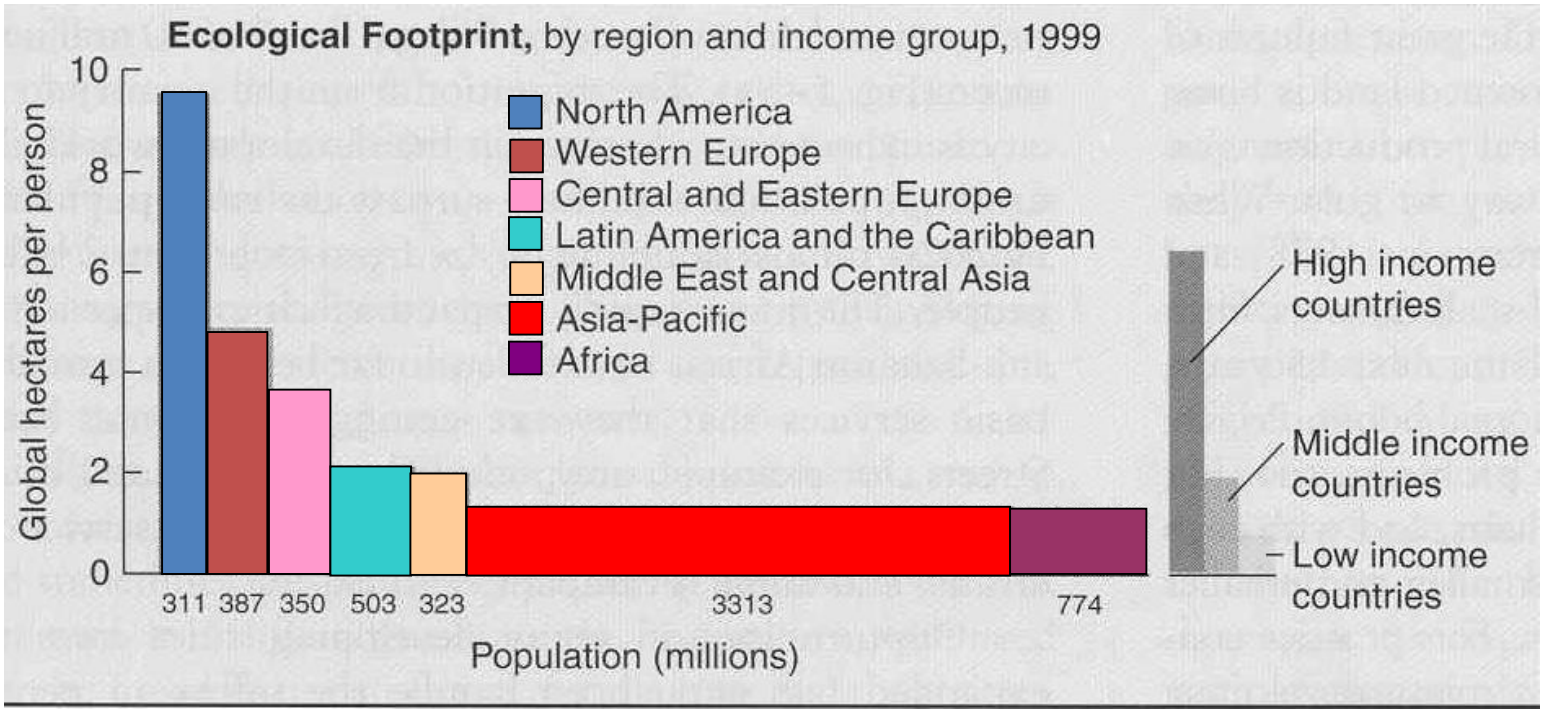
- GDP per capita has been rising steadily over the last few centuries and is driving up human impact in the **I=PAT** equation.



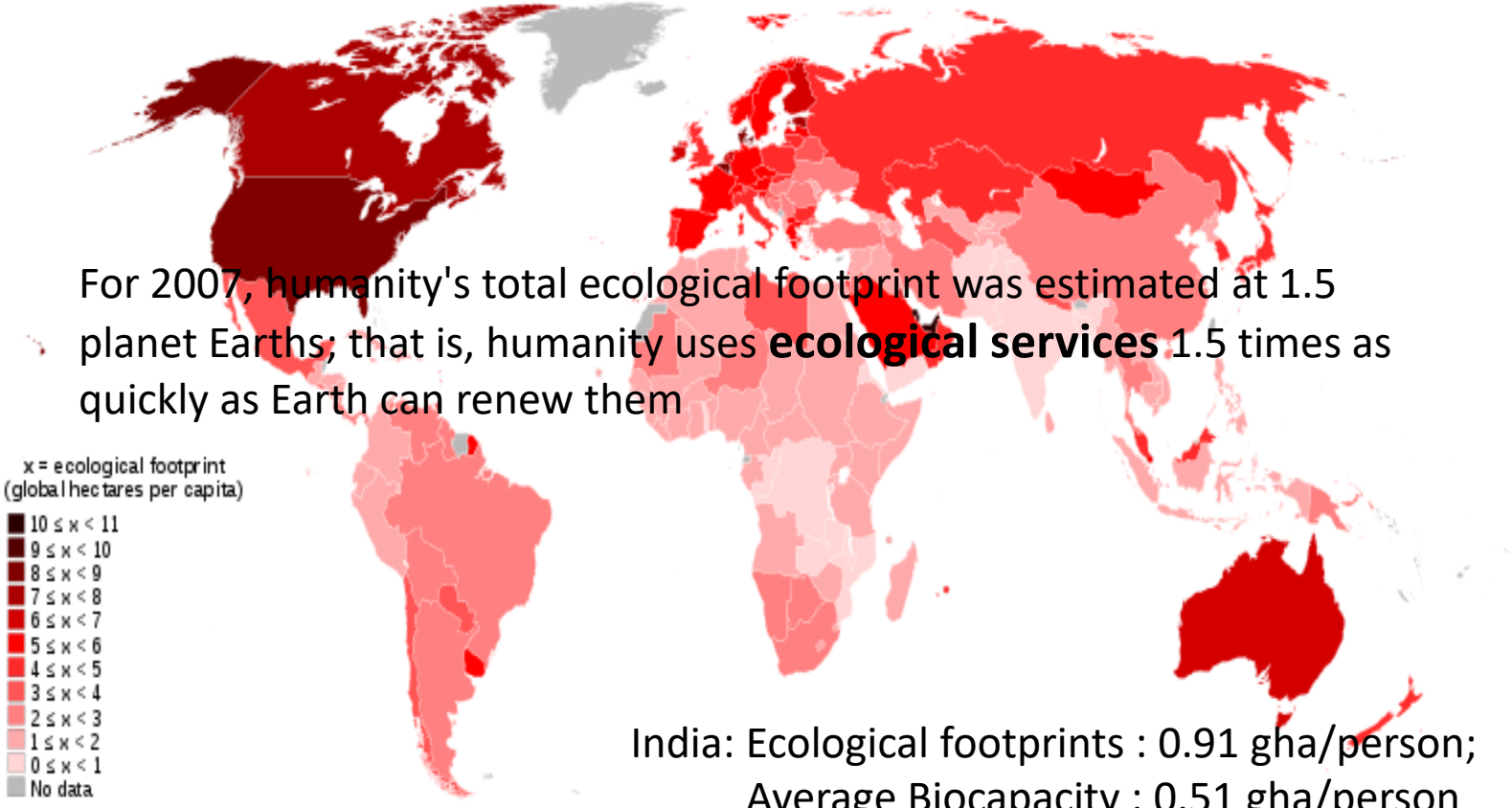
World GDP per capita (in 1990 Geary-Khamis dollars)

Ecological Footprint

- Ecological footprint is a measure of human demand on the Earth's ecosystems
- It is a standardized measure of demand for natural capital that may be contrasted with the planet's ecological capacity to regenerate
- Represents the amount of biologically productive land and sea area necessary to supply the resources a human population consumes, and to assimilate associated waste.



World map of countries by ecological footprint (2007)



For 2007, humanity's total ecological footprint was estimated at 1.5 planet Earths; that is, humanity uses **ecological services** 1.5 times as quickly as Earth can renew them

India: Ecological footprints : 0.91 gha/person;
Average Biocapacity : 0.51 gha/person

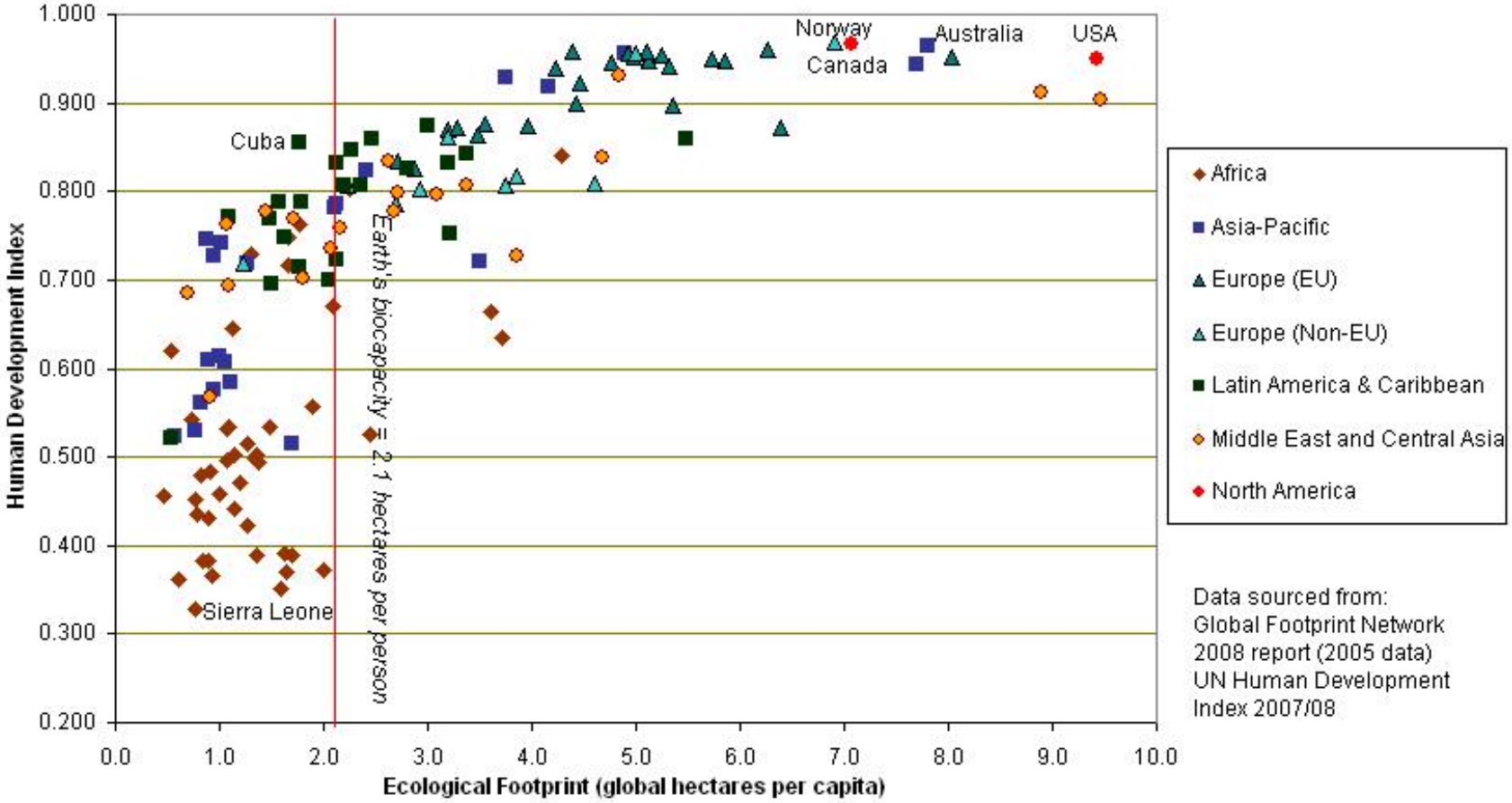
World: Ecological footprints : 2.7 global hectares per person (gha/person)
Average biocapacity : 1.8 (gha/person)

http://en.wikipedia.org/wiki/List_of_countries_by_ecological_footprint

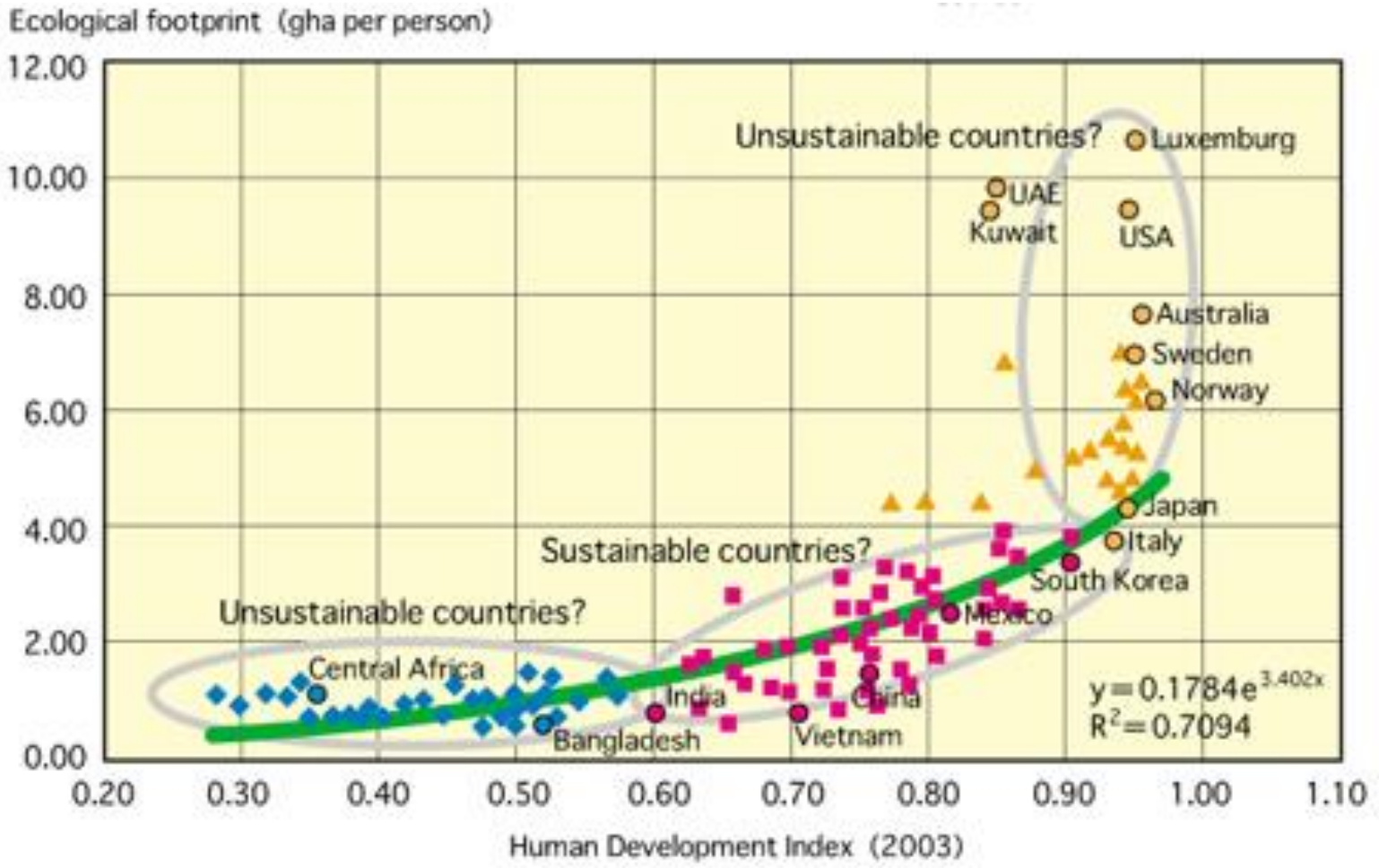
Human Development Index (HDI)

- The **Human Development Index** (**HDI**) is a composite statistic of **life expectancy**, **education**, and **income indices** used to rank countries into **human development**

Human Welfare and Ecological Footprints compared

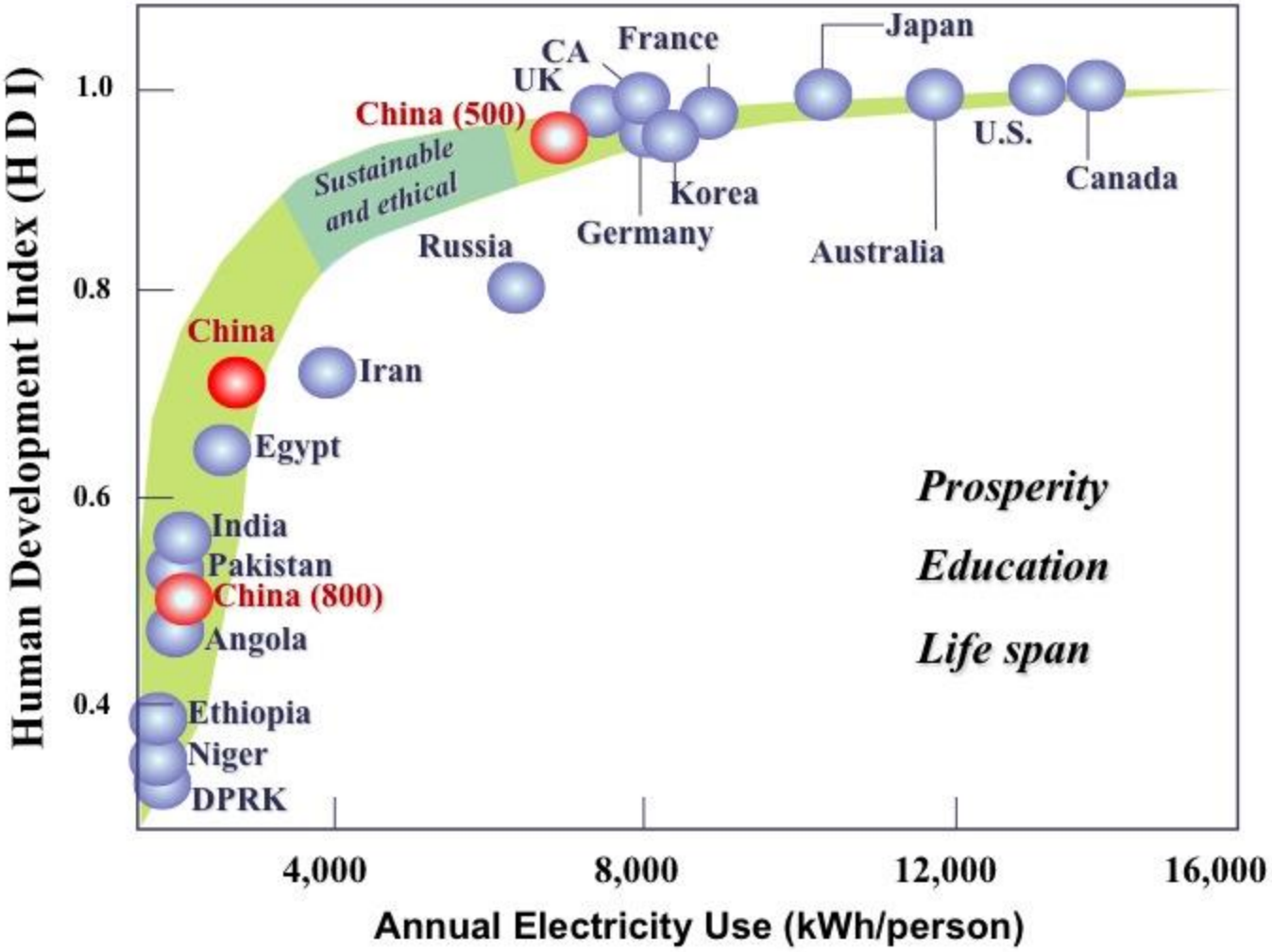


Data sourced from:
Global Footprint Network
2008 report (2005 data)
UN Human Development
Index 2007/08



http://www.sos2006.jp/english/rsbs_summary_e/5-are-we-living-beyond-earths-capacity.html

Human Development Index (HDI) and Energy Use



Technology (T)

- The **T** variable represents how resource intensive the production of affluence is; how much environmental impact is involved in creating, transporting and disposing of the goods, services and amenities used.

- Improvements in efficiency can reduce resource intensiveness, reducing the T multiplier.

- Technology can affect environmental impact in many different ways

Human's impact on environment

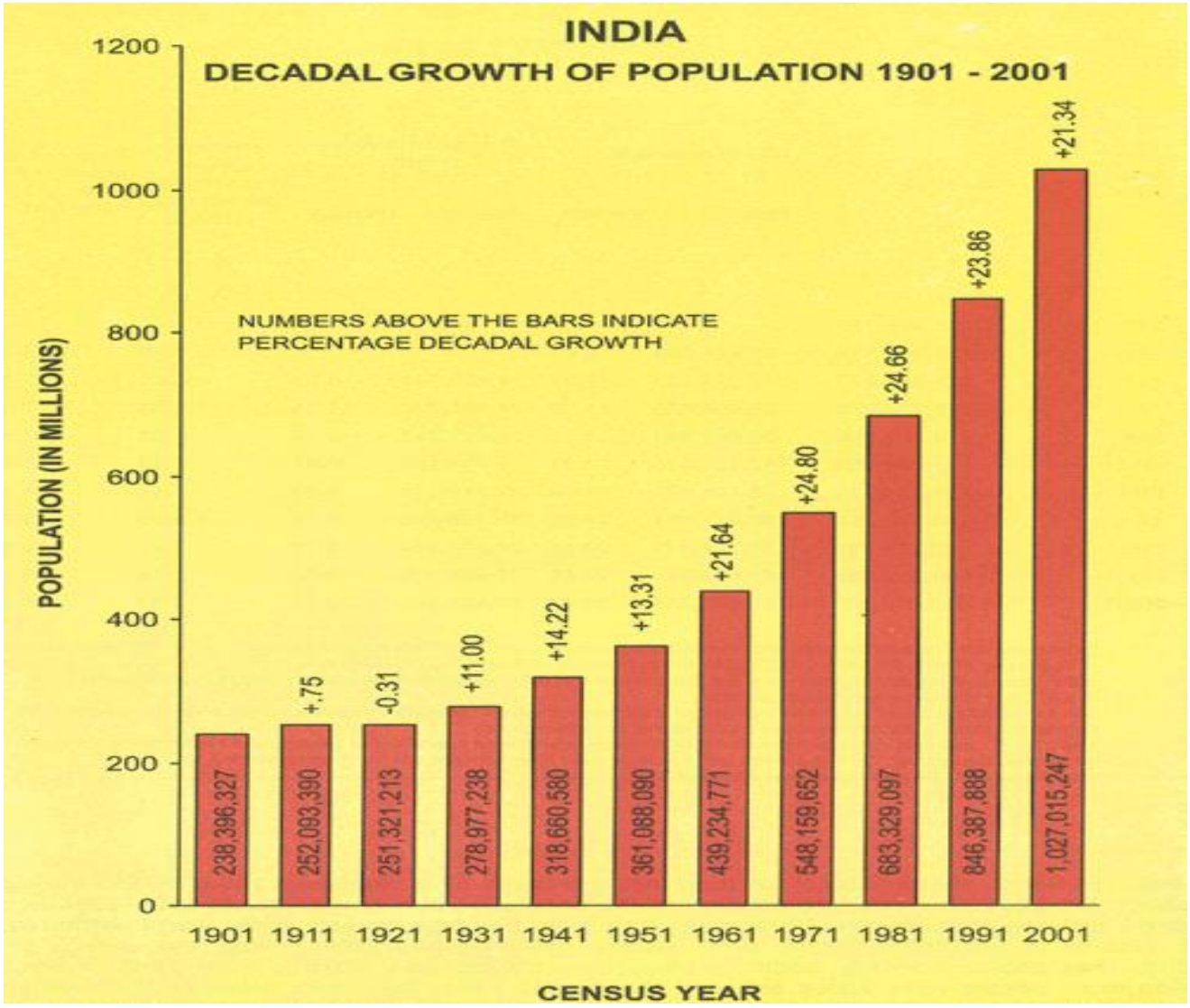
- Ehrlich proposed that the environmental impact is related to human population and the varying degrees of pressure different people put on the environment .
- More affluent countries, even though they are smaller in population, have more of an affect on the environment because they use substantially more resources. Thus, in this case, human population differences between developed and developing nations may not be the sole reason for environmental degradation.
- "It is hypocritical to criticize developing countries for continuing to grow their populations. Those who live in wealthy, but population-stable, developed countries are equally guilty of environmental misuse"
- USA has 5% of the population but is currently responsible for 24% of the total global emissions of CO_2.
- USA has a lager "Ecological footprint" than other developing countries.

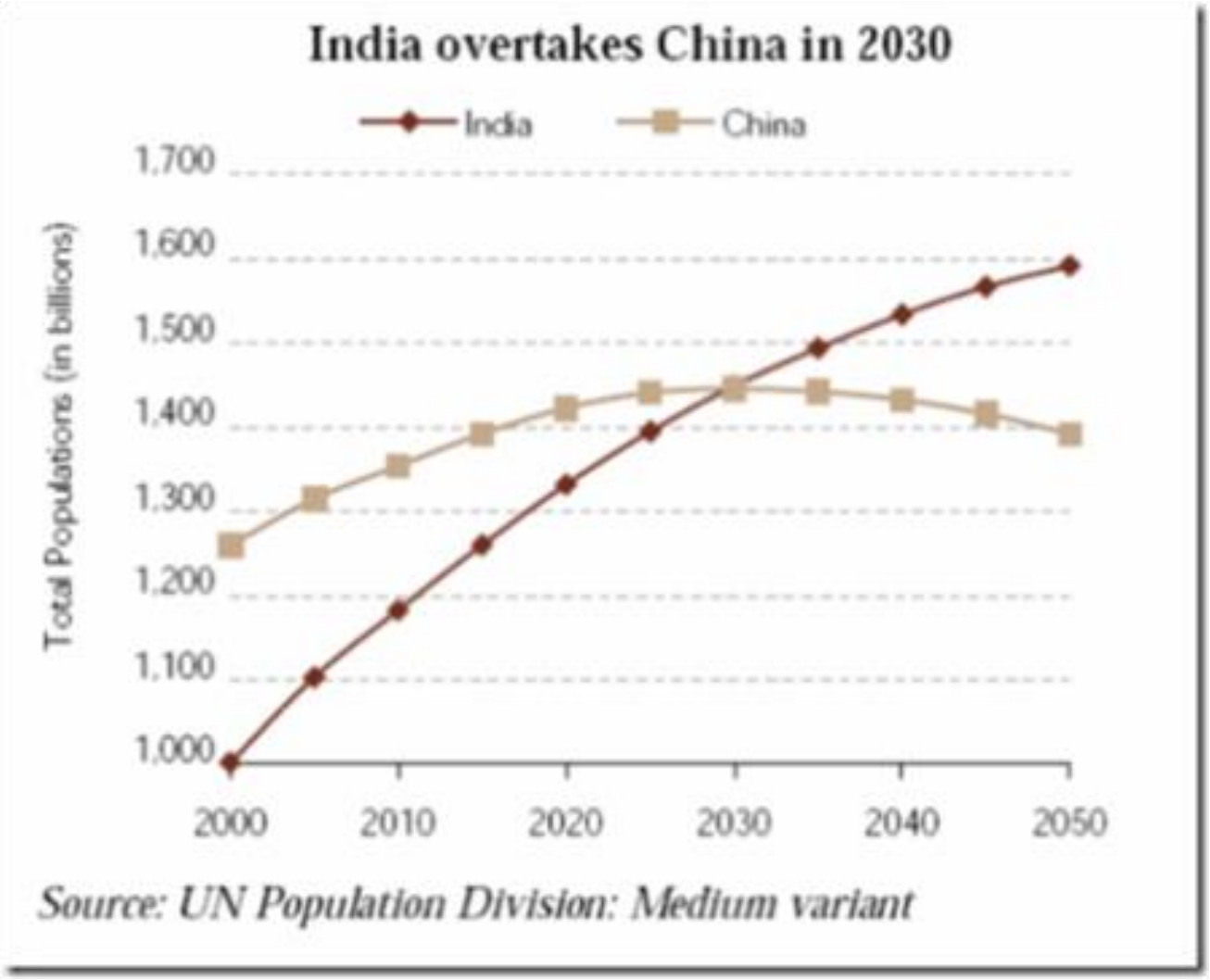
Can everyone live the same way?

- **No. There is not enough earth to support it**
- **Someone must bear the ecological burden of consumption by the affluent**
- **Our continued over-consumption hits the poor hardest**

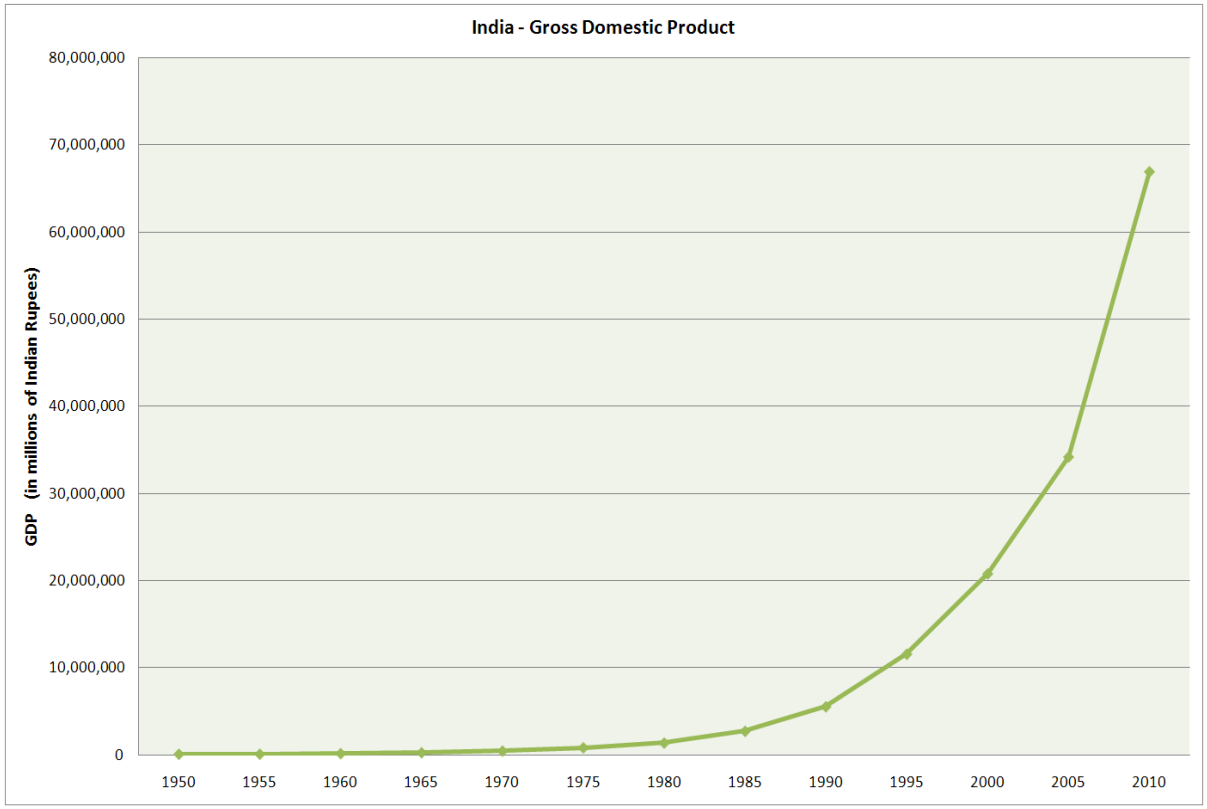
What is fair is not sustainable and what is sustainable is not fair

India Population



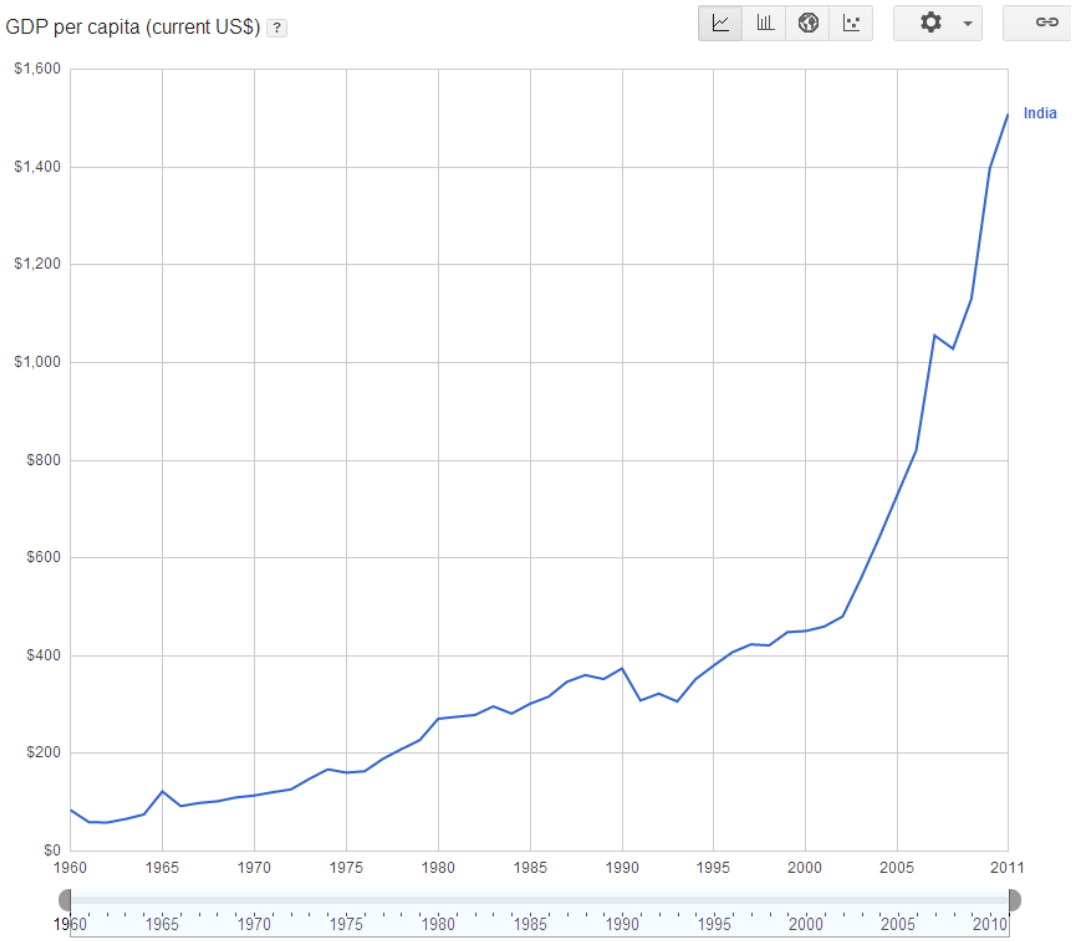

India overtakes China in 2030
India
China
Total Populations (in billions)
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
2000
2010
2020
2030
2040
2050
Source: UN Population Division: Medium variant

GDP Growth of India

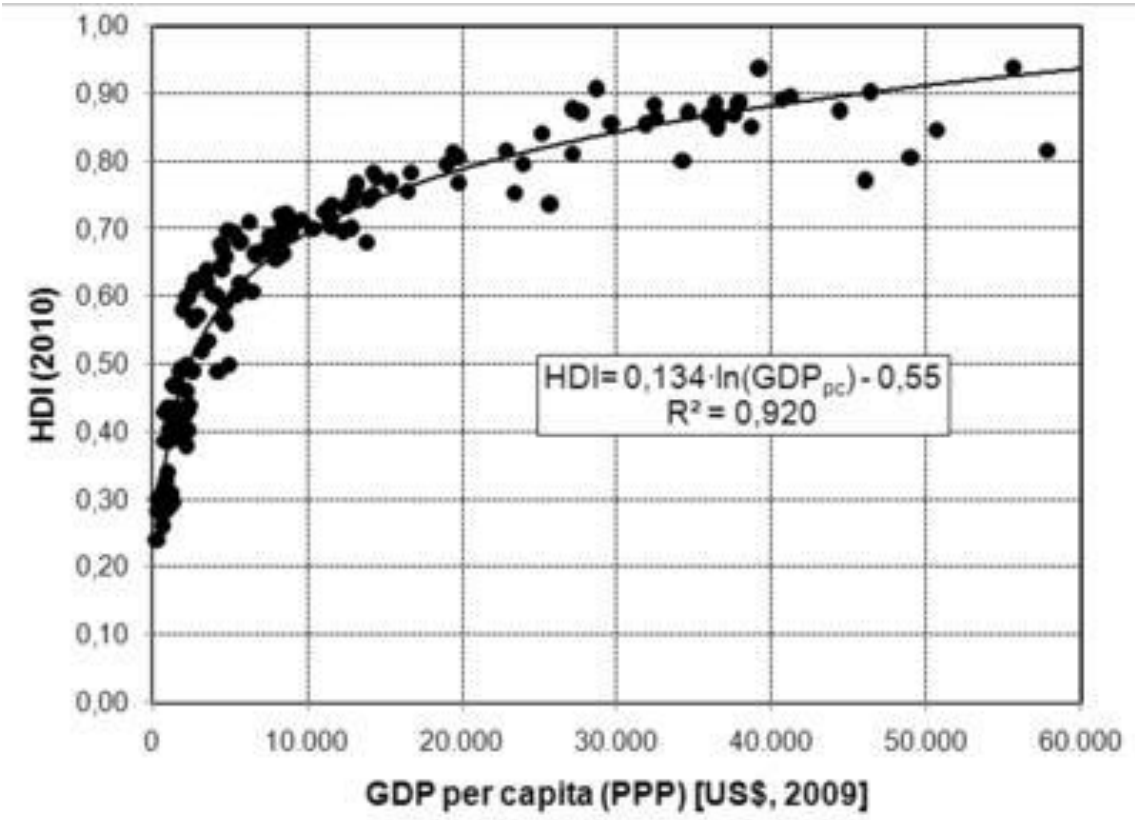


Source: en.wikipedia.org/wiki/Economy_of_India

GDP Per capita India



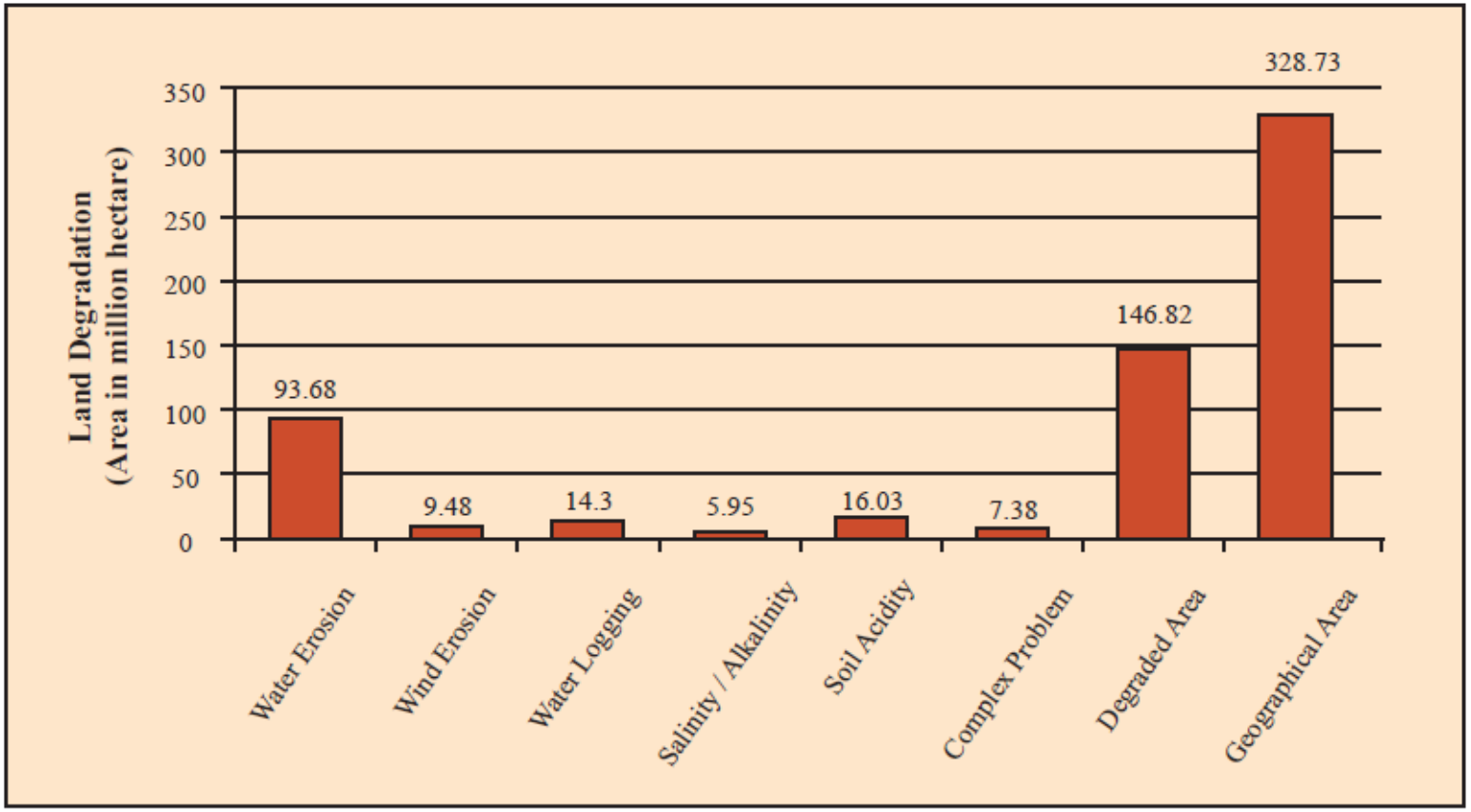
Source: World Bank


1,00
0,90
0,80
0,70
0,60
0,50
0,40
0,30
0,20
0,10
0,00
HDI (2010)
HDI= 0,134·ln(GDP$_{pc}$) - 0,55
R² = 0,920
0
10.000
20.000
30.000
40.000
50.000
60.000
GDP per capita (PPP) [US$, 2009]

State of Environment in India

- Indian domestic and industrial infrastructure is experiencing tremendous strain and rapidly expanding economic activity has been showing its impact on the country's environment.
- The negative impact on environment includes:
  - Deforestation,
  - Air pollution
  - Soil erosion,
  - Water pollution,
  - Land degradation etc…

Land Degradation



Source: National Bureau of Soil Survey and Land Use Planning, 2005

Source: State of Environment 2009, MoEF, GoI

Causes of Land Degradation

- **Agricultural Practices**
  - **Shifting Cultivation**
- **Excessive Chemical Usage:** Per hectare consumption of fertilizers has increased from 69.8 kg in 1991-92 to 113.3 kg in 2006-07
- **Agricultural Waste Residue Burning**
- **Soil Erosion**
- **Change in Forest Cover**
- **Mining**
- **Flooding**
- **Desertification**
- **Pollution**

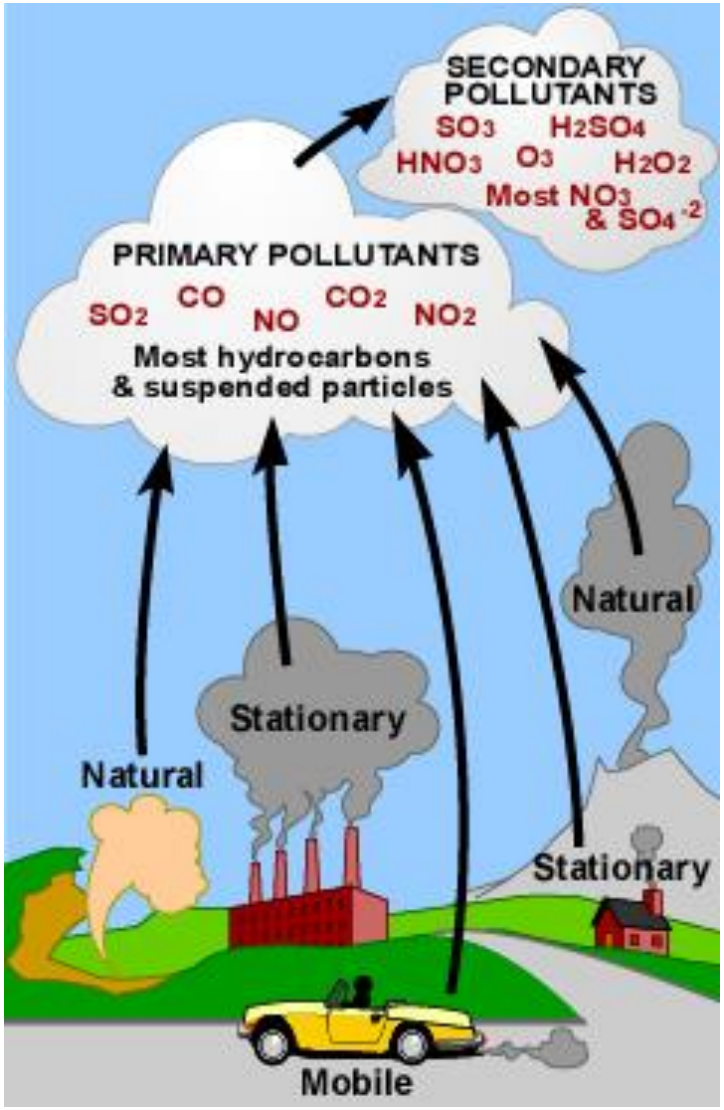
1ha = 10000m²

Air Pollution

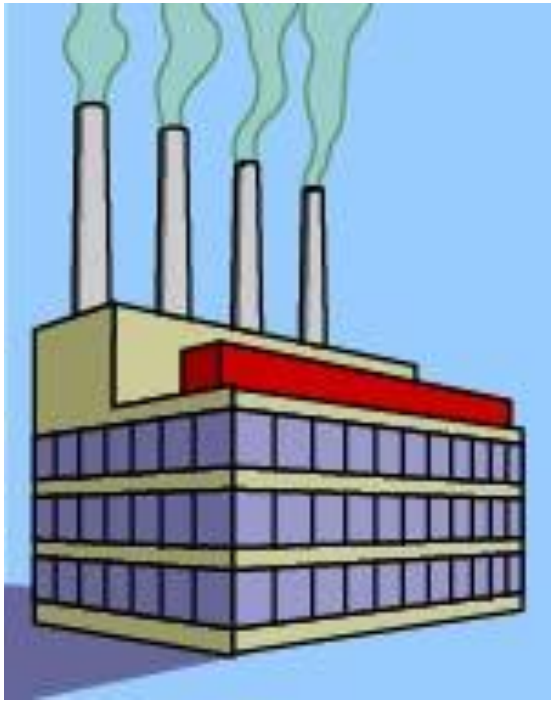
Combustion

- **Fuel (H, C, S, N, Pb, ash) + Air (N_2 + O_2) → CO_2, CO, NOx, SOx, Pb, Particulate matter PM (Primary Pollutants)**
- **Primary Pollutants + Air components (moisture etc) → (Secondary Pollutants) (Acid Rain, Photochemical Smog)**
- **Criteria pollutants are: Carbon monoxide (CO), particulate matter (PM), sulfur oxides (SOx), nitrogen oxides (NOx), lead (Pb), and ozone (O_3),**

Common pollutants detrimental to human welfare



TYPES AND SOURCES OF AIR POLLUTANTS

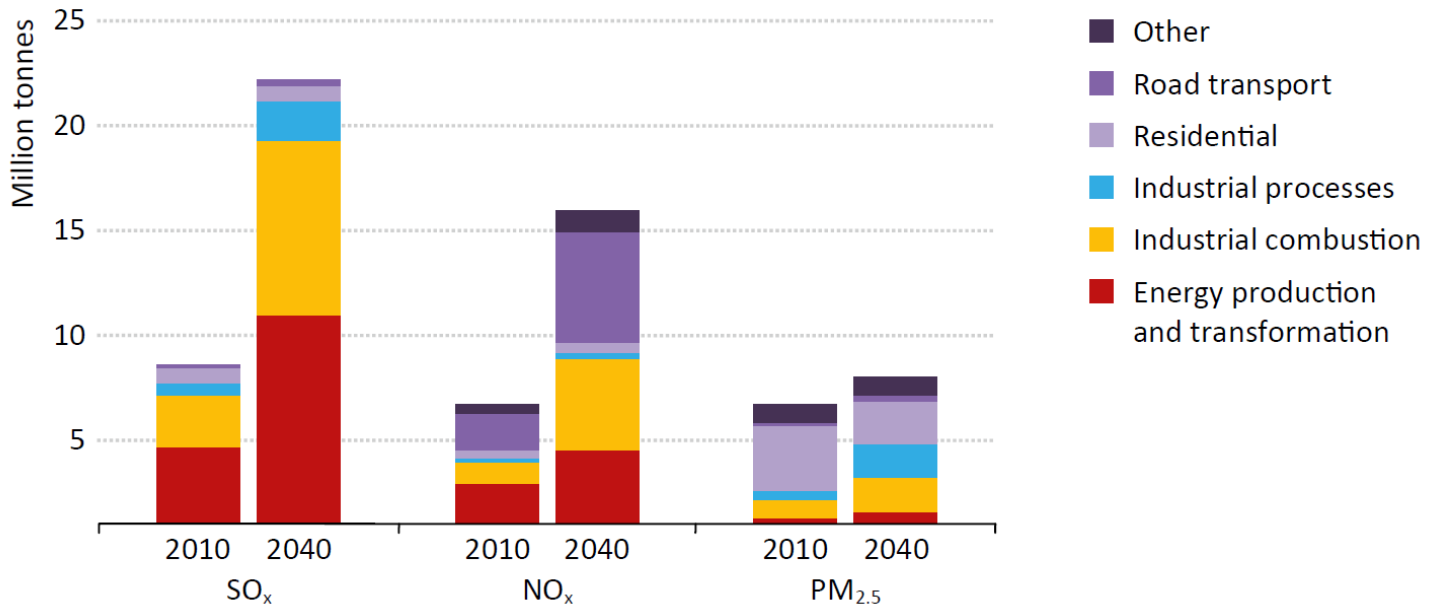


Stationary

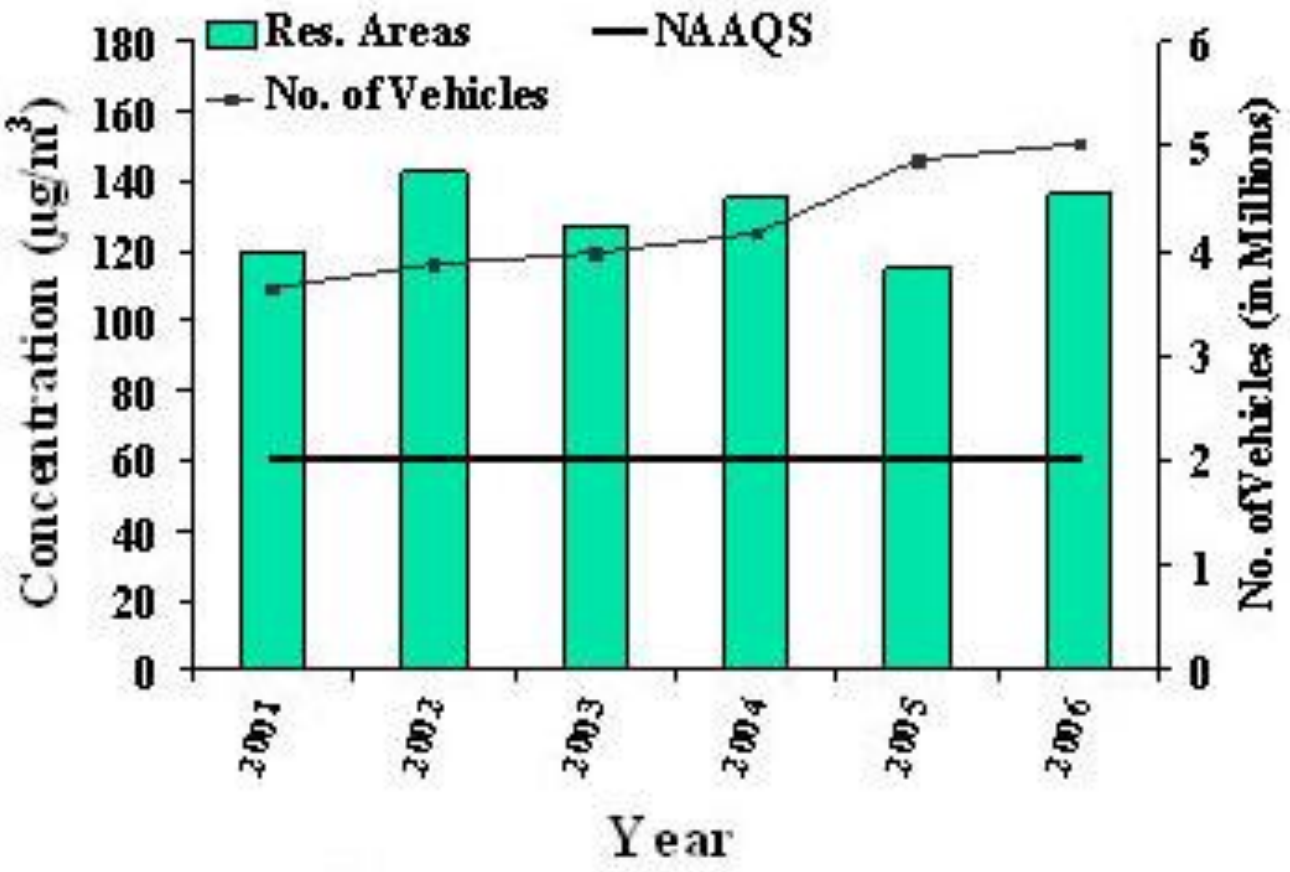
Mobile: On-road sources

Mobile: Non-road sources

Emissions of SO_x, NO_x and $PM_{2.5}$ in India by sector, 2010 and 2040



https://www.iea.org/publications/freepublications/publication/IndiaEnergyOutlook_WEO2015.pdf



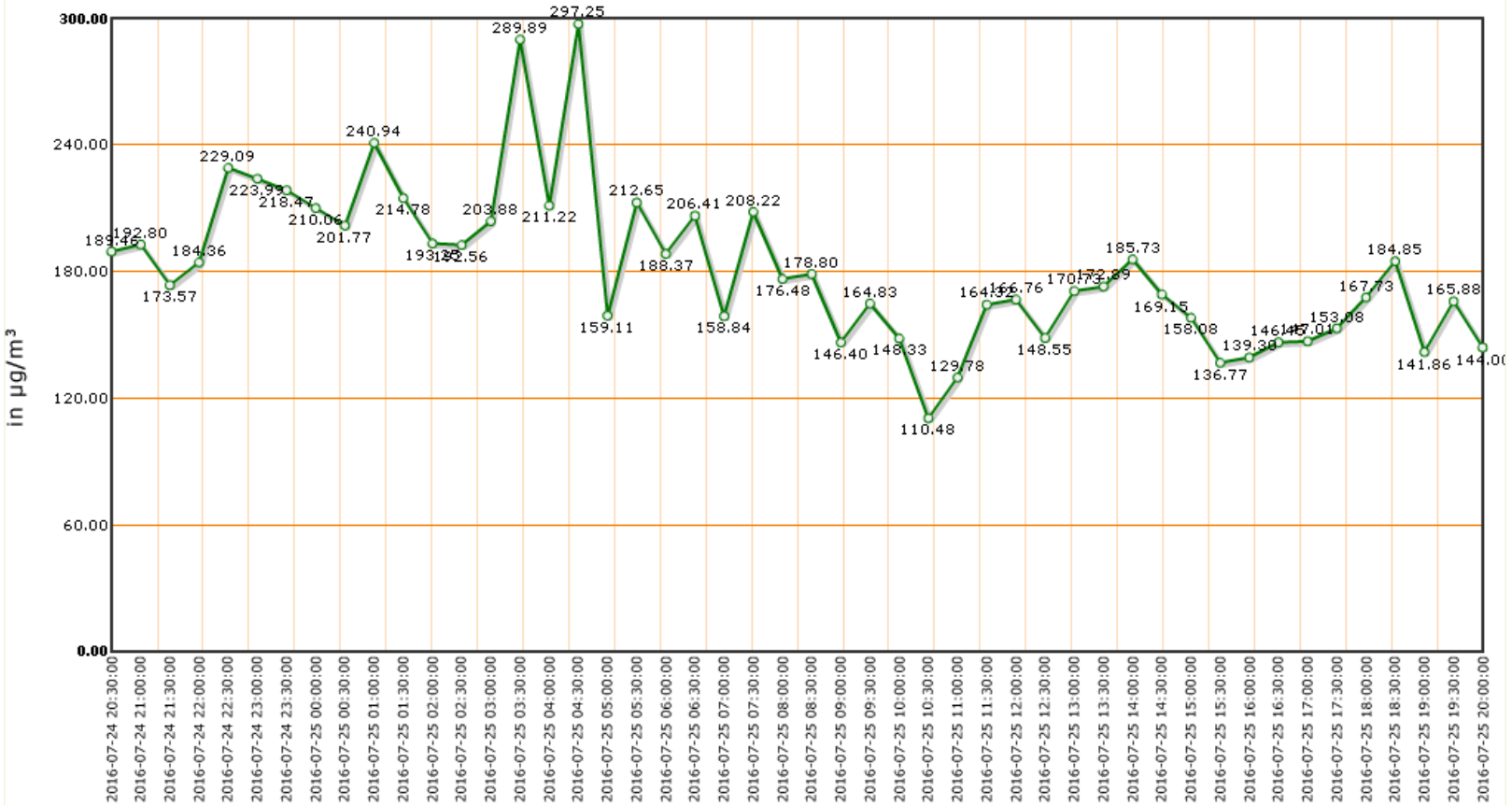
Trends in Annual Average Concentration of RSPM in residential areas of Delhi

PARTICULATE CONCENTRATION & METEOROLOGICAL CONDITION

Air Quality Monitoring Station : IGI Airport

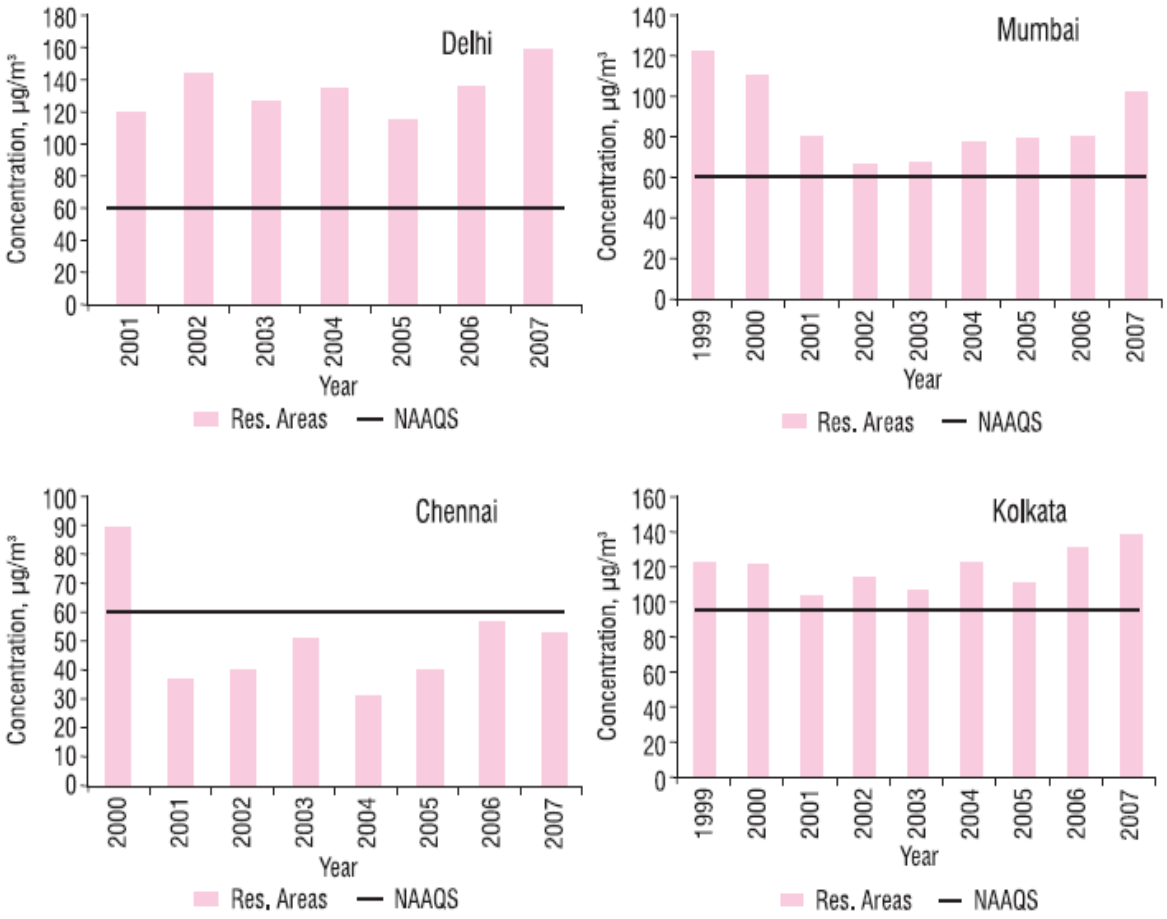
Particulates PM 10 in Real Time

Standard : 100 µg/m³



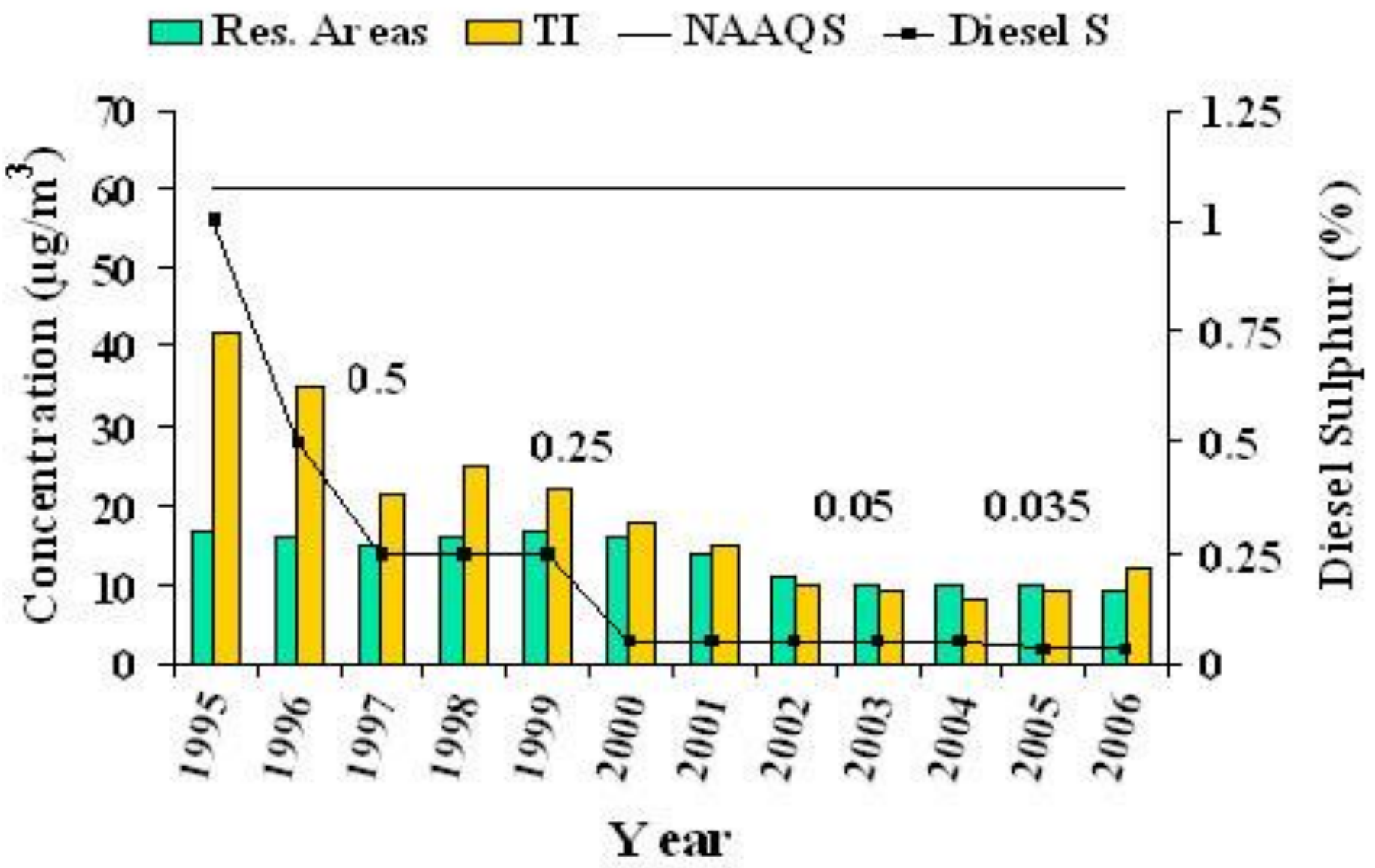
http://www.dpccairdata.com/dpccairdata/display/airportMetView15MinGraph.php?sql=RtpmPM10&name=Particulates+PM+10+in+Real+Time&graph=Line

Figure 2.2c Trends in Annual Average Concentration of RSPM in Residential areas of Delhi, Mumbai, Chennai and Kolkata.



Vehicles have been found as one of the major sources of NO_2 and RSPM

http://www.cpcb.nic.in/Highlights/2007/15-44.pdf



Trends in Annual Average Concentration of SO_2 in residential areas of Delhi

GAS CONCENTRATIONS

Air Quality Monitoring Station : IGI Airport

Sulphur Dioxide for last 24 hours

Standard : 80 µg/m³

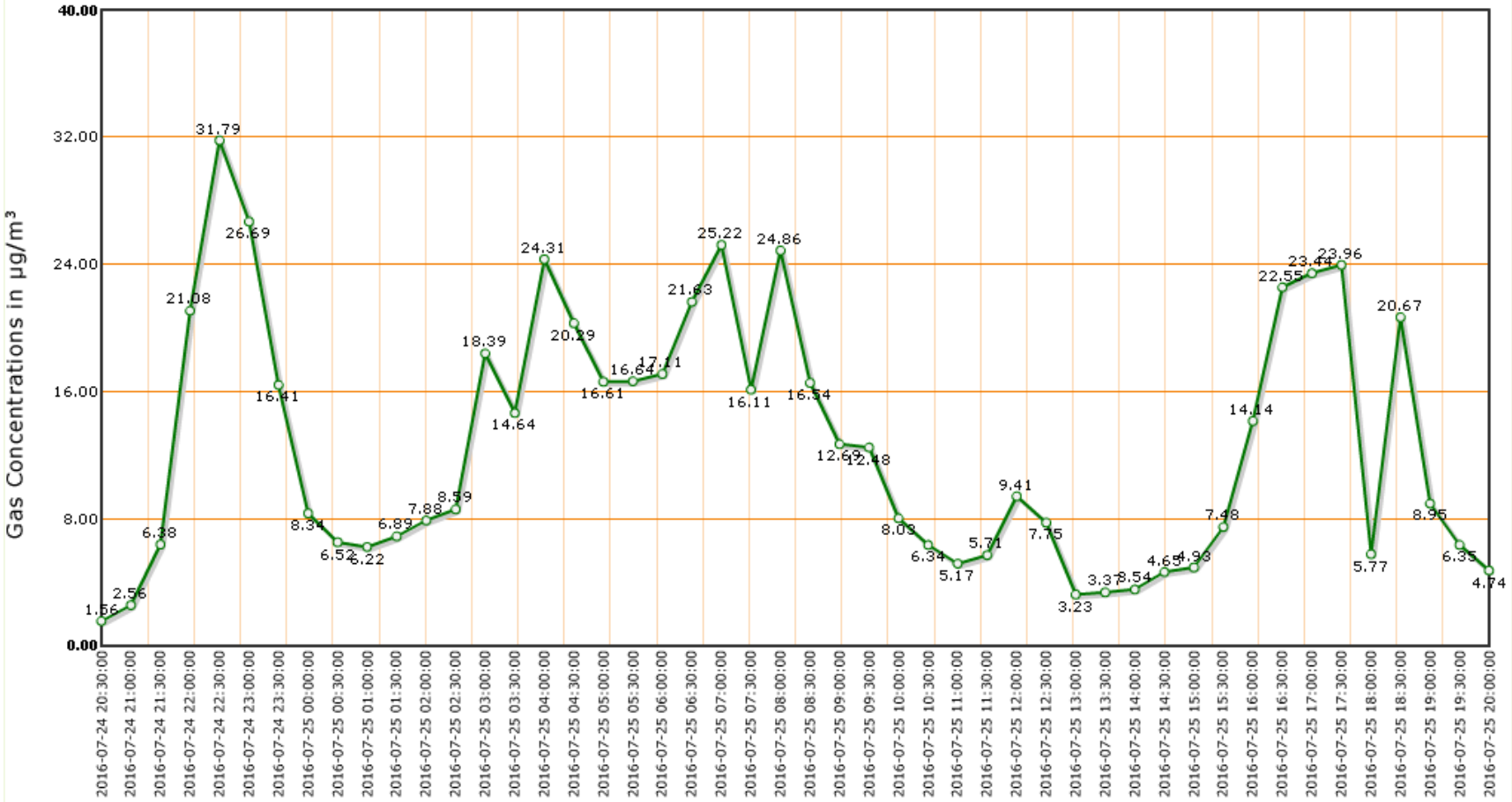
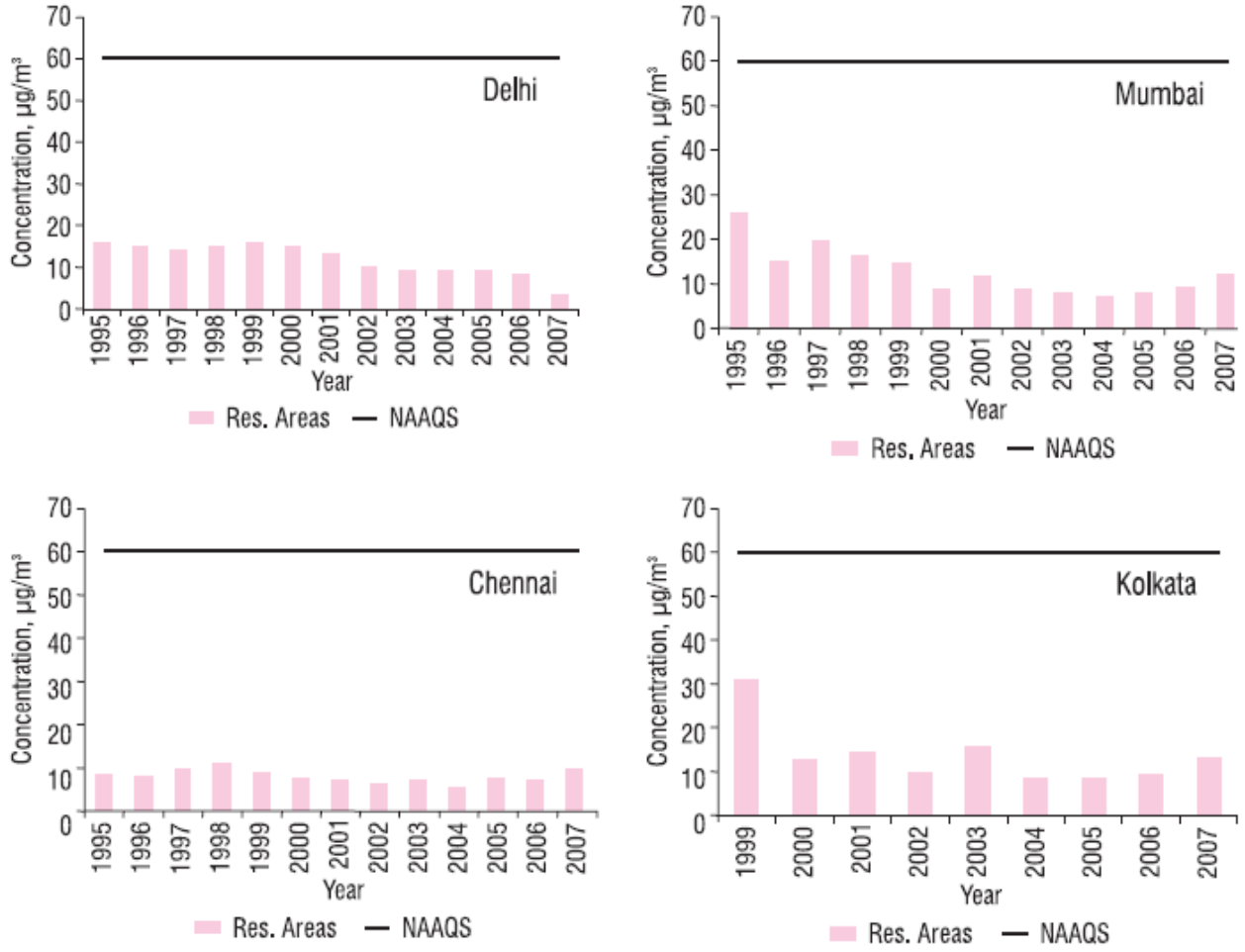
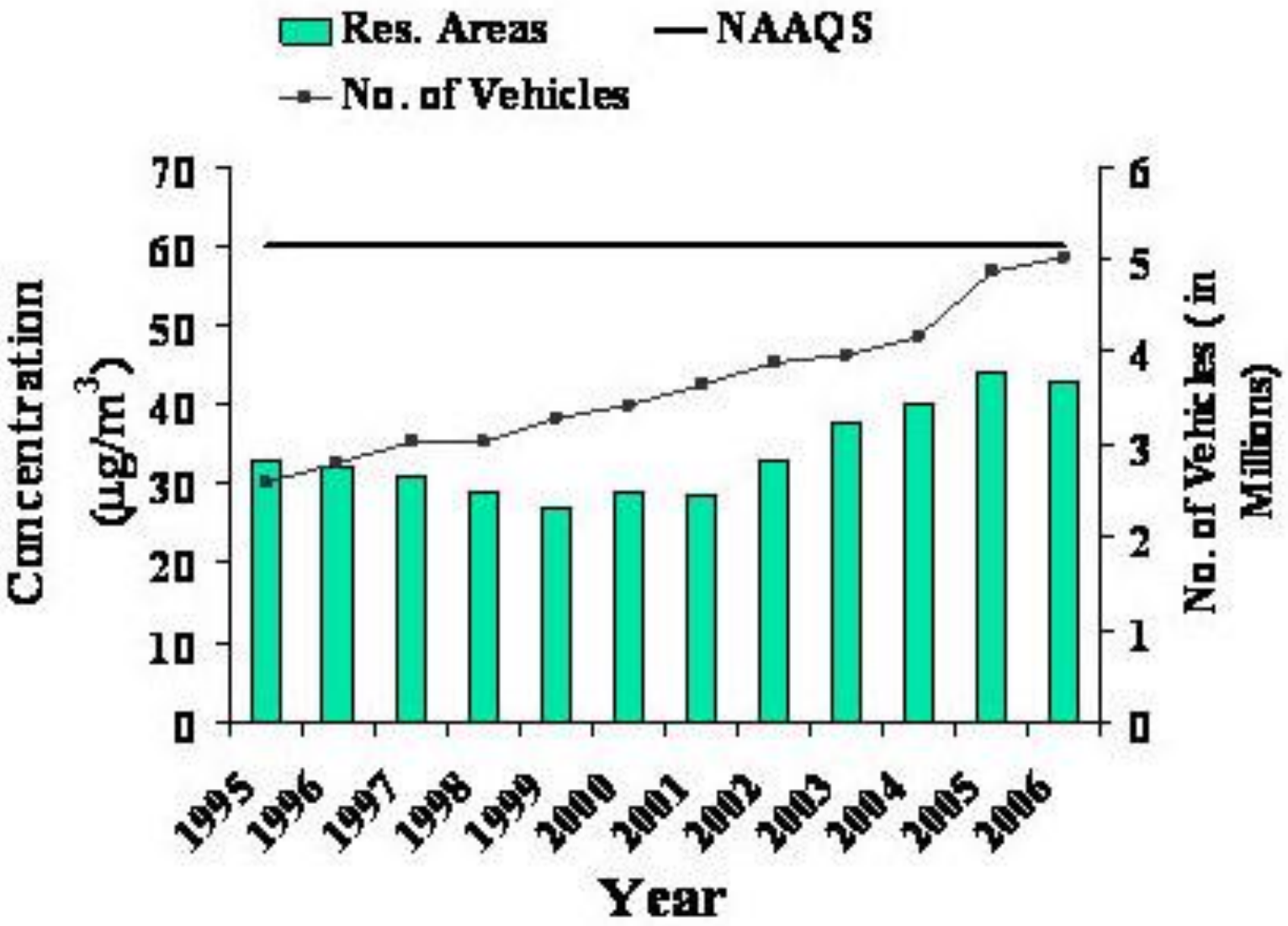


Figure 2.2a Trends in Annual Average Concentration of SO_2 in Residential areas of Delhi, Mumbai, Chennai and Kolkata.



Source: www.cpcb.nic.in/Highlights/2007/15-44.pdf



Trends in Annual Average Concentration of NO_2 in residential areas of Delhi

GAS CONCENTRATIONS

Air Quality Monitoring Station : IGI Airport

Nitrogen Dioxide for last 24 hours

Standard : 80 µg/m³

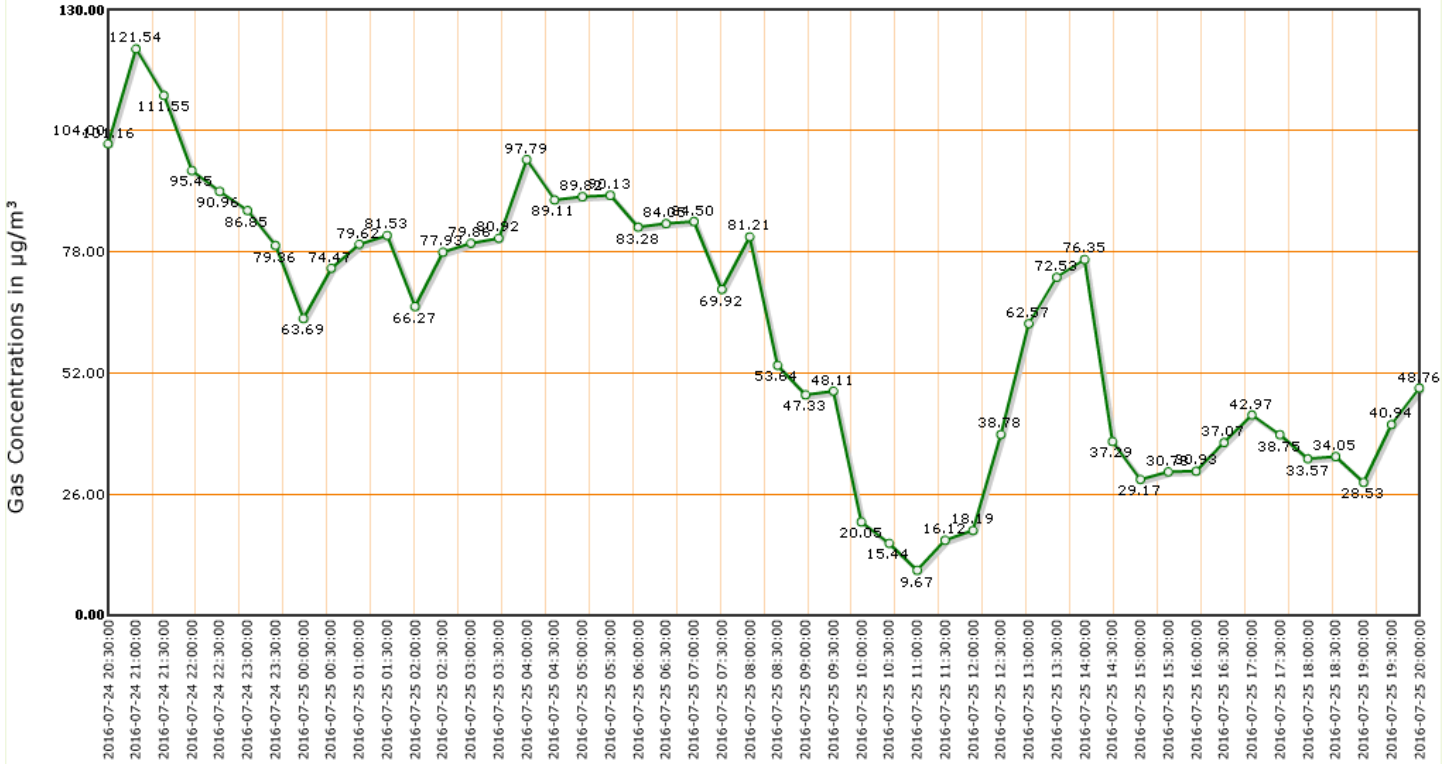
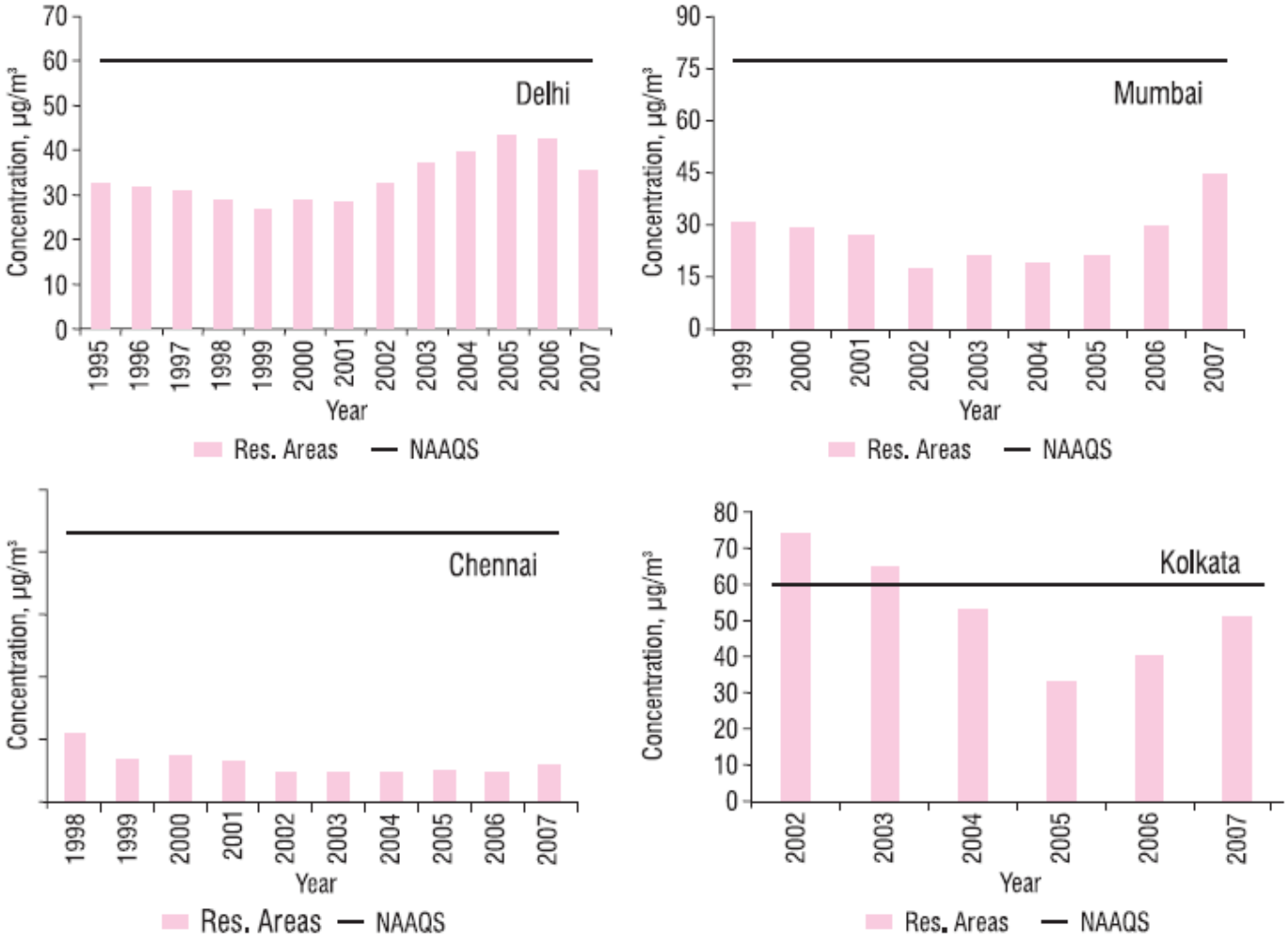


Figure 2.2b Trends in Annual Average Concentration of Nitrogen Dioxide (NO_2 in residential areas of Delhi, Mumbai, Chennai and Kolkata.



Source: www.cpcb.nic.in/Highlights/2007/15-44.pdf

Landmark Date lines to Capital Clean

- April 1995: Mandatory fitting of catalytic convertors.
- April 1996: Low sulphur diesel introduced.
- April 1998: Introduction of CNG buses in Delhi.
- Sept 1998: Complete removal of lead in petrol.
- Dec 1998: Restrict plying of goods vehicles during the day.
- Sept 1999: Amendment of Motor Vehicles Act to include CNG.
- April 2000: Private vehicles to be registered only if they conform to Euro II standards.
- April 2000: Eight-year-old commercial vehicles phased out.
- Nov 2002: Conversion of all public transport buses to CNG.

- India’s urban air quality ranks amongst the world's worst.
- Of the three million premature deaths in the world that occur each year due to outdoor and indoor air pollution, the highest numbers are assessed to occur in India.
- The amount of registered vehicles in Delhi has increased fifty-one times over a thirty year period.
- The development of a diversified industrial structure, based on a combination of large and small-scale industries, along with growing population has contributed to the growing incidence of air pollution.

Source: State of Environment 2009, MoEF, GoI

HEALTH

Exercise does more harm than good in these cities!

By Jomy M. Joseph | February 17, 2017

https://www.theweek.in/content/archival/news/sci-tech/exercise-pollution.html

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Canadian firm to sell canned air in India at Rs 12.50 per breath

Anirudh Bhattacharyya, Hindustan Times, Toronto | Updated: May 02, 2016 08:01 IST

Vitality Air's founder Moses Lam has shipped nearly 12,000 pieces of the canned natural air to smog-hit Beijing. (HT Photo)

Just how much is a breath of fresh air worth? For people in New Delhi, ranked number one on a WHO list of cities with the foulest air, it may seem priceless.

But a Canadian company thinks the price is about Rs 12.50 per breath.

The start-up Vitality Air, based in Edmonton in the western province of Alberta, plans to start selling canned natural air from the Canadian Rockies to Indian consumers this May. The company made plenty of headlines in Canada in 2015 after it launched its

- Source: http://www.hindustantimes.com/world/canadian-firm-to-sell-canned-air-in-india-at-rs-12-50-per-breath/story-N9nxidXg809hKG5tQnkEoL.html

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- ★ OXY99 Can is fitted with ergonomically Built-In mask and Trigger system for easy use at anytime and carry with you anywhere.
- ★ OXY99 instantly increases oxygen levels in the body and helps restore brain and body functions to normal. It is safe and easy to use oxygen in a can. By using just 5 to 6 short bursts of oxygen, it helps through conditions resulting from low oxygen levels in the body.
- ★Useful for SPORTS RECOVERY, FATIGUE, BREATHLESSNESS, POLLUTION, HANGOVER, ALTITUDE etc . Helps you recover from breathlessness & suffocation caused by pollution, smoking, stale air, poorly ventilated rooms, high altitude, etc.

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WATER

Water Requirements for Various Sectors

Sector	Water Demand in km^3 (or BCM)					
	Standing Sub-Committee of MoWR			NCIWRD		
Year	2010	2025	2050	2010	2025	2050
Irrigation	688	910	1072	557	611	807
Drinking Water	56	73	102	43	62	111
Industry	12	23	63	37	67	81
Energy	5	15	130	19	33	70
Others	52	72	80	54	70	111
Total	**813**	**1093**	**1447**	**710**	**843**	**1180**

Source: Website of Ministry of Water Resources, Govt. of India, National Council for Integrated Water Resource and Development (NCIWRD)

Current estimate of utilizable water resource potential: 1,122 km^3

(i) Surface Water Resources: 691 km^3

(ii) Ground Water Resources : 431 km^3

Water Pollution

- ~70% of surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic and inorganic pollutants (*MOWR 2000)*
- In many cases, these sources have been rendered unsafe for human consumption as well as for other activities such as irrigation and industrial needs.

Pesticide and Fertilizers Consumption

- Pesticide consumption < 1 million tonne in 1948 to a 75 million tonnes in 1990 (CSE,1999).
- Studies on the Ganga River indicate the presence of chemicals such as DDT, endosulfan, methyl malathion, malathion, dimethoate, and ethion in levels greater than those recommended by the international standards (*World Bank 1999).*
- Per hectare consumption of fertilizers has increased from 69.8 kg in 1991-92 to 113.3 kg in 2006-07
- High levels of fertilizer use has been associated with increased incidence of **Eutrophication** in rivers and lakes in several of India's most important water bodies

  E.g. Hussein Sagar in Hyderabad and Nainital in Uttarakhand (*MOWR 2000)*

Lake Eutrophication: Disrupted Ecosystem

Industrial Usage

- Industrial sector only accounts for 3% of the annual water withdrawals in India, its contribution to water pollution, particularly in urban areas, is considerable.

Water Pollution

- All of India's 14 major river systems are heavily polluted, mostly from the 50 million cubic meters of untreated sewage discharged into them each year

- Only ~19% of the rural and 70% of the urban inhabitants have access to adequate sanitation facilities (*WRI 2000).*

- Water contaminated by human waste is often discharged directly into watercourses or seeps into the groundwater table from faulty septic tanks or pit latrines.

- The level of faecal coliform bacteria in most rivers often exceeds the standards and is responsible for causing a number of gastro-intestinal ailments among the population.

Status of sewage generation and treatment capacity in metropolitan cities

S. No.	Name of the city	Sewage generation (in MLD)	Sewage Treatment Capacity (in MLD)	Percent of treatment capacity
1	Hyderabad	426.21	593	100
2	Vishakhapatnam	134.99	-	-
3	Vijayawada	128.39	-	-
4	Patna	279.14	105	37
5	Delhi	3800	2330	61
6	Ahmadabad	472	488	96
7	Surat	432	202	46
8	Rajkot	108.8	44.5	40
9	Vadodara	180	206	100
10	Bangalore	771.75	-	-
11	Indore	204	78	38
12	Bhopal	334.75	22	6
13	Jabalpur	143.34	-	-
14	Mumbai	2671	2130	80
15	Pune	474	305	64
16	Nagpur	380	100	26
17	Nasik	227.84	107.5	47
18	Ludhiana	235.2	311	100
19	Amritsar	192	-	-
20	Jaipur	451.71	54	11
21	Chennai	158	264	100
22	Kanpur	417.35	171	41
23	Lucknow	363.81	42	11
24	Agra	260.36	88	33
25	Kolkata	705.86	172	24
26	Faridabad	164	65	39
27	Jamshedpur	199.43	-	-
28	Asansol	147	-	-
29	Coimbatore	120	-	-
30	Madurai	97.93	-	-
31	Meerut	177.05	-	-
32	Varanasi	230.17	102	44
33	Allahabad	176	60	34
34	Kochi	188.4	-	-
35	Dhanbad	192	-	-
Total		**15644**	**8040**	**51**

Population

Class I – >100,000
Class II –50,000 – 99,999
Class III –20,000 – 49,999
Class IV - 10,000 to 19,999
Class V - 5,000 to 9,999
Class VI - <5,000

>5,000,000- Megacity
1,000,000-4,999,999 - Metropolis
500,000-999,999 - Sub-Metropolis

Source: CPCB, 2009

State-wise sewage generation of Class-I Cities

S. No.	State/Union Territory	No. of Cities	Population (in Year 2008)	Sewage Generation (In MLD)	Sewage Treatment Capacity (in MLD)
1	Andaman & Nicobar	1	107200	12	-
2	Andhra Pradesh	47	20143050	1760.60	654
3	Assam	5	1417820	380.14	-
4	Bihar	23	5783554	1009.7	135.5
5	Chandigarh	1	994820	429.76	164.79
6	Chhattisgarh	7	2515100	350.47	69
7	Delhi	1	14858800	3800	2330
8	Goa	1	122330	9.79	-
8	Gujarat	28	14678240	1680.92	782.5
9	Haryana	20	5494110	626.69	312
10	Himachal Pradesh	1	163490	28.94	35.63
11	Jammu & Kashmir	2	1910060	213.93	-
12	Jharkhand	14	4964171	830.47	-
13	Karnataka	33	15102373	1790.40	43.44
14	Kerala	8	3778516	575.17	-
15	Madhya Pradesh	25	10795000	1248.72	186.1
16	Maharashtra	50	40255170	9986.29	4225.25
17	Manipur	1	249870	26.74	-
18	Meghalaya	1	186030	20.84	-
19	Mizoram	1	282550	5.71	-
20	Nagaland	1	171810	13.62	-
21	Orissa	12	3335930	660.73	53
22	Pondicherry	2	504130	56.46	-
23	Punjab	19	6329860	1528.26	411
24	Rajasthan	24	9611490	1382.37	54
25	Tamilnadu	42	16852940	1077.21	333.42
26	Tripura	1	214327	24	-
27	Uttar Pradesh	61	25762280	3506.01	1240.13
28	Uttrakhand	6	1249380	176.97	18
29	West Bengal	60	19818471	2345.21	505.92
	Total	**498**	**22,76,52,872**	**35558.12**	**11553.68**

32.5%

State-wise sewage generation of Class-II Cities

S.No.	State/Union Territory	Population in Year 2008	No of Class-II Towns	Sewage generation of Class-II Towns (in MLD)	Sewage Treatment Capacity (in MLD)
1	Andhra Pradesh	3448610	52	217.59	10.42
2	Assam	573290	8	6.46	-
3	Bihar	1113800	14	107.42	2
4	Chhattisgarh	566080	7	40.82	
5	Goa	172850	2	13.89	18.18
6	Gujarat	2180590	31	227.55	-
7	Haryana	544040	7	43.52	-
8	Jammu & Kashmir	244990	4	27.86	-
9	Jharkhand	826300	10	78.21	-
10	Karnataka	1800258	26	233.37	12.18
11	Kerala	1686660	26	231.32	-
12	Madhya Pradesh	1745050	23	130.9	9.00
13	Maharashtra	2503080	34	213.73	29
14	Meghalaya	81750	1	11.25	-
15	Nagaland	126520	1	1.36	-
16	Orissa	904510	12	78.42	-
17	Pondicherry	79690	1	7.984	-
18	Punjab	1109670	14	157.4	42.80
19	Rajasthan	1599260	21	147.79	-
20	Tamilnadu	3254950	42	184.67	29.3
21	Uttar Pradesh	3382520	46	345.7	12.61
22	Uttrakhand	69490	1	9.07	6.33
23	West Bengal	2004440	27	180.42	61.88
	Total	**3,00,18,398**	**410**	**2696.70**	**233.7**

< 9%

Summary of water supply, sewage generation and its treatment

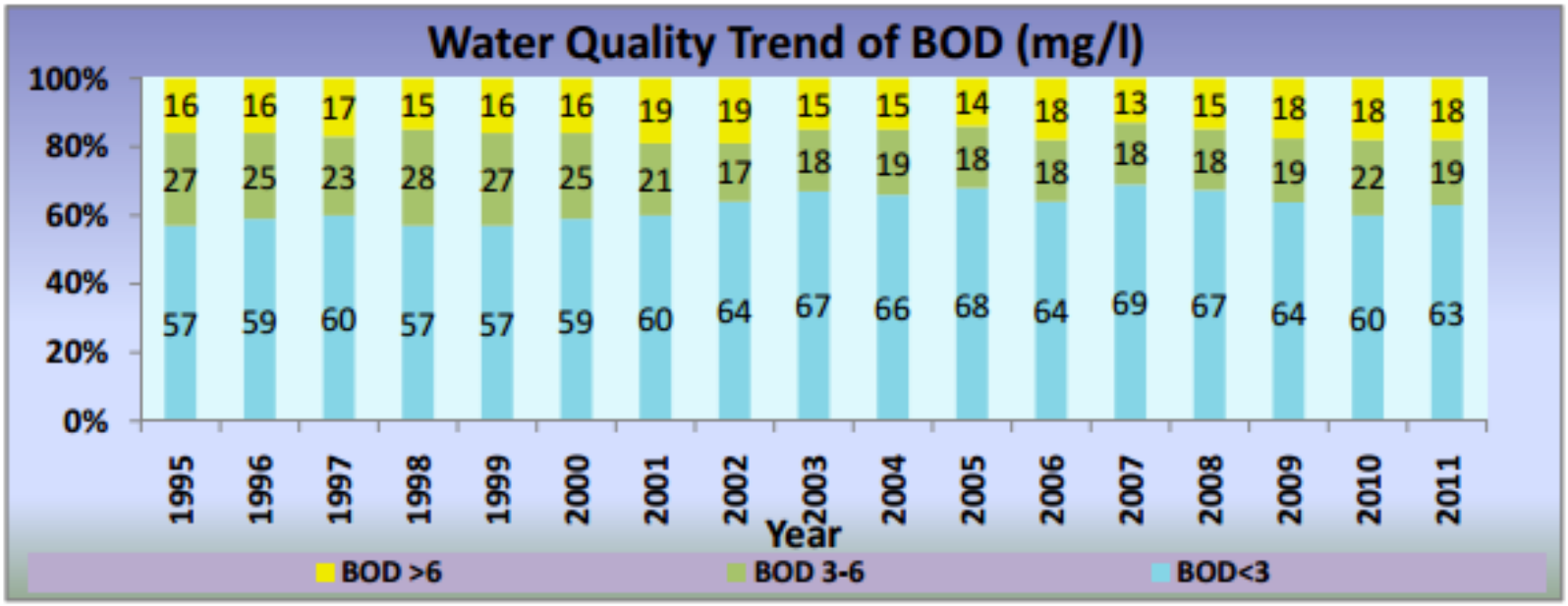
Category	No. of Cities	Population	Total Water Supply (in MLD)	Wastewater Generation (in MLD)	Treatment Capacity (in MLD)
Class-I City	498	14,30,83,804	44,769.05	35,558.12	11,553.68
Class-II town	410	3,00,18,368	3,324.83	2,696.7	233.7
Total	**908**	**25,77,54,640**	**48,093.88**	**38254**	**11787.38** (30.8%)

National Water Quality Monitoring Programme

- Started in 1977-78 under CPCB
- 2500 stations in 28 states and 6 UTs

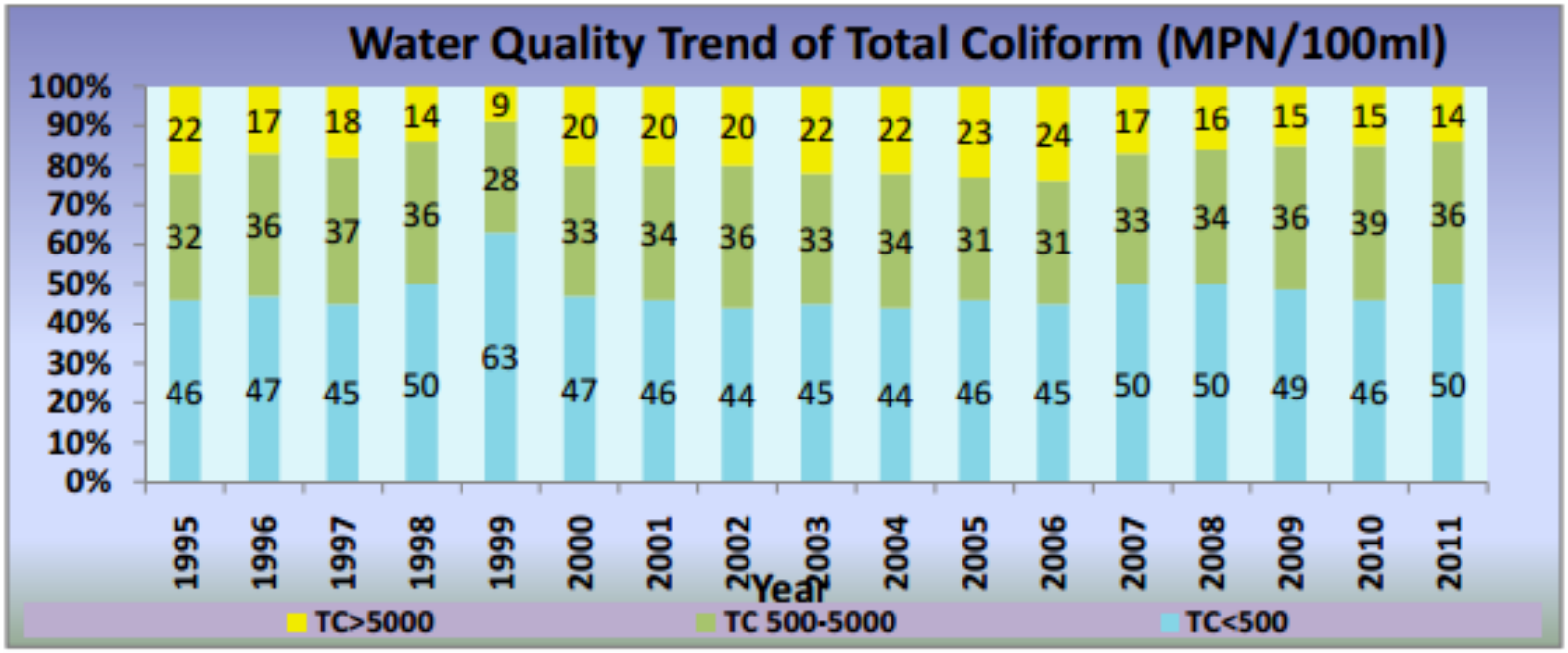
TYPE OF WATER BODIES	NUMBER OF WATER BODIES	NUMBER OF STATIONS
RIVERS	445	1275
LAKES	154	190
TANKS	12	12
PONDS	78	79
CANALS	25	41
CREEKS/SEA WATER	41	41
DRAINS	45	45
WELLS	807	807
WATER TREATMENT PLANT	10	10
TOTAL		2500

Designated-Best-Use	Class of water	Criteria
Drinking water Source without conventional treatment but after disinfection	**A**	•Total Coliforms Organism MPN/100ml shall be **<50** •pH: **6.5-8.5** •Dissolved Oxygen **≥6mg/l** •Biochemical Oxygen Demand 5 days 20°C **≤2mg/l**
Outdoor bathing (Organised)	**B**	•Total Coliforms Organism MPN/100ml shall be **≤ 500** •pH: **6.5-8.5** •Dissolved Oxygen **≥ 5mg/l** •Biochemical Oxygen Demand 5 days 20°C **≤3mg/l**
Drinking water source after conventional treatment and disinfection	**C**	•Total Coliforms Organism MPN/100ml shall be **≤ 5000** • pH: **6-9** •Dissolved Oxygen **≥ 4mg/l** •Biochemical Oxygen Demand 5 days 20°C **≤ 3mg/l**
Propagation of wild life and fisheries	**D**	•pH between **6.5 to 8.5** •Dissolved Oxygen **≥ 4mg/l** •Free Ammonia (as N) **≤1.2 mg/l**
Irrigation, industrial cooling, controlled waste disposal	**E**	•pH: **6.0-8.5** •Electrical Conductivity at 25°C micro mhos/cm Max.2250 •Sodium absorption ratio Max. **26** •Boron Max. **2mg/l**
	Below-E	**Not Meeting A, B, C, D & E Criteria**



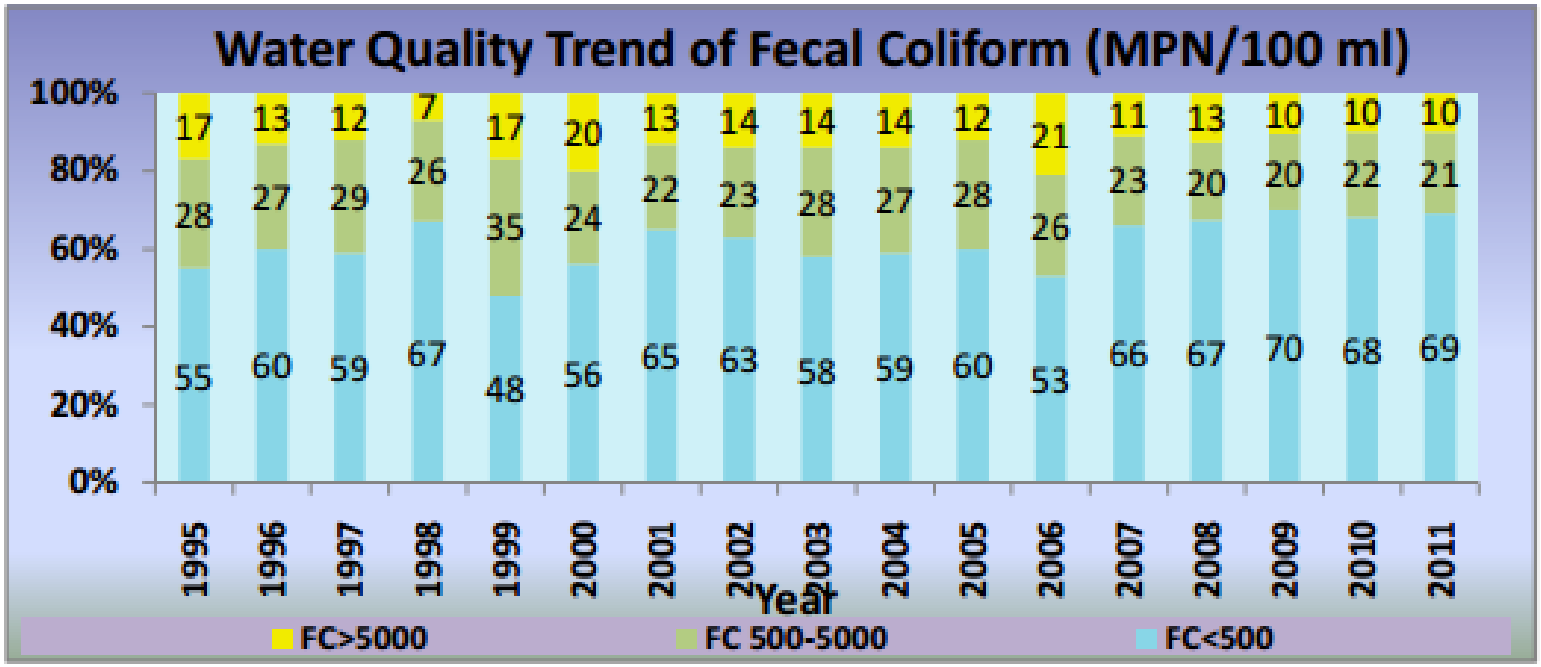
Use	Criteria (BOD5) at 20°C
Drinking Water Source without conventional treatment but after disinfection	≤2mg/l
Outdoor bathing	≤3mg/l
Drinking water source after conventional treatment and disinfection	≤3mg/l

Source: Status of Water Quality in India-2011, CPCB

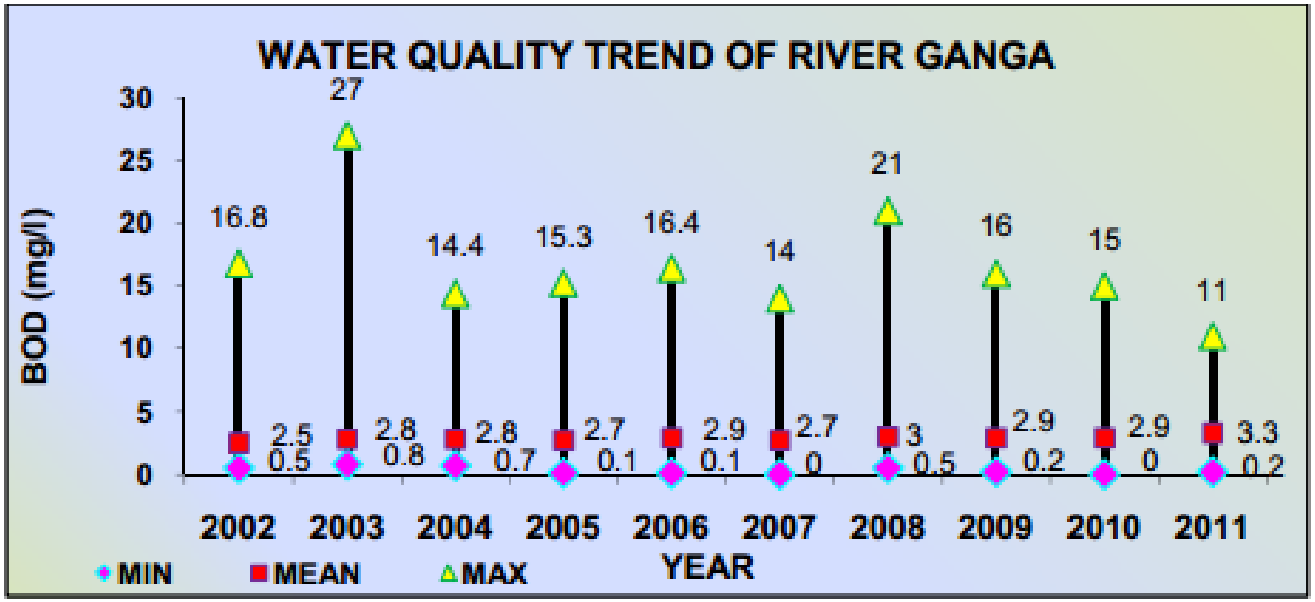


Designated-Best-Use	Criteria (TC) MPN/100 ml
Drinking Water Source without conventional treatment but after disinfection	•50 or less
Outdoor bathing (Organised)	•500 or less
Drinking water source after conventional treatment and disinfection	5000 or less

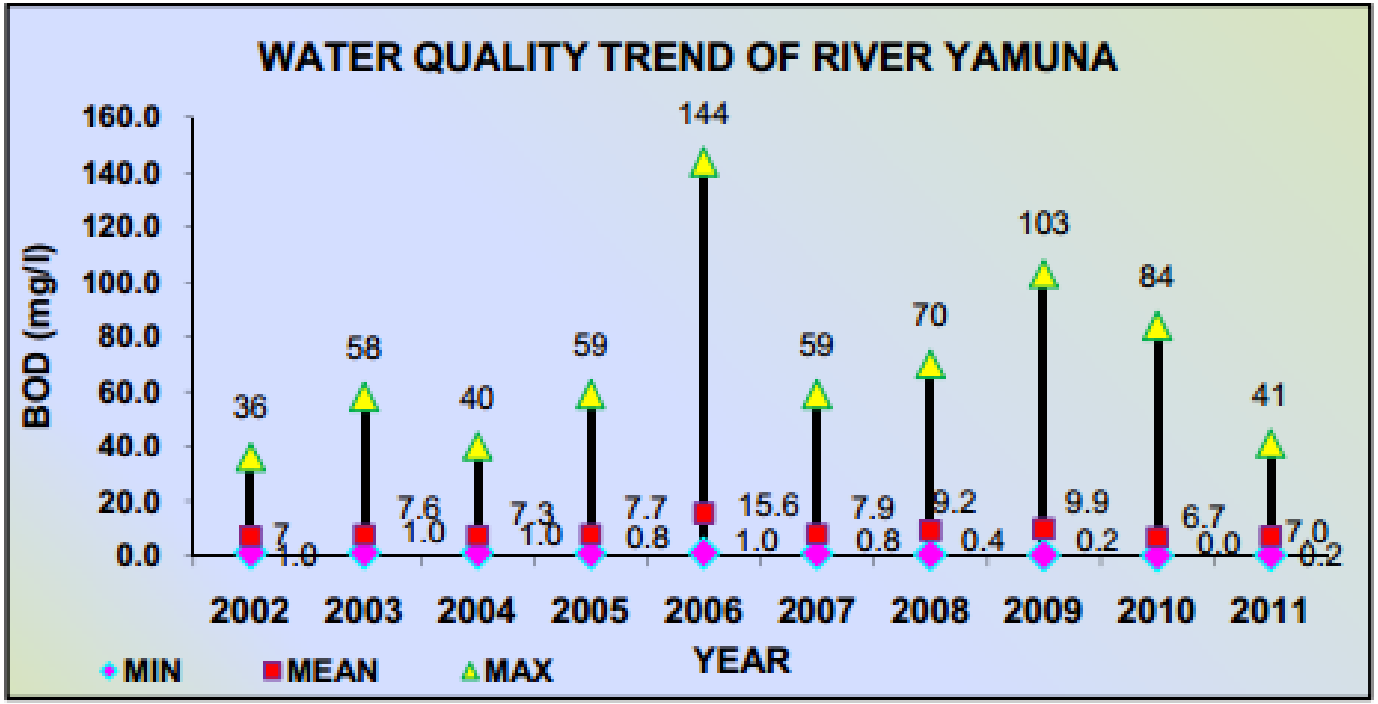
Source: Status of Water Quality in India-2011, CPCB



Source: Status of Water Quality in India-2011, CPCB



Source: Status of Water Quality in India-2011, CPCB



Source: Status of Water Quality in India-2011, CPCB

State-wise riverine length (in Km) under different level of pollution

	Bio Chemical Oxygen Demand, mg/L			
State	**>6**	**3-6**	**<3**	**Total**
Jammu & Kashmir	0	0	2291	2291
Himachal Pradesh	19	0	1076	1095
Punjab	70	132	870	1072
Haryana	95	87	167	349
Uttar Pradesh	1180	1966	2473	5619
Rajasthan	76	160	606	842
Madhya Pradesh	365	1157	4569	6091
Bihar	63	126	2337	2526
West Bengal	69	221	874	1164
Orissa	247	1507	473	2227
Andhra Pradesh	361	803	2854	4018
Maharashtra	2721	1706	187	4614
Gujarat	265	185	706	1156

Analysis of 10 years data with respect to BOD values as indicator of organic pollution

State-wise riverine length (in Km) under different level of pollution (contd.)

Karnataka	258	143	2467	2868
Kerala	0	15	1395	1410
Tamil Nadu	269	470	1290	2029
Assam	0	0	2043	2043
Meghalaya	0	0	557	557
Manipur	0	0	759	759
Arunachal Pradesh	0	0	707	707
Sikkim	0	0	754	754
Nagaland	0	0	503	503
Mizoram	0	0	235	235
Goa	0	13	53	66
Delhi	28	0	20	48
T O T A L :-	**6086**	**8691**	**30266**	45043

River basin-wise riverine length (in Km.) under different level of pollution

	Bio Chemical Oxygen Demand, mg/L			
State	>6	3-6	<3	Total
Indus	70	132	3917	4119
Ganga	1760	3612	7318	12690
Bramaputra	0	0	5013	5013
Sabarmati	65	95	165	325
Mahi	70	160	292	522
Narmada	120	360	902	1382
Tapi	160	280	537	977
Subernrekha	90	120	79	289
Brahmini	45	160	380	585
Mahanadi	210	370	1393	1973
Godavari	960	856	2676	4492

River basin-wise riverine length(in Km.) under different level of pollution (contd..)

Subernrekha	90	120	79	289
Brahmini	45	160	380	585
Mahanadi	210	370	1393	1973
Godavari	960	856	2676	4492
Krishna	840	956	1988	3784
Pennar	0	80	440	520
Cauvery	70	320	928	1318
Ghaggar	140	148	70	358
Medium	1090	734	3210	5034
Minor	396	308	958	1662
T O T A L : -	**6086**	**8691**	**30266**	**45043**

WATER QUALITY STATUS

Analysis of 10 years data with respect to BOD values as indicator of organic pollution

S. No	Level of Pollution	Pollution Criteria BOD (mg/l)	Riverine length, Km.	Riverine length (%)
01.	Severely polluted	> 6	6086	14
02.	Moderately polluted	3-6	8691	19
03.	Relatively clean	<3	30242	67

Water Quality in Indian Rivers during the years – 2002-2011

Name of the River	Length (Km)	No of Monitoring locations	Year	Observed Range of Water Quality Parameters						
				Temp.(^{0}C)	pH	Conductivity(µmhos/cm)	DO(mg/l)	BOD(mg/l)	Total Coliform (MPN/100 ml)	Faecal Coliform (MPN/100 ml)
Ganga	2525	34	2002	3-34	6.4-9.0	19-2720	2.7-11.5	0.5 – 16.8	300-25x10^5	20-11x10^5
		34	2003	4-34	6.8-8.9	49-1323	4-11	0.8-27	47-45x10^5	26-12x10^5
		34	2004	5-35	7-8.8	72-4080	0.3-13.2	0.7-14.4	11-45x10^5	11-7x10^5
		39	2005	4-39	6.1-9	23-1696	3.2-12.8	0.1-15.2	13-45x10^5	13-11x10^5
		39	2006	9-33	7.0-8.88	97-5620	2.2-11.9	0.1-16.4	1-25x10^5	17-11x10^5
		39	2007	4-33	6.1-8.8	23-5040	1.4-11	0-14	0-28x10^5	0-7 x10^5
		39	2008	2.5-35.5	6.1-8.9	39-6320	1.2 - 11.6	0.5-21.0	0- 101 x10^5	0 - 85 x10^4
		57	2009	4-37	6.5-8.9	68-4460	4.3-11.2	0.2-16	2-65 x10^4	0-4 x10^5
		57	2010	4-35	6.7-9.0	21-5250	3.6-12	0.2-15	3-14 x10^5	2-4 x10^5
		61	**2011**	**3-37**	**6.7-9.1**	**49-10240**	**4-14.3**	**0.2-11**	**5-25 x10^5**	**5-11 x10^5**
Yamuna	1376	23	2002	3-34	6.7-9.8	56-1959	0.1-22.7	1.0 – 36	27-26.3x10^6	11-17.2x10^5
		23	2003	2-38	6.6-10	45-3500	0.3-22.8	1-58	110-171x10^7	40-203x10^6
		23	2004	7-35	6.8-9	76-2150	0.3-19.5	1-40	21-1103x10^6	18-62x10^6
		23	2005	11-37	6.8-9.1	90-2290	0.5-17.3	0.8-59	14-307x10^6	11-52x10^5
		23	2006	4-34	7.14-9.5	220-1876	1.3-18.8	1.0-144	7-231x10^7	2-13x10^6
		23	2007	6.5-34	5-8.4	57-1940	0-17.7	0-93	0-32 x10^7	0-23 x10^6
		23	2008	7.5-32	6.8 - 9.5	40-3340	0.0 - 20.6	0.4-70.0	0 - 103x10^6	11 -109x10^5
		27	2009	5-35	7.0 - 8.8	80 - 3040	0.0 - 17.9	0.2 - 103	4 - 23 x10^9	9 - 21 x10^8

Source: Status of Water Quality in India-2011, CPCB

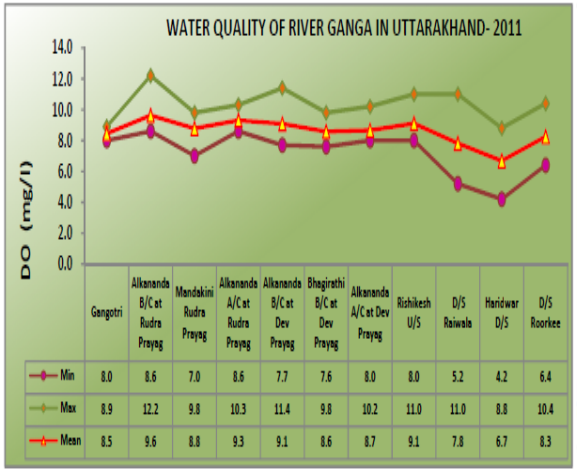
Comparative Assessment of BOD levels in Rivers

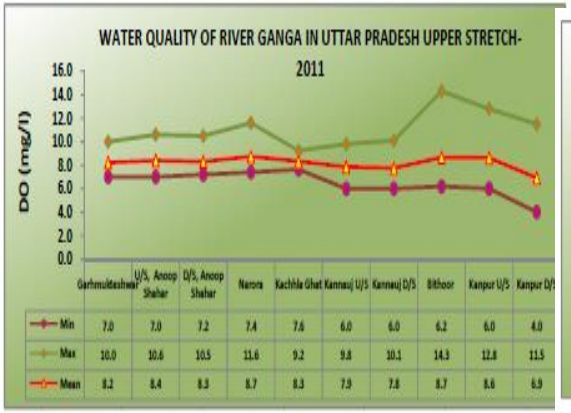
River	B.O.D. (mg/l)		Trend	River	B.O.D. (mg/l)		Trend
	2011	2010			2011	2010	
Kala Amb	535.0	1025.0	Decreasing	Ghaggar	68.0	70.0	Decreasing
Kundalika	12.0	250	Decreasing	Amravati (Tapi)	10.0	12.0	Decreasing
Hindon	50.0	278	Decreasing	Girna	10.0	12.0	Decreasing
Khan	1.3	120	Decreasing	Gomai	8.0	10.0	Decreasing
Bhavani	6.2	93.0	Decreasing	Wena	12.0	13.6	Decreasing
Mula	19.5	88.5	Decreasing	Gomti	10.5	12.0	Decreasing
Mula-Mutha	21.5	79.0	Decreasing	Hiwara	8.0	9.0	Decreasing
Mutha	23.5	68.0	Decreasing	Kalisot	5.4	6.4	Decreasing
Yamuna	41.0	84.0	Decreasing	Nira (Godavari)	8.5	9.2	Decreasing
Pawana	19.5	58.0	Decreasing	Kharkhla	7.5	7.8	Decreasing
Indrayani	13.0	46.0	Decreasing	Purna (Tapi)	14.0	14.0	Same
Varuna	27.6	54.0	Decreasing	Umtrew	8.8	8.5	Increasing
Godavari	37.0	60	Decreasing	Bindusar	7.4	7.0	Increasing
Urmodi	7.5	28.7	Decreasing	Bichia	8.5	8	Increasing
Venna	10.0	30.0	Decreasing	Mahananda	6.6	5.5	Increasing
Cauvery	7.2	27.0	Decreasing	Kansi	6.1	4.9	Increasing
Kathajodi	3.9	22.5	Decreasing	Brahmani	6.8	5.6	Increasing
Bhima	22.0	38.5	Decreasing	Chandrabhaga	10.5	9.2	Increasing
Wainganga	12.0	28.0	Decreasing	Koyna	9.0	7.5	Increasing
Nira (Krishna)	13.0	28.0	Decreasing	Kuakhai	6.5	5	Increasing
Morna	6.6	20.0	Decreasing	Sonai	6.0	4.5	Increasing
Mahanadi	3.6	14.3	Decreasing	Pennar	6.0	4.4	Increasing
Rapti	7.5	18.0	Decreasing	Teesta	6.2	4.4	Increasing
Kolar	8.0	18.0	Decreasing	Darna	12.0	10.0	Increasing
Bharalu	50.0	58	Decreasing	Waghur	10.0	8.0	Increasing
Satluj	32.0	40.0	Decreasing	Damodar	7.8	5.8	Increasing
Panzara	10.0	18.0	Decreasing	Burhidihing	9.8	7.8	Increasing
Mor	7.0	14.0	Decreasing	Surya	7.0	4.4	Increasing
Manjira	7.6	14.0	Decreasing	Digboi	7.0	4.3	Increasing
Purna (Godavari)	7.7	14.0	Decreasing	Brahmaputra	9.2	6.3	Increasing
Chambal	42.0	48	Decreasing	Kshipra	28.0	25	Increasing
Kan	10.0	16.0	Decreasing	Nakkavagu	18.0	15.0	Increasing

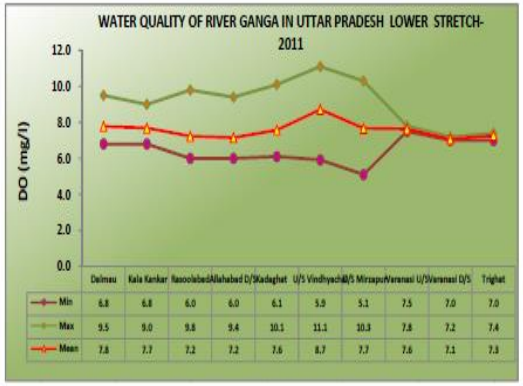
Source: Status of Water Quality in India-2011, CPCB

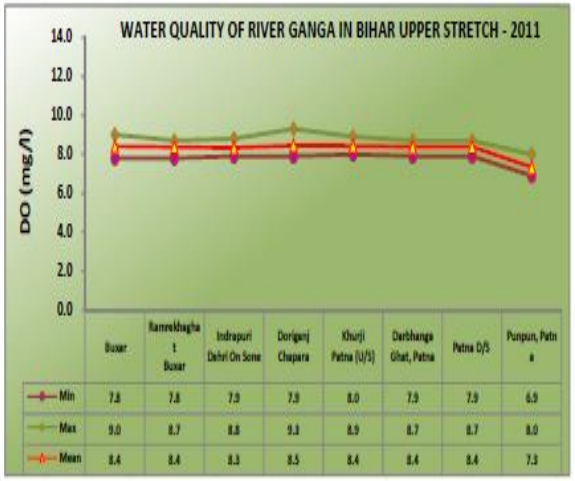
Tapi	10.0	16.0	Decreasing	Vel	14.0	11.0	Increasing
Malei	1.2	6	Decreasing	Karola	6.1	3.1	Increasing
Assonora	2.3	7.0	Decreasing	Disang	6.3	3.2	Increasing
Bicholim	3.9	8.1	Decreasing	Chuntkol	7.0	3.8	Increasing
Kali (M&M)	4.3	8.4	Decreasing	Maner	9.5	6.0	Increasing
Ganga	11.0	15.0	Decreasing	Sina	12.2	8.4	Increasing
Titur	10.0	14.0	Decreasing	Ramganga	12.4	8.6	Increasing
Bori	8.0	12.0	Decreasing	Rihand	7.2	2.9	Increasing
Burai	8.0	12.0	Decreasing	Dhansiri	6.8	2.4	Increasing
Deepar Bill	6.4	10.4	Decreasing	Tambiraparani	8.0	3.1	Increasing
Mindhola	4.0	8	Decreasing	Patalganga	16.0	11.0	Increasing
Dwarka	12.2	15.4	Decreasing	Tungabhadra	8.2	3.0	Increasing
Dhadar	19.0	22	Decreasing	Krishna	16.0	10.0	Increasing
Kanhan	11.0	14.0	Decreasing	Penganga	15.0	9.0	Increasing
Ghod	10.5	13.5	Decreasing	Kadambayar	9.4	3.4	Increasing
Shivna	4.0	7	Decreasing	Vaitarna	10.0	3.5	Increasing
Karmana	18.0	20.4	Decreasing	Bhatsa	10.0	3.4	Increasing
	B.O.D. (mg/l)				B.O.D. (mg/l)		
River	2011	2010	Trend	River	2011	2010	Trend
Sirsa	15.0	8.0	Increasing	Pedhi	46.0	16.4	Increasing
Tansa	11.0	4.0	Increasing	Thirumanimuthar	83.7	54.0	Increasing
Manusmar	10.0	2.7	Increasing	Musi	145.0	110.0	Increasing
Suswa	38.0	30.0	Increasing	Panchaganga	67.5	28.0	Increasing
Harbora	12.0	3.5	Increasing	Churni	64.0	3.7	Increasing
Kalu	15.0	4.0	Increasing	Sarabanga	85.0	5.6	Increasing
Nambul	30.5	19	Increasing	Kali (W)	369.0	287	Increasing
Ram Rekha	15.0	3.5	Increasing	Matha Bhanga	90.0	5.4	Increasing
Kalinadi (E)	161.0	146	Increasing	Wardha	110.0	25.0	Increasing
Budhabalanga	22.0	2.2	Increasing	Mithi	175.0	75.0	Increasing
Vindyadhari	26.8	6.6	Increasing	Damanganga	354.0	32	Increasing
Betwa	104.0	78	Increasing	Vasista	340.0	5.0	Increasing
Jalangi	28.0	1.9	Increasing	Savitri	525.0	5.4	Increasing

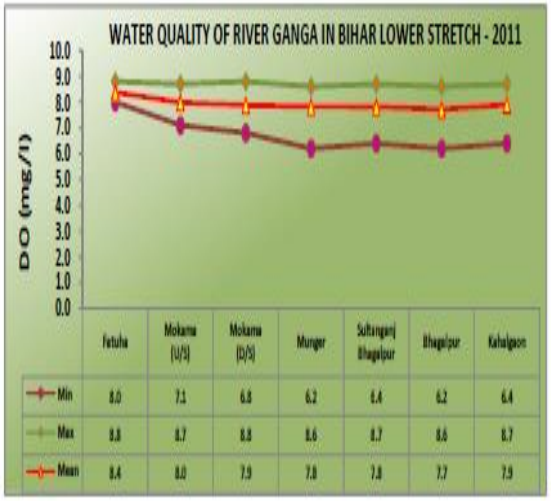
Source: Status of Water Quality in India-2011, CPCB

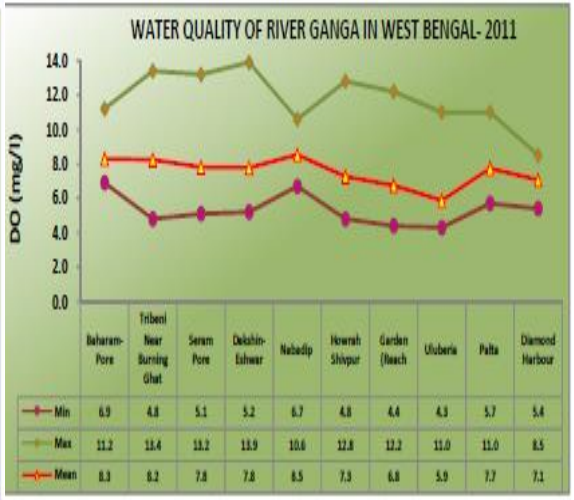




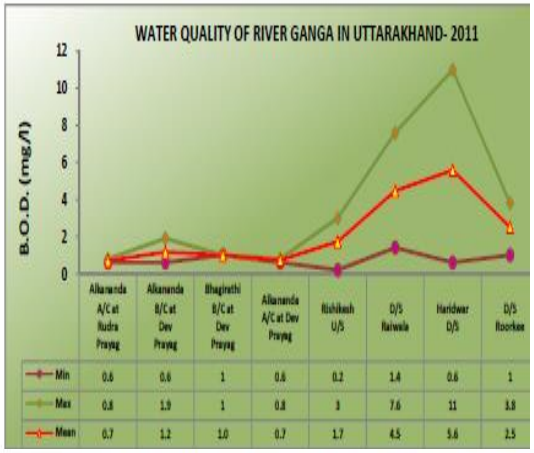


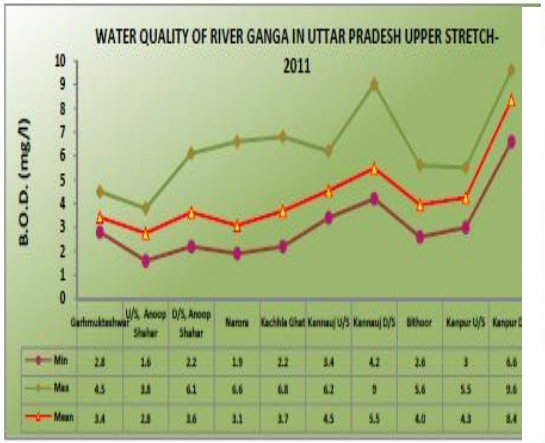


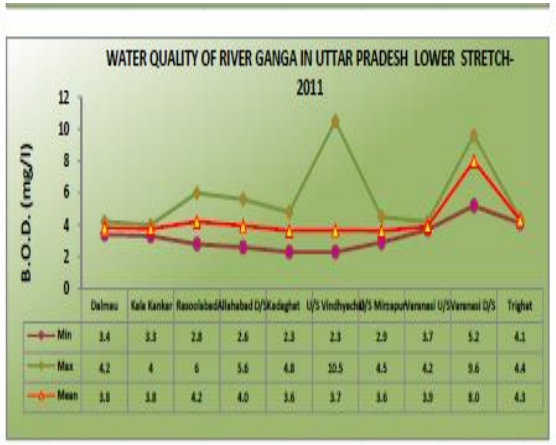


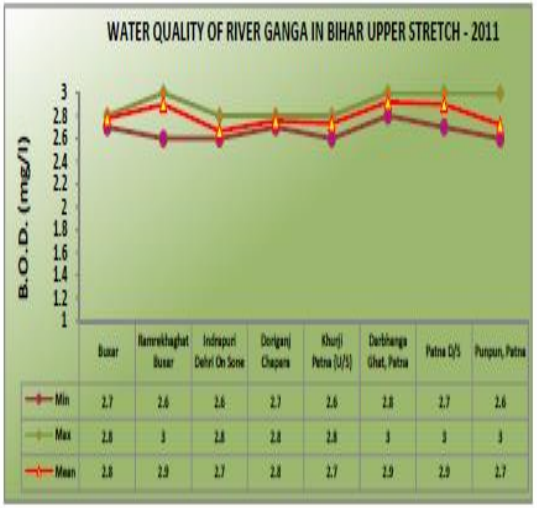


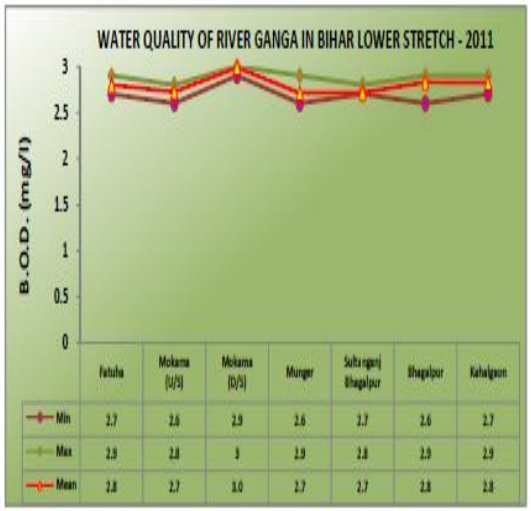
Use	Criteria (DO)
Drinking Water Source without conventional treatment but after disinfection	6mg/l or more
Outdoor bathing (Organised)	5mg/l or more
Drinking water source after conventional treatment and disinfection	4mg/l or more
Propagation of Wild life and Fisheries	4mg/l or more

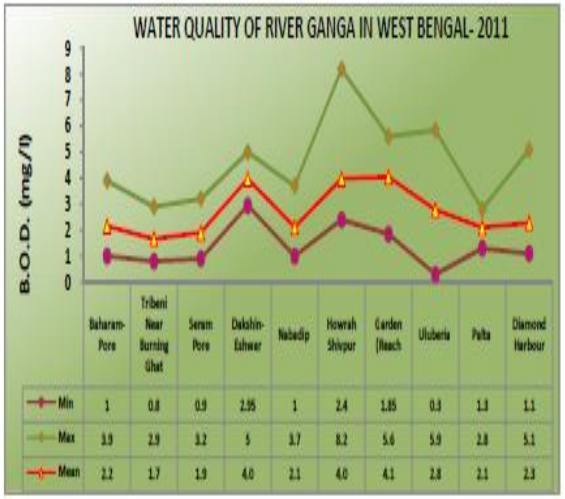




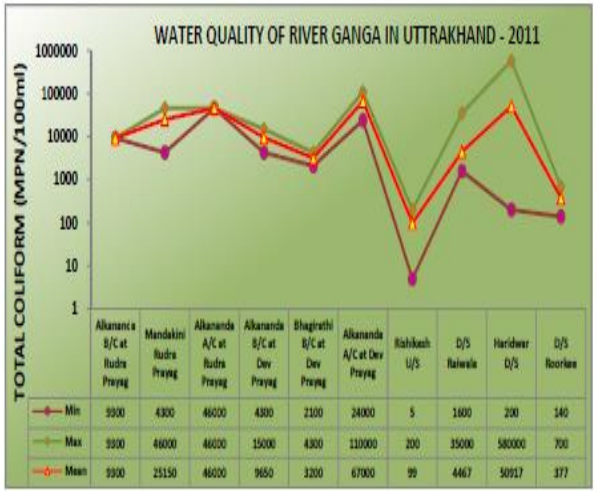


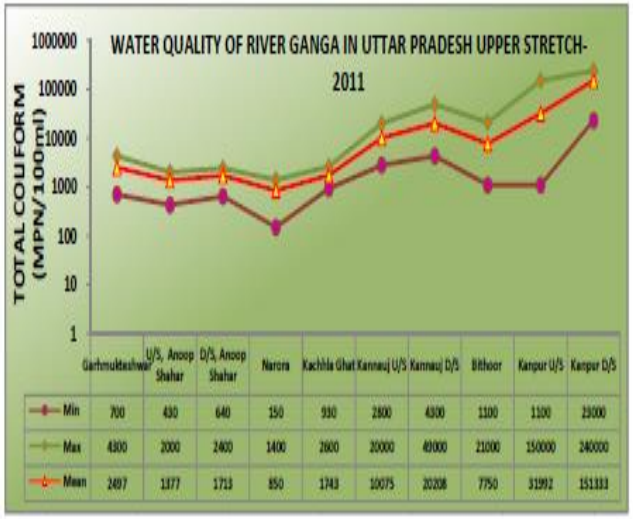


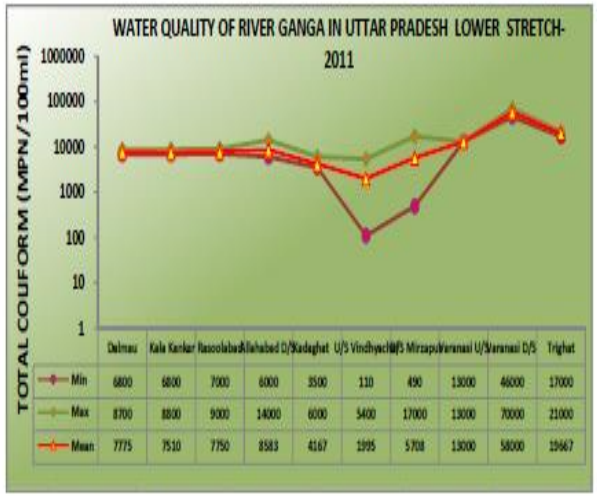


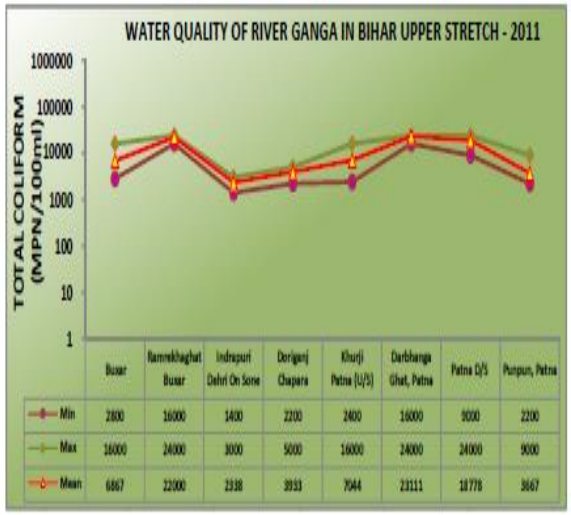


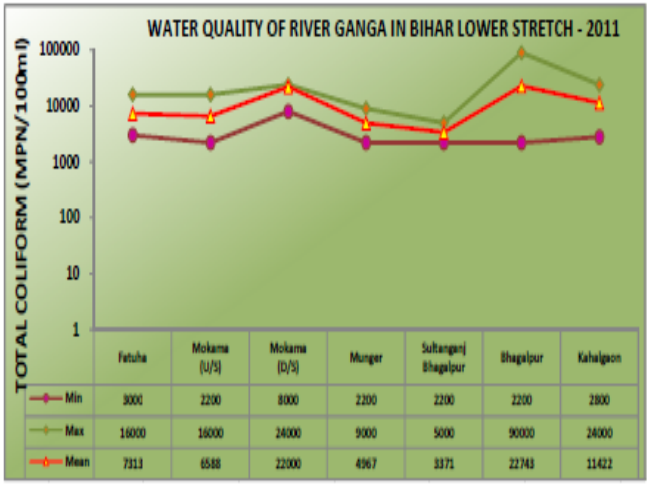
Use	Criteria (BOD5) at 20°C
Drinking Water Source without conventional treatment but after disinfection	2mg/l or less
Outdoor bathing (Organised)	3mg/l or less
Drinking water source after conventional treatment and disinfection	3mg/l or less

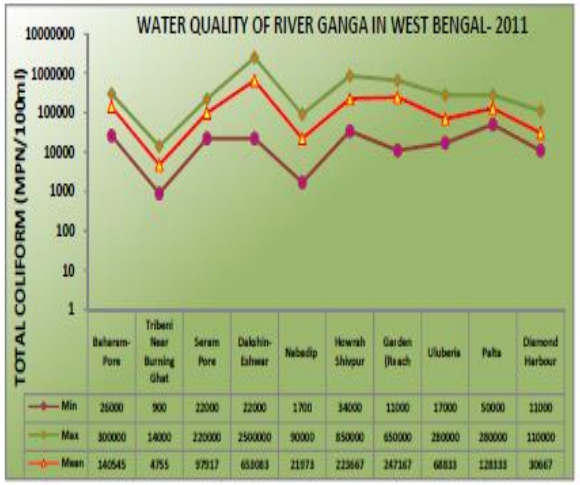




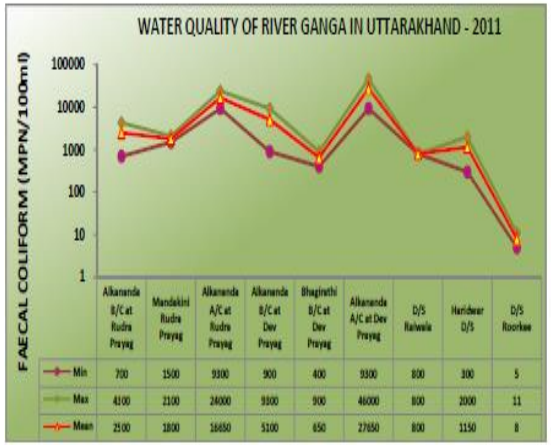


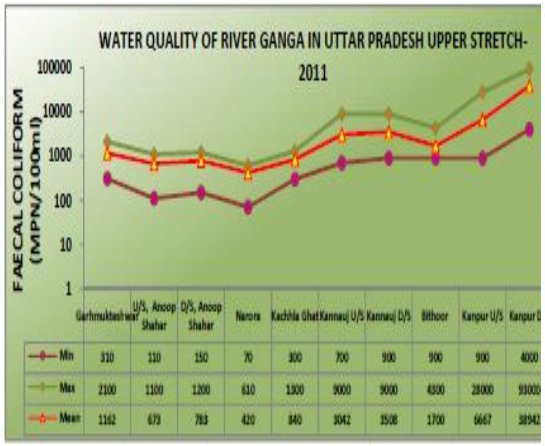


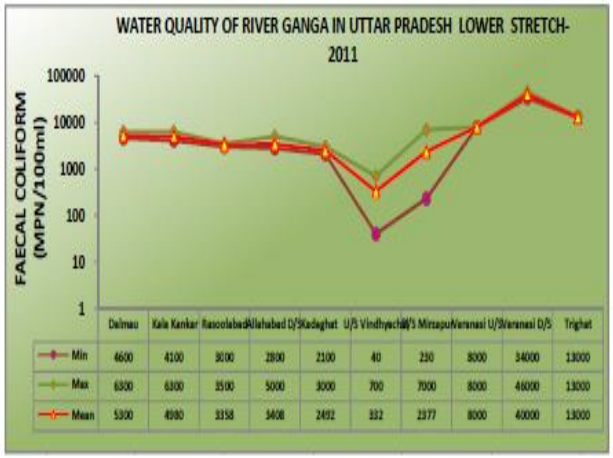


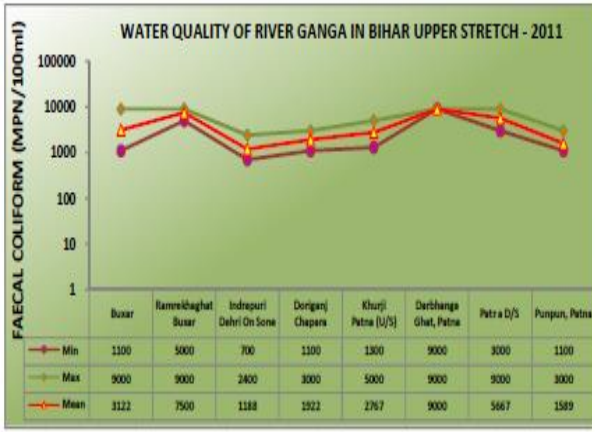


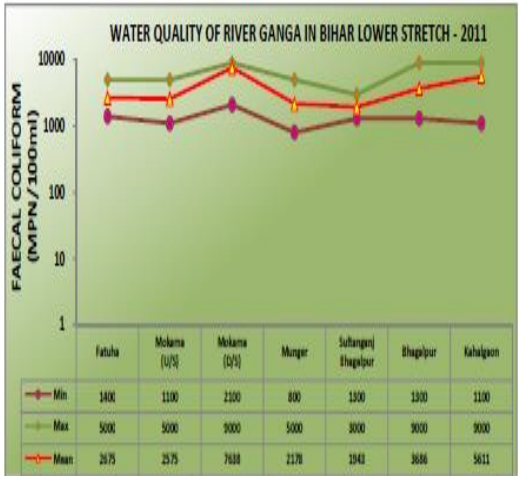
Designated-Best-Use	Criteria (TC) MPN/100 ml
Drinking Water Source without conventional treatment but after disinfection	•50 or less
Outdoor bathing (Organised)	•500 or less
Drinking water source after conventional treatment and disinfection	5000 or less

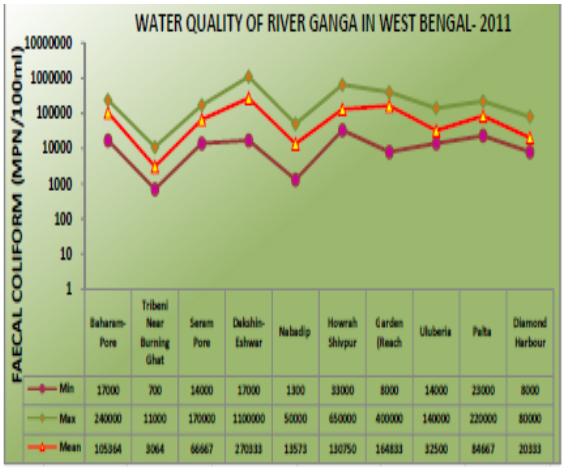

WATER QUALITY OF RIVER GANGA IN UTTARAKHAND - 2011
FAECAL COLIFORM (MPN/100ml)
100000
10000
1000
100
10
1
Alkananda B/C at Rudra Prayag
Mandakini Rudra Prayag
Alkananda A/C at Rudra Prayag
Alkananda B/C at Dev Prayag
Bhagirathi B/C at Dev Prayag
Alkananda A/C at Dev Prayag
D/S Kaliwala
Haridwar D/S
D/S Roorkee
Min 700 1500 9300 900 400 9300 800 300 5
Max 4100 2100 24000 9300 900 46000 800 2000 11
Mean 2500 1800 16650 5100 650 27650 800 1150 8

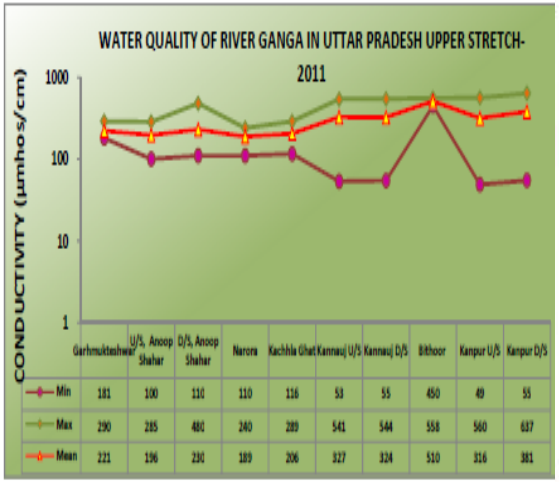

WATER QUALITY OF RIVER GANGA IN UTTAR PRADESH UPPER STRETCH- 2011
FAECAL COLIFORM (MPN/100ml)
100000
10000
1000
100
10
1
Garhmukteshwar
U/S, Anoop Shahar
D/S, Anoop Shahar
Narora
Kachhla Ghat
Kannauj U/S
Kannauj D/S
Bithoor
Kanpur U/S
Min 310 110 150 70 300 700 900 900 900 4000
Max 2100 1100 1200 610 1300 9000 9000 4300 28000 93000
Mean 1162 673 783 420 840 3042 3508 1700 6667 38942

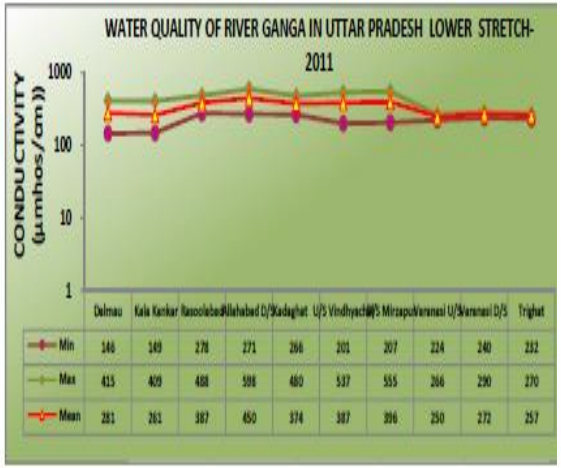

WATER QUALITY OF RIVER GANGA IN UTTAR PRADESH LOWER STRETCH- 2011
FAECAL COLIFORM (MPN/100ml)
100000
10000
1000
100
10
1
Dalmau
Kala Kankar
Rasoolabad
Allahabad D/S
Kadeghat
U/S Vindhyachal
D/S Mirzapur
Varanasi U/S
Varanasi D/S
Trighat
Min 6600 4100 3000 2800 2100 40 230 8000 34000 13000
Max 6300 6300 3500 5000 3000 700 7000 8000 46000 13000
Mean 5300 4980 3358 3408 2492 332 2377 8000 40000 13000

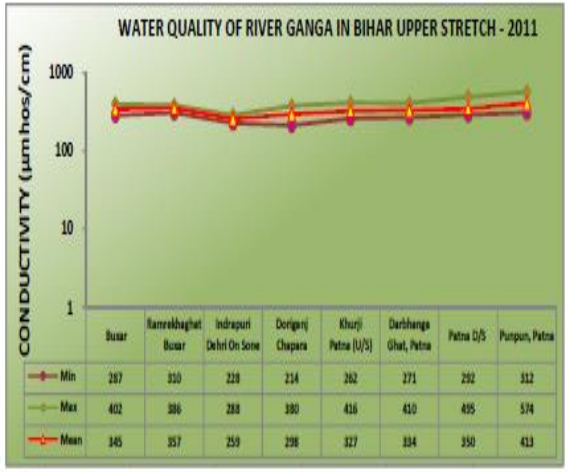

WATER QUALITY OF RIVER GANGA IN BIHAR UPPER STRETCH - 2011
FAECAL COLIFORM (MPN/100ml)
100000
10000
1000
100
10
1
Buxar
Ramrekhaghat Buxar
Indrapuri Dehri On Sone
Doriganj Chapara
Khurji Patna (U/S)
Darbhanga Ghat, Patna
Patna D/S
Punpun, Patna
Min 1100 5000 700 1100 1300 9000 3000 1100
Max 9000 9000 2400 3000 5000 9000 9000 3000
Mean 3122 7500 1188 1922 2767 9000 5667 1589

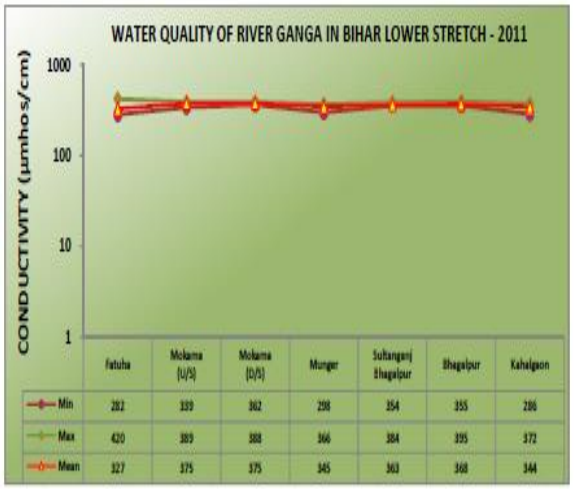

WATER QUALITY OF RIVER GANGA IN BIHAR LOWER STRETCH - 2011
FAECAL COLIFORM (MPN/100ml)
10000
1000
100
10
1
Fatuha
Mokama (U/S)
Mokama (D/S)
Munger
Sultanganj Bhagalpur
Bhagalpur
Kahalgaon
Min 1400 1100 2100 800 1300 1300 1100
Max 5000 5000 9000 5000 3000 9000 9000
Mean 2675 2575 7638 2178 1943 3686 5611

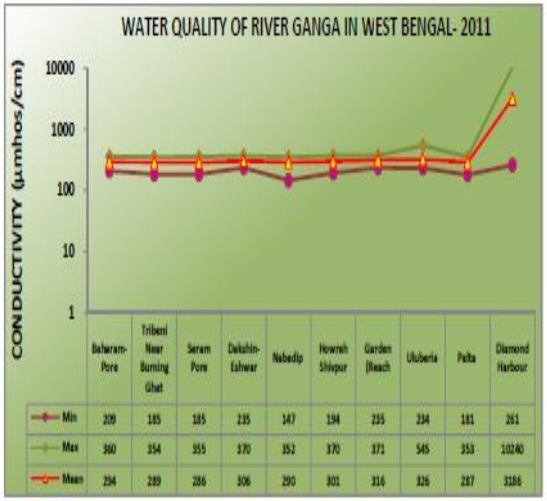

WATER QUALITY OF RIVER GANGA IN WEST BENGAL- 2011
FAECAL COLIFORM (MPN/100ml)
10000000
1000000
100000
10000
1000
100
10
1
Baharam-Pore
Tribeni Near Burning Ghat
Seram Pore
Dakshin-Eshwar
Nabadip
Howrah Shivpur
Garden (Reach
Uluberia
Palta
Diamond Harbour
Min 17000 700 14000 17000 1300 33000 8000 14000 23000 8000
Max 240000 11000 170000 1100000 50000 650000 400000 140000 220000 80000
Mean 105364 3064 66667 270333 13573 130750 164833 32500 84667 20333


WATER QUALITY OF RIVER GANGA IN UTTAR PRADESH UPPER STRETCH-2011
CONDUCTIVITY (µmhos/cm)
1000
100
10
1
Garhmukteshwar
U/S, Anoop Shahar
D/S, Anoop Shahar
Narora
Kachhla Ghat
Kannauj U/S
Kannauj D/S
Bithoor
Kanpur U/S
Kanpur D/S
Min 181 100 110 110 116 53 55 450 49 55
Max 290 285 480 240 289 541 544 558 560 637
Mean 221 196 230 189 206 327 324 510 316 381


WATER QUALITY OF RIVER GANGA IN UTTAR PRADESH LOWER STRETCH-2011
CONDUCTIVITY (µmhos/cm))
1000
100
10
1
Dalmau
Kala Kankar
Rasoolabad
Allahabad D/S
Kadaghat
U/S Vindhyachal
D/S Mirzapur
Varanasi U/S
Varanasi D/S
Trighat
Min 146 149 278 271 266 201 207 224 240 232
Max 415 409 488 598 480 537 555 266 290 270
Mean 281 261 387 450 374 387 396 250 272 257


WATER QUALITY OF RIVER GANGA IN BIHAR UPPER STRETCH - 2011
CONDUCTIVITY (µmhos/cm)
1000
100
10
1
Buxar
Ramrekhaghat Buxar
Indrapuri Dehri On Sone
Dorigunj Chapara
Khuriji Patna (U/S)
Darbhanga Ghat, Patna
Patna D/S
Punpun, Patna
Min 287 310 228 214 262 271 292 312
Max 402 386 288 380 416 410 495 574
Mean 345 357 259 298 327 334 350 413


WATER QUALITY OF RIVER GANGA IN BIHAR LOWER STRETCH - 2011
CONDUCTIVITY (µmhos/cm)
1000
100
10
1
Fatuha
Mokama (U/S)
Mokama (D/S)
Munger
Sultanganj Bhagalpur
Bhagalpur
Kahalgaon
Min 282 339 362 298 354 355 286
Max 420 389 388 366 384 395 372
Mean 327 375 375 345 363 368 344


WATER QUALITY OF RIVER GANGA IN WEST BENGAL- 2011
CONDUCTIVITY (µmhos/cm)
10000
1000
100
10
1
Baharam-Pore
Triveni Near Burning Ghat
Seram Pore
Dakshin-Eshwar
Nabadip
Howrah Shivpur
Garden Reach
Ulubaria
Palta
Diamond Harbour
Min 209 185 185 235 147 194 235 234 181 261
Max 360 354 355 370 352 370 371 545 353 10240
Mean 294 289 286 306 290 301 316 326 287 3186

MAHARASHTRA

Water Quality (surface water)

- 13 % is violating to DO (2175 observations points)
- 78% is not confirming to BOD (2267 observation points)
- FC and TC are confirming to the desired levels require in riverine environment.

Water Quality (ground water) (94 observation points)

- 66 % are not confirming to BOD
- 1 % are violating to Nitrate
- FC and TC are confirming to the desired levels required.

Water Quality (river water) (1759 observations points)

- 12 % are violating to DO
- 75% are not confirming to BOD
- FC and TC are confirming to the desired levels require in riverine environment

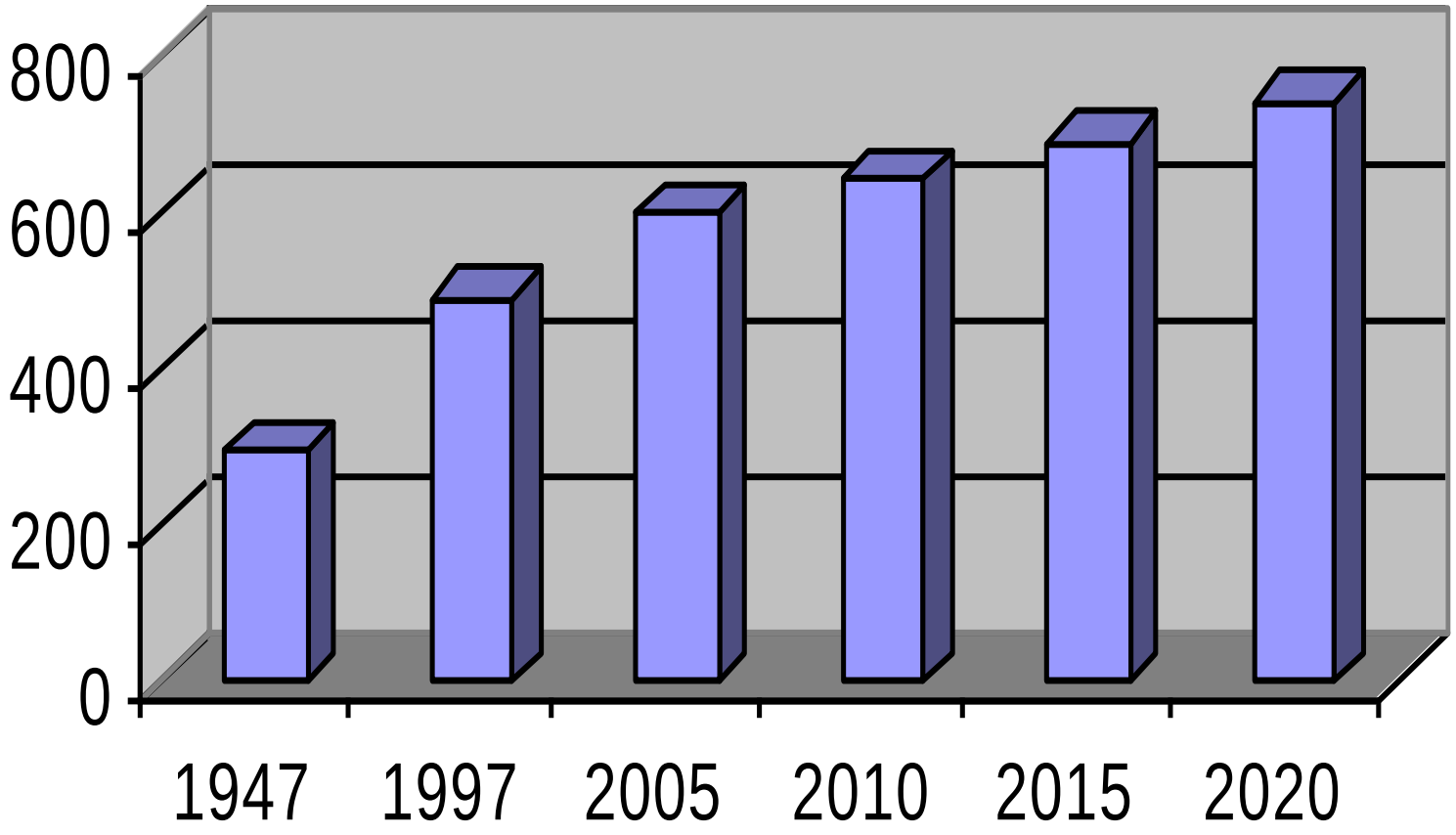
Municipal Solid Waste (MSW)

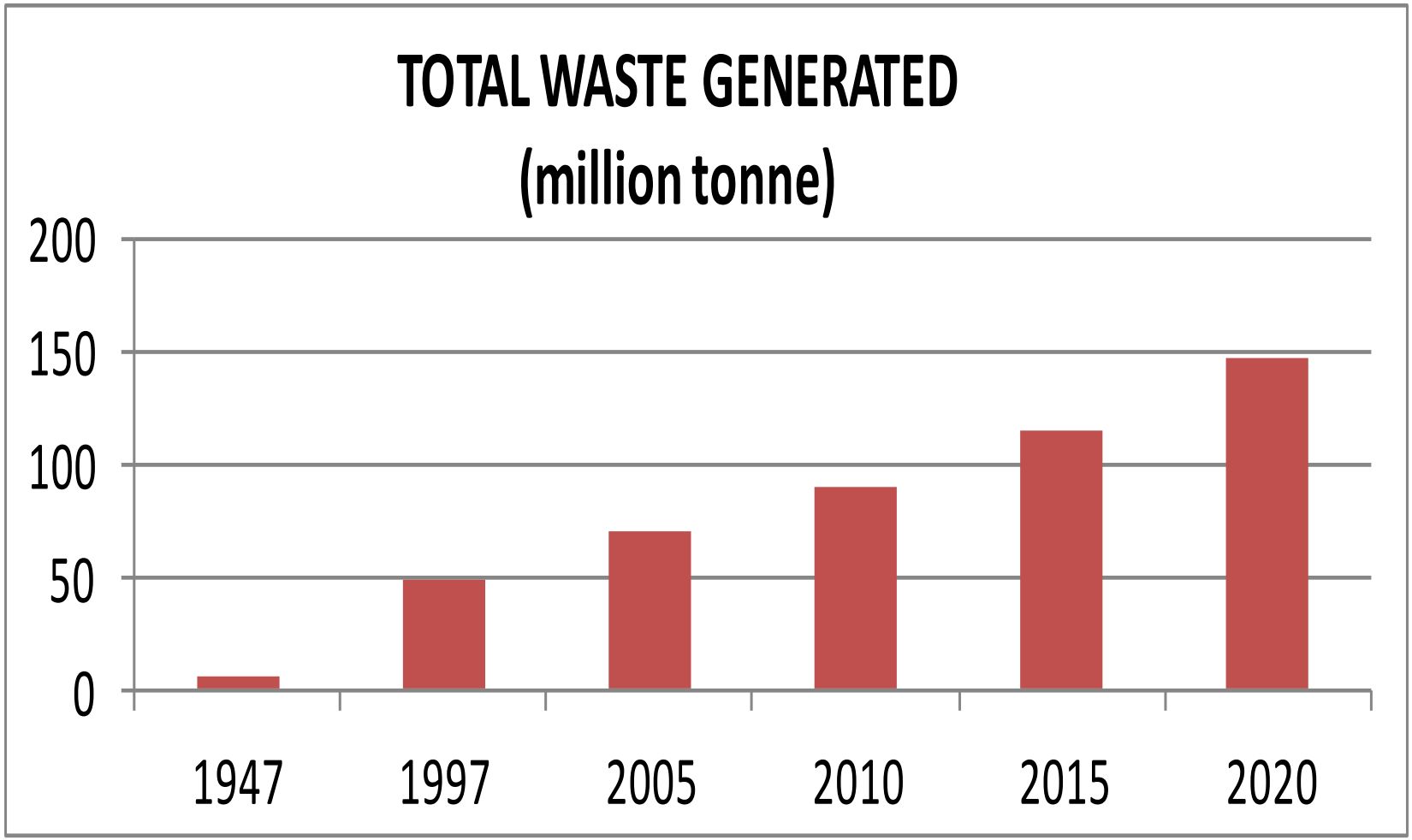
Municipal Solid Waste Generation in India

TOTAL QUANTITY OF SOLID WASTE PER DAY (TPD) OF THE COUNTRY	**1.15 LAKH TONNE GENERATED IN URBAN AREAS**	
		% OF TOTAL GARBAGE
WASTE GENERATED IN 6 MEGA CITIES	**21,100 TPD**	**18.35%**
WASTE GENERATED IN METRO CITIES (1 MILLION PLUS TOWNS)	**19,643 TPD**	**17.08%**
WASTE GENERATED IN OTHER CLASS-I TOWNS (0.1 MILLION PLUS TOWNS)	**42,635 TPD**	**37.07%**
	83,378 TPD	**72.5%**

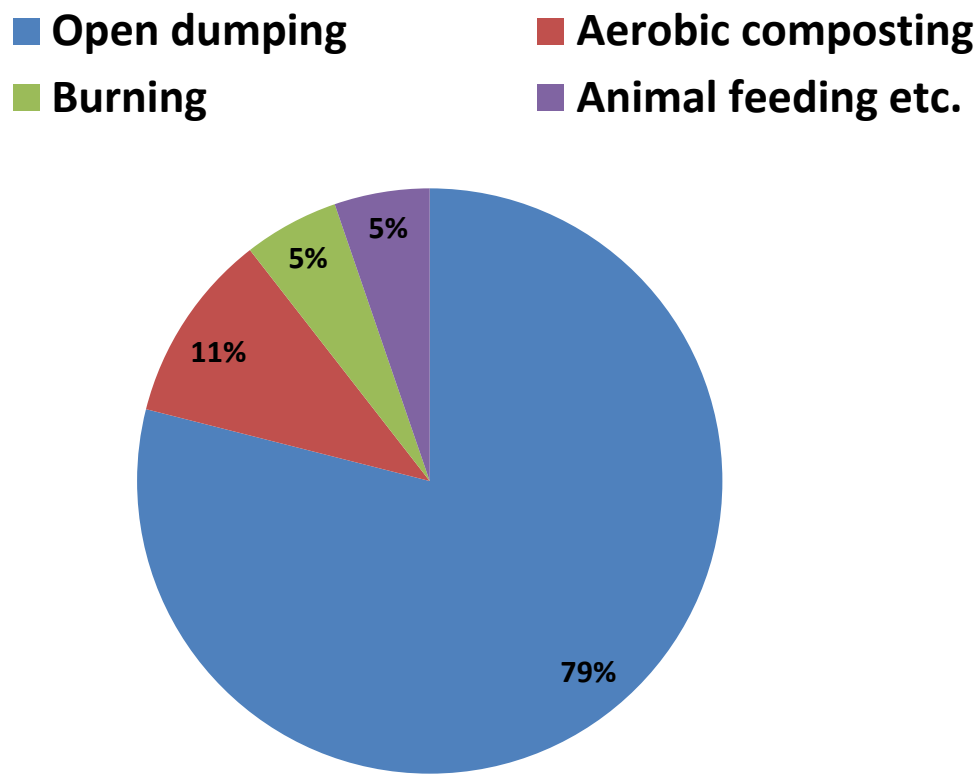
Per capita generation: 0.2-0.6 kg.
Collection efficiency: 90 % in metro and 50 % in smaller cities.

DAILY PER CAPITA WASTE GENERATION (gram)




TOTAL WASTE GENERATED
(million tonne)
200
150
100
50
0
1947
1997
2005
2010
2015
2020

Management of MSW in India



Source: Bhada, 2007

Open Dump: Health Effect

- Areas used for open dumping may be easily accessible to people, especially children, who are vulnerable to the physical (protruding nails or sharp edges) and chemical (harmful fluids or dust) hazards posed by wastes.
- Rodents, insects, and other vermin attracted to open dump sites may also pose health risks.
- Poisoning and chemical burns resulting from contact with small amounts of hazardous, chemical waste mixed with general waste during collection & transportation.
- Burns and other injuries can occur resulting from occupational accidents and methane gas exposure at waste disposal sites.
- Anaerobic decomposition of the organic fraction of the MSW produces foul odors such as H_2S and Mercaptans

Open Dump: Environmental Effects

Air pollution

- Dust generated from on-site vehicle movements, and placement of waste and materials

Water pollution

- Runoff from open dump sites containing chemicals may contaminate wells and surface water used as sources of drinking water
- Open dumping can also impact proper drainage of runoff, making areas more susceptible to flooding when wastes block ravines, creeks, culverts, and drainage basins & also contamination of groundwater resources and surface water from leachate emissions.

Soil Contamination

- Permanent or temporary loss of productive land

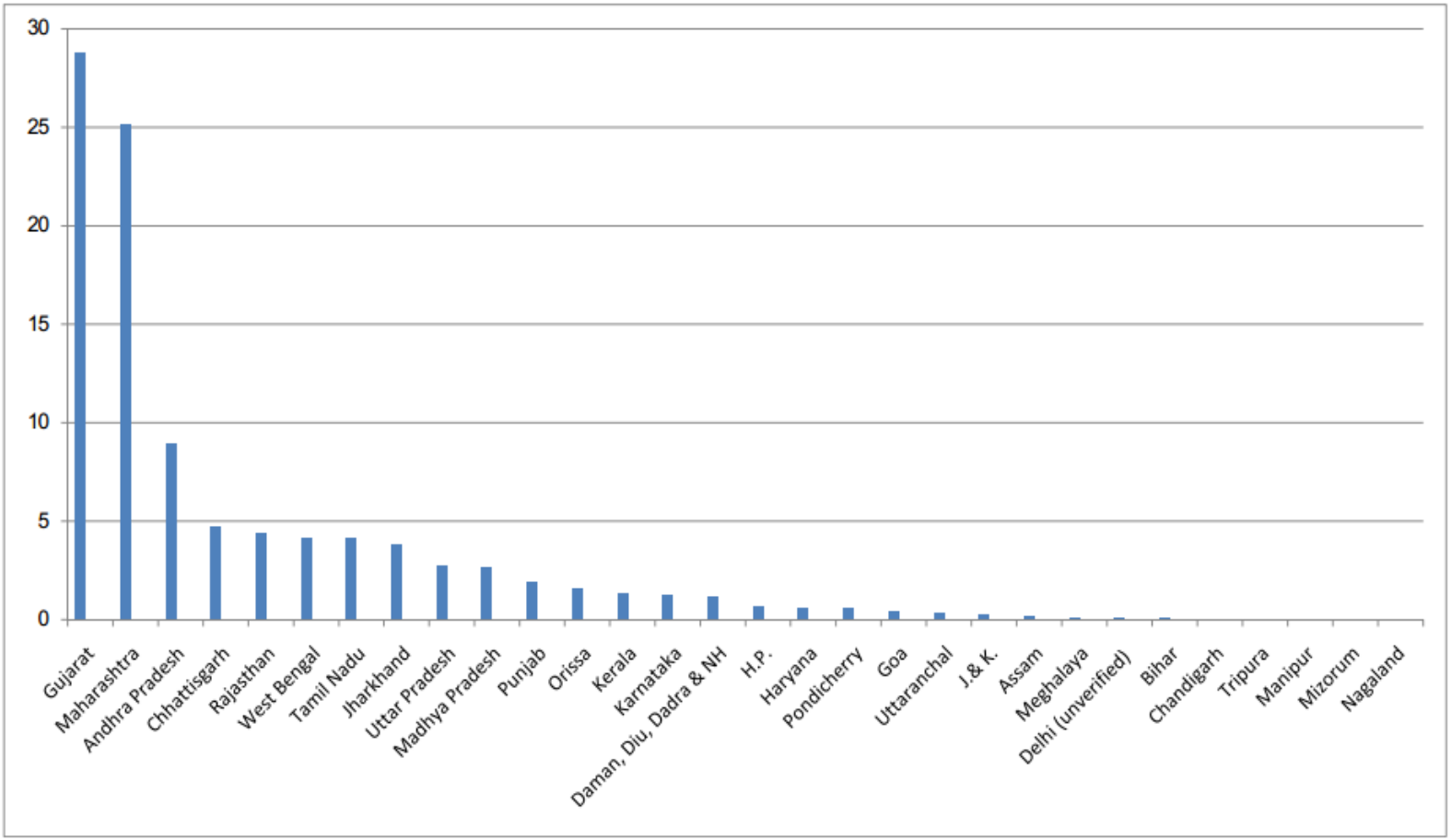
Global Warming and Climate Change

- The waste in the dumping ground undergoes various anaerobic reactions produces offensive green house gases such as CO_2, CH_4 etc. These gases are contributing potentially to Global Warming & Climate Change phenomenon

Hazardous Waste Management India

- **36,165 nos. of hazardous waste generating industries, generating 62,32,507 metric tonnes of hazardous wastes every year (CPCB, 2009)**
- **41,523 number of hazardous waste generating industries in India and their hazardous waste generation is ~7.90 million tonnes per annum (Latest information on CPCB website, after 2009, no date available)**

Percentage Contribution towards HW Generation by Different States / UTs



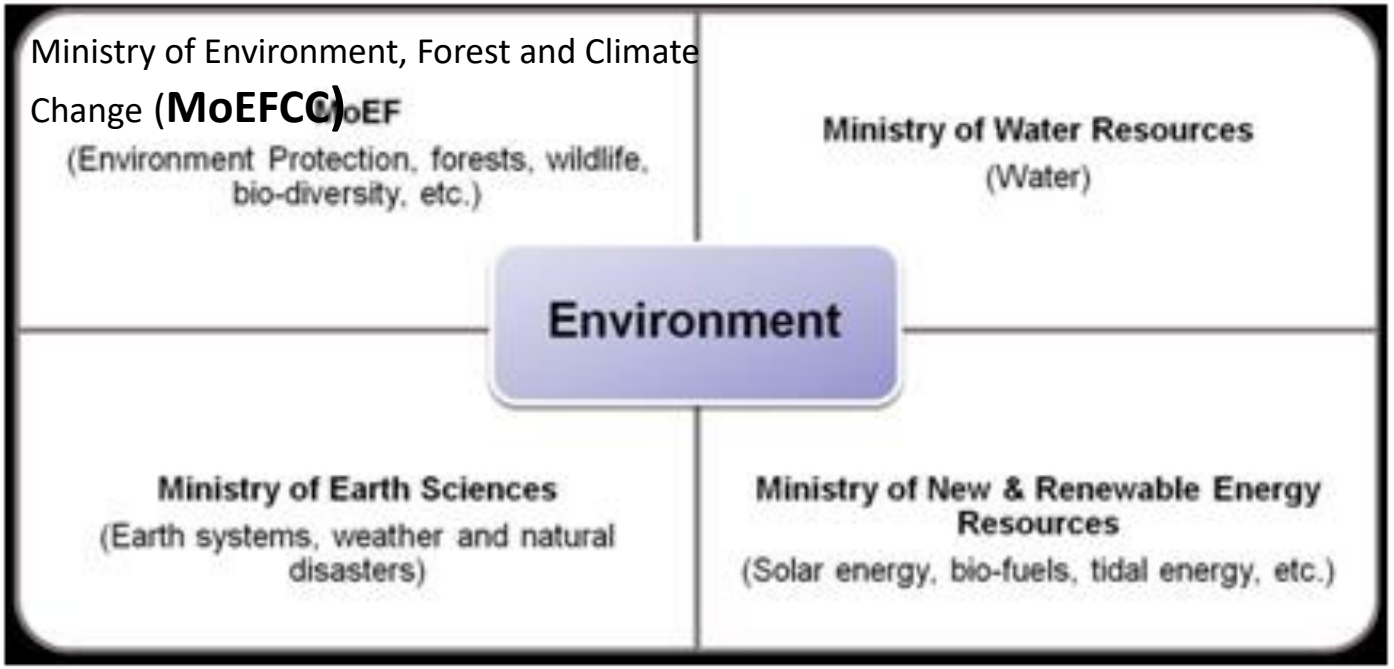
HW Generating Industries & HW Generation – Comparative Figures

S.No.	State	HW generating Industries (No.s) as per HWM Rules, 2000/2003	Total HW generation in TPA
1.	AP	1532	507046
2.	Assam	23	4,000
3.	Bihar	31	Not given
4.	Chandigarh	271	8,425
5.	Delhi	1777	17,000
6	Goa	49	Not Provided
7.	Gujarat	6052	12, 07,000
8.	Haryana	889	14,972
9.	Himachal	575	Not given
10.	Karnataka	1589	92,013
11.	Kerala	423	83,530
12.	Maharashtra	4571	14,07,480
13.	MP	753	Not given
14.	Orissa	257	74,918
15.	J & K	207	Not provided

HW Generating Industries & HW Generation – Comparative Figures

S. No.	Name of the State	No. of HW Industries as per HWM Rules, 2000/2003	Total HW generation in TPA
16.	Pondicherry	66	30,320
17.	Punjab	1448	15,769
18.	Rajasthan	512	1,83,737
19.	Tamilnadu	2177	1,81, 624
20.	Uttarpradesh	1633	82,375
21.	West Bengal	568	Not given
22	Chattisgarh	149	Not given
23.	Mizoram	Nil	Nil
24.	Meghalaya	39	37, 412
25.	Nagaland	03	448
26.	Daman, Diu & DNH	598	Not given
27.	Jharkhand	169	Not given
28.	Uttaranchal	137	Not given
29.	Manipur	Nil	-
30.	Tripura	187	Not given

Environmental Regulators in India



Source: Environmental Law Institute

Legislative Powers

Union	• Regulation and development of inter-state rivers
State	• Land • Water (Supply, irrigation, storage, water power)
Concurrent	• Forests • Wildlife

Source: Environmental Law Institute

Important Environnemental Legislations in India

Environment Protection	•Water (Prevention and Control of Pollution) Act, 1974 •Air (Prevention and Control of Pollution) Act 1981 •Environment Protection Act, 1986
Forests	• Indian Forest Act, 1927 • Forest (Conservation) Act, 1980
Biodiversity	• Biological Diversity Act, 2002
Coastal Ecology	• Declaration of Coastal Stretches as Coastal Regulation Zone (CRZ) Notification, 1991

Source: Environmental Law Institute

Important Environmental Legislations in India

Wildlife	• Wildlife Protection Act, 1972
Public Liability Insurance	• Public Liability Insurance Act, 1991
Tribunals / Authorities	• National Environment Tribunal Act, 1995 • National Environment Appellate Authority Act, 1997 • National Green Tribunal Act, 2010

Source: Environmental Law Institute

Water Pollution Act

The Water (Prevention and Control of Pollution) Act, 1974 & Rules:

- Prevention and control of water pollution and for the maintaining or restoring of wholesomeness of water in the country.
- Establishment of boards/ authorities at Central and State level, i.e., Central Pollution Control Board (CPCB), and State Pollution Control Boards (SPCBs) / Pollution Control Committees (PCCs).
- Mandates prior approval of SPCB / PCC for operating, establishing and expanding industrial activities leading to discharge of industrial effluents.
- Empowers SPCB / PCC to enter into industrial plants, factories, etc., and inspect plant, records, registers and documents.
- Empowers SPCB / PCC to take samples of industrial effluents and analysis of same.
- Provides for Criminal liabilities.

Source: Environmental Law Institute

Role of CPCB

- The Central Board may perform all or any of the following functions:
  - Advise the Central Government on any matter concerning the prevention and control of water pollution;
  - Co-ordinate the activities of the State Boards and resolve disputes among them;
  - Provide technical assistance and guidance to the State Boards, carry out and sponsor investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution;
  - Plan and organise the training of persons engaged or to be engaged in programmes for the prevention, control or abatement of water pollution on such terms and conditions as the Central Board may specify;
  - Organise through mass media a comprehensive programme regarding the prevention and control of water pollution;
  - Collect, compile and publish technical and statistical data relating to water pollution and the measures devised for its effective prevention and control and prepare manuals, codes or guides relating to treatment and disposal of sewage and trade effluents and disseminate information connected therewith;
  - Lay down, modify or annul, in consultation with the State Government concerned, the standards for a stream or well;
  - Plan and execute a nation-wide programme for the prevention, control or abatement of water pollution;

Role of SPCB

- Plan a comprehensive programme for the prevention, control or abatement of pollution of streams and wells in the State and to secure the execution thereof;
- Advise the State Government on any matter concerning the prevention, control or abatement of water pollution;
- Collect and disseminate information relating to water pollution and the prevention. control or-abatement thereof;
- Encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution;
- Collaborate with the Central Board in organizing the training of persons engaged or to be engaged in programmes relating to prevention, control or abatement of water pollution and to organize mass education programmes relating thereto;
- Inspect sewage or trade effluents, works and plants for the treatment of sewage and trade effluents and to review plans, specifications or other data relating to plants

Role of SPCB

- Evolve economical and reliable methods of treatment of sewage and trade effluents, having regard to the peculiar conditions of soils, climate and water resources of different regions and more especially the prevailing flow characteristics of water in streams and wells which render it impossible to attain even the minimum degree of dilution;
- Lay down standards of treatment of sewage and trade effluents to be discharged into any particular stream taking into account the minimum fair weather dilution available in that stream and the tolerance limits of pollution permissible in the water of the stream, after the discharge of such effluents;
- **To make, vary or revoke any order-**
  - *(i)* for the prevention, control or abatement of discharges of waste into streams or wells;
  - *(ii)* requiring any person concerned to construct new systems for the disposal of sewage and trade effluents or to modify, alter or extend any such existing system or to adopt such remedial measures as are necessary to prevent control or abate water pollution;
- Advise the State Government with respect to the location, of any industry the carrying on of which is likely to pollute a stream or well
- Evolve methods of utilization of sewage and suitable trade effluents in agriculture;

The Water (Prevention and Control of Pollution) Cess Act, 1977

- To provide for the levy and collection of a cess on water consumed by persons operating and carrying on certain types of industrial activities.

- Cess is collected with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974.

- The Act amended in 2003.

Water (Prevention and Control of Pollution) Cess Act, 1977 amended 2003

"SCHEDULE II
(see section 3)

Purpose for which water is consumed	Maximum rate under sub-section (2)◆ of section 3	Maximum rate under ◆Sub-section (2A) of Section 3
1. Industrial cooling, spraying◆◆◆ in mine pits or boiler feeds	Five paise per kilolitre	Ten◆ paise Per kilolitre.
2. Domestic purpose	Two paise per kilolitre	Three paise per kilolitre.
3. Processing whereby water gets polluted and the pollutants are ◆ a) easily biodegradable ; or b) non ◆ toxic; or c) both non toxic and easily bio degradable.	Ten paise per kilolitre	Twenty paise per kilolitre.
4. Processing whereby water gets polluted◆ and the pollutants are ◆ a) not easily biodegradable; or b) toxic; or c) both toxic and not easily biodegradable.	Fifteen paise per kilolitre	Thirty paise per kilolitre."

All industries consuming water less than 10 kilo liters per day are exempted from the levy of Cess specify in this notification.

No exemption shall be applicable in case of industries generating" hazardous wastes" as defined in the Hazardous waste (Management and Handling) Rules,1989,made under the Environment(Protection) Act,1986

Water (Prevention and Control of Pollution) Cess Act, 1977

SCHEDULE I

- Ferrous metallurgical industry.
- Non-ferrous metallurgical industry.
- Mining industry.
- Ore processing industry.
- Petroleum industry.
- Petro-chemical industry
- Chemical industry.
- Ceramic industry.
- Cement industry.
- Textile industry. [including cotton synthetic and semi-synthetic fibres manufactured from these fibres];
- Paper industry.
- Fertilizer industry.
- Coal (including coke) industry.
- Power (thermal, diesel) and [Hydel] generating industry
- Processing of animal or vegetable products industry [including processing of milk, meat, hides and skins, all agricultural products and their wastes].
- Engineering industry

Air Pollution

Air (Prevention and Control of Pollution) Act 1981

- Prevention, control and abatement of air pollution.
- Empowers CPCB/ SPCBs/ PCCs to take appropriate actions in this regard.
- Declaration of certain areas as ‘air pollution control areas’.
- Prior approval of SPCB / PCC required for operating, establishing, and expanding industrial activities in air pollution control areas leading to discharge of emissions and pollutants in the air.
- Provisions relating to entry and inspection.
- Powers to take samples of ambient air, stack emissions, etc.
- Criminal Liabilities.

Source: Environmental Law Institute

NATIONAL AMBIENT AIR QUALITY STANDARDS
CENTRAL POLLUTION CONTROL BOARD
NOTIFICATION

New Delhi, the 18th November, 2009

No. B-29016/20/90/PCI-L—In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No.14 of 1981), and in supersession of the Notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect, namely:-

NATIONAL AMBIENT AIR QUALITY STANDARDS

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual*	50	20	- Improved West and Gaeke
		24 hours**	80	80	-Ultraviolet fluorescence
2	Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual*	40	30	- Modified Jacob & Hochheiser (Na-Arsenite)
		24 hours**	80	80	- Chemiluminescence
3	Particulate Matter (size less than 10µm) or PM_{10} $\mu g/m^3$	Annual*	60	60	- Gravimetric - TOEM
		24 hours**	100	100	- Beta attenuation
4	Particulate Matter (size less than 2.5µm) or $PM_{2.5}$ $\mu g/m^3$	Annual*	40	40	- Gravimetric - TOEM
		24 hours**	60	60	- Beta attenuation
5	Ozone (O_3) $\mu g/m^3$	8 hours**	100	100	- UV photometric - Chemilminescence
		1 hour**	180	180	- Chemical Method
6	Lead (Pb) $\mu g/m^3$	Annual*	0.50	0.50	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours**	1.0	1.0	
7	Carbon Monoxide (CO) mg/m^3	8 hours**	02	02	- Non Dispersive Infra Red (NDIR) spectroscopy
		1 hour**	04	04	
8	Ammonia (NH_3) $\mu g/m^3$	Annual*	100	100	-Chemiluminescence
		24 hours**	400	400	-Indophenol blue method

(1)	(2)	(3)	(4)	(5)	(6)
9	Benzene (C_6H_6) $\mu g/m^3$	Annual*	05	05	- Gas chromatography based continuous analyzer - Adsorption and Desorption followed by GC analysis
10	Benzo(a)Pyrene (BaP) - particulate phase only, ng/m^3	Annual*	01	01	- Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As), ng/m^3	Annual*	06	06	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni), ng/m^3	Annual*	20	20	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note. — Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

"…the environment cannot be improved in conditions of poverty, unless we are in a position to provide employment and purchasing power for the daily necessities of the tribal people and those who live in around our jungles, we cannot prevent them from combing the forests for food and livelihood; from poaching and from despoiling the vegetation. How can we speak to those who live in villages and slums about keeping the oceans, the rivers and the air clean when their own lives are contaminated at the source?"

-- *Indira Gandhi, United Nations Conference on the Human Environment, Stockholm, 1972*

Environment Protection Act, 1986 ("EPA")

- Enacted pursuant to the UN Conference on the Human Environment held in 1972.

- An umbrella legislation for environment protection and improvement through regulation of developmental activities.

- Empowers Ministry of Environment, Forest and Climate Change ("MoEFCC") with powers relating to formulation of nation-wide planning, policymaking and co-ordination of actions taken by State Governments

Source: Environmental Law Institute

MoEFCC Powers under EPA

EPA enables MoEFCC to:

- Lay down standards for environmental quality; emissions or discharge of environmental pollutants from various sources.
- Devise procedures for handling hazardous substances.
- Formulate rules for locating industry.
- Mandates compulsory reporting of environment pollution by industry.
- Provide for recovery of costs of cleanup from the polluter.

Bhopal disaster, 1984

- Deaths: At least 3,787; over 16,000 claimed
- Injuries: At least 558,125
- Union carbide compensation: US $470 million

Deepwater Horizon oil spill

or **BP oil spill**, or the **BP oil disaster or** the **Gulf of Mexico oil spill**

Location: Gulf of Mexico near Mississippi River Delta, United States

Casualties: 11 dead

Spill date: 20 April – 15 July 2010
Well officially sealed: 19 September 2010

Operator: Transocean under contract for BP

Spill characteristics

Volume: 4.9 million barrels (780,000 cubic meters)±10%

Area: 6,500 to 180,000 km^2

In November 2012, BP and the United States Department of Justice settled federal criminal charges with BP pleading guilty to 11 counts of manslaughter, two misdemeanors, and a felony count of lying to Congress.

BP also agreed to four years of government monitoring of its safety practices and ethics, and the Environmental Protection Agency announced that BP would be temporarily banned from new contracts with the US government.

BP and the Department of Justice agreed to a record-setting $4.525 billion in fines and other but further legal proceedings not expected to conclude until 2014 are ongoing to determine payouts and fines under the Clean Water Act and the Natural Resources Damage Assessment.

As of February 2013, criminal and civil settlements and payments to a trust fund had cost the company $42.2 billion.

In July 2015, BP agreed to pay $18.7 billion dollars in fines, the largest corporate settlement in U.S. history.

Umbrella framework under Environment Protection Rules, 1986

Land use regulation

- Declaration of ecologically fragile and historically significant areas as 'No-development zones', such as, Taj Trepezium near Taj Mahal, etc.

Waste management

- Hazardous and Other Wastes (Management &Transboundary Movement) Rules, 2016
- Bio-Medical Waste Management Rules, 2016
- Solid Waste Management Rules, 2016
- Construction and Demolition Waste Management Rules, 2016
- Plastic Waste Management Rules 2016

Environment impact assessment ("EIA")

- Environment Impact Assessment Notification, 2006

Regulation of developmental activities in coastal stretches

- Coastal Regulation Zone Notification, 1991 ("CRZ Notification")

Source: Environmental Law Institute

Umbrella framework under Environment Protection Rules, 1986

Management of Chemicals

- Manufacture, Storage, and Import of Hazardous Chemical Rules, 1989
- Ozone Depleting Substances (Regulation and Control) Rules, 2000
- The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996
- Rules for the Manufacture, Use, Import, Export and Storage of Hazardous micro-organisms Genetically engineered organisms or cells, 1989

Noise Pollution

- Noise Pollution (Regulation & Control) Rules, 2000

Eco-marks Scheme

- Scheme on Labeling of Environment Friendly Products (ECOMARK), 1991
- The criteria for labeling Cosmetics as Environment Friendly Products, 1992

Electronic Waste

- E-waste (Management) Rules, 2016

Others

- Batteries (Management and Handling) Rules, 2001
- The Recycled Plastics Manufacture and Usage Rules, 1999

Source: Environmental Law Institute

Solid Waste Management Rules, 2016

- The objective was to make every municipal authority responsible for the implementation of the various provisions of the Rules within its territorial area and also to develop an effective infrastructure for collection, storage, segregation, transportation, processing and disposal of Municipal Solid Wastes.

Legal Framework-MSW

As per the Rules, the citizens are responsible for

(1) Every waste generator shall,-

(a) segregate and store the waste generated by them in three separate streams namely bio-degradable, non biodegradable and domestic hazardous wastes in suitable bins and handover segregated wastes to authorised waste pickers or waste collectors as per the direction or notification by the local authorities from time to time;

(b) wrap securely the used sanitary waste like diapers, sanitary pads etc., in the pouches provided by the manufacturers or brand owners of these products or in a suitable wrapping material as instructed by the local authorities and shall place the same in the bin meant for dry waste or non- bio-degradable waste;

(c) store separately construction and demolition waste, as and when generated, in his own premises and shall dispose off as per the Construction and Demolition Waste Management Rules, 2016; and

(d) store horticulture waste and garden waste generated from his premises separately in his own premises and dispose of as per the directions of the local body from time to time

Legal Framework-MSW

(2) No waste generator shall throw, burn or burry the solid waste generated by him, on streets, open public spaces outside his premises or in the drain or water bodies.

(3) All waste generators shall pay such user fee for solid waste management, as specified in the bye-laws of the local bodies

(4) No person shall organise an event or gathering of more than one hundred persons at any unlicensed place without intimating the local body, at least three working days in advance and such person or the organiser of such event shall ensure segregation of waste at source and handing over of segregated waste to waste collector or agency as specified by the local body.

(5) Every street vendor shall keep suitable containers for storage of waste generated during the course of his activity such as food waste, disposable plates etc.

(6) All resident welfare and market associations shall, within one year from the date of notification of these rules and in partnership with the local body ensure segregation of waste at source by the generators as prescribed in these rules, facilitate collection of segregated waste in separate streams, handover recyclable material to either the authorised waste pickers or the authorised recyclers. The bio-degradable waste shall be processed, treated and disposed off through composting or bio-methanation within the premises as far as possible. The residual waste shall be given to the waste collectors or agency as directed by the local body.

(7) All gated communities and institutions with more than 5,000 sqm area shall, same as above

(8) Same for hotels and restaurants as above

Standards for disposal of treated leachate

S.No	Parameter	Standards (Mode of Disposal)		
		Inland surface water	Public sewers	Land disposal
1.	Suspended solid, mg/1, max	100	600	200
2.	Dissolved solids (inorganic) mg/1, max	2100	2100	2100
3.	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
4.	Ammonical nitrogen (as N), mg/1, max	50	50	-
5.	Total Kjeldahl nitrogen (as N), mg/1, max.	100	-	-
6.	Biochemical oxygen demand (3 days at 27^0 C_ max. (mg/1)	30	350	100
7.	Chemical oxygen demand, mg/1, max.	250	-	-
8.	Arsenic (as As), mg/1, max	0.2	0.2	0.2
9.	Mercury (as Hg), mg/1, max	0.01	0.01	-
10.	Lead (as Pb), mg/1, max	0.1	1.0	-
11.	Cadmium (as Cd), mg/1, max	2.0	1.0	-
12.	Total Chromium (as Cr), mg/1, max.	2.0	2.0	-
13.	Copper (as Cu), mg/1, max	3.0	3.0	-
14.	Zinc (as Zn), mg/1, max	5.0	15	-
15.	Nickel (as Ni), mg/1, max	3.0	3.0	-
16.	Cyanide (as CN), mg/1, max	0.2	2.0	0.2
17.	Chloride (as Cl), mg/1, max	1000	1000	600
18.	Fluoride (as F), mg/1, max	2.0	1.5	-
19.	Phenolic compounds (as C_6H_5OH) mg/1, max.	1.0	5.0	-

Compost Standards

Parameters	Organic Compost (FCO 2009)	Phosphate Rich Organic Manure (FCO 2013)
(1)	(2)	(3)
Arsenic (mg/Kg)	10.00	10.00
Cadmium (mg/Kg)	5.00	5.00
Chromium (mg/Kg)	50.00	50.00
Copper (mg/Kg)	300.00	300.00
Lead (mg/Kg)	100.00	100.00
Mercury (mg/Kg)	0.15	0.15
Nickel (mg/Kg)	50.00	50.00
Zinc (mg/Kg)	1000.00	1000.00
C/N ratio	<20	Less than 20:1
pH	6.5-7.5	(1:5 solution) maximum 6.7
Moisture, percent by weight, maximum	15.0-25.0	25.0
Bulk density (g/cm^3)	<1.0	Less than 1.6
Total Organic Carbon, per cent by weight, minimum	12.0	7.9

Compost Standards

Total Nitrogen (as N), per cent by weight, minimum	0.8	0.4
Total Phosphate (as $P_2 0_5$) percent by weight, minimum	0.4	10.4
Total Potassium (as $K_2 0$), percent by weight, minimum	0.4	-
Colour	Dark brown to black	-
Odour	Absence of foul Odor	-
Particle size	Minimum 90% material should pass through 4.0 mm IS sieve	Minimum 90% material should pass through 4.0 mm IS sieve
Conductivity (as dsm-1), not more than	4.0	8.2

* Compost (final product) exceeding the above stated concentration limits shall not be used for food crops. However, it may be utilized for purposes other than growing food crops.

Time frame for implementation

Identification of suitable sites for setting up solid waste processing facilities	1 year
Identification of suitable sites for setting up common regional sanitary landfill facilities for suitable clusters of local authorities under 0.5 million population and for setting up common regional sanitary landfill facilities or stand alone sanitary landfill facilities by all local authorities having a population of 0.5 million or more	1 year
Procurement of suitable sites for setting up solid waste processing facility and sanitary landfill facilities	2 year
Enforcing waste generators to practice segregation of bio degradable, recyclable, combustible, sanitary waste domestic hazardous and inert solid wastes at source ,	2 years
Ensure door to door collection of segregated waste and its transportation in covered vehicles to processing or disposal facilities. Ensure separate storage, collection and transportation of construction and demolition wastes	2 years

Time frame for implementation

Setting up solid waste processing facilities by all local bodies having 100,000 or more population	2 years
Setting up solid waste processing facilities by local bodies and census towns below 100,000 population	3 years
Setting up common or stand alone sanitary landfills by or for all local bodies having 0.5 million or more population for the disposal of only such residual wastes from the processing facilities as well as untreatable inert wastes as permitted under the Rules	3 years
Setting up common or regional sanitary landfills by all local bodies and census towns under 0.5 million population for the disposal of permitted waste under the rules	3 years
Bio-remediation or capping of old and abandoned dump sites	5 years

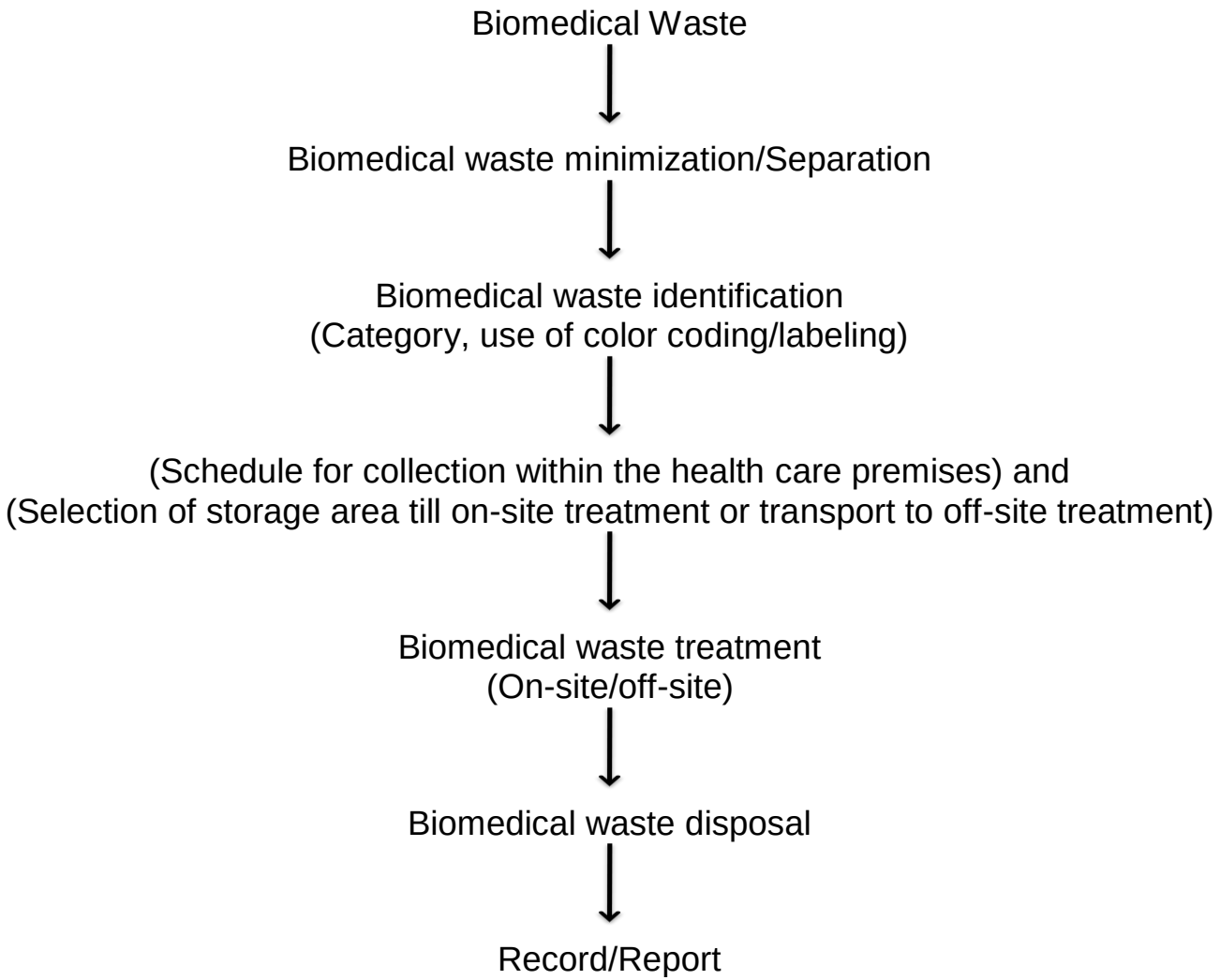
Bio Medical Waste : (Management and Handling) Rules 2016

- Every occupier generating BMW, irrespective of the quantum of wastes comes under the BMW Rules and requires to obtain authorisation

- **Every hospital generating Biomedical waste need to set up requisite Biomedical Waste Treatment facilities to ensure requisite treatment of waste.**

- **No untreated Biomedical waste shall be kept stored beyond a period of 48 hours.**

Elements of the Biomedical Waste Management (As per rules)



Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Yellow	**(a) Human Anatomical Waste:** Human tissues, organs, body parts and fetus below the viability period (as per the Medical Termination of Pregnancy Act 1971, amended from time to time).	Yellow coloured non-chlorinated plastic bags	Incineration or Plasma Pyrolysis or deep burial*
	(b)Animal Anatomical Waste : Experimental animal carcasses, body parts, organs, tissues, including the waste generated from animals used in experiments or testing in veterinary hospitals or colleges or animal houses.	Yellow coloured non-chlorinated plastic bags	Incineration or Plasma Pyrolysis or deep burial*
	(c) Soiled Waste: Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components.	Yellow coloured non-chlorinated plastic bags	Incineration or Plasma Pyrolysis or deep burial* In absence of above facilities, autoclaving or microwaving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery.

Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Yellow	**(d) Expired or Discarded Medicines:** Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc.	Yellow coloured non-chlorinated plastic bags or containers	Expired cytotoxic drugs and items contaminated with cytotoxic drugs to be returned back to the manufacturer or supplier for incineration at temperature >1200 C or to common bio-medical waste treatment facility or hazardous waste treatment, storage and disposal facility for incineration at >1200C Or Encapsulation or Plasma Pyrolysis at >1200C. All other discarded medicines shall be either sent back to manufacturer or disposed by incineration.
	(e) Chemical Waste: Chemicals used in production of biological and used or discarded disinfectants.	Yellow coloured containers or non-chlorinated plastic bags	Disposed of by incineration or Plasma Pyrolysis or Encapsulation in hazardous waste treatment, storage and disposal facility.
	(f) Chemical Liquid Waste : Liquid waste generated due to use of chemicals in production of biological and used or discarded disinfectants, Silver X-ray film developing liquid, discarded Formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-keeping and disinfecting activities etc.	Separate collection system leading to effluent treatment system	After resource recovery, the chemical liquid waste shall be pre-treated before mixing with other wastewater. The combined discharge shall conform to the discharge norms given in Schedule III.

Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Yellow	**(g)** Discarded linen, mattresses, beddings contaminated with blood or body fluid.	Non-chlorinated yellow plastic bags or suitable packing material	Non- chlorinated chemical disinfection followed by incineration or Plazma Pyrolysis or for energy recovery In absence of above facilities, shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery or incineration or Plazma Pyrolysis.
	(h) Microbiology, Biotechnology and other clinical laboratory waste: Blood bags, Laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures	Autoclave safe plastic bags or containers	Pre-treat to sterilize with nonchlorinated chemicals on-site as per National AIDS Control Organisation or World Health Organisation guidelines thereafter for Incineration.

Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Red	**Contaminated Waste (Recyclable)** (a) Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vaccutainers with their needles cut) and gloves.	Red coloured non-chlorinated plastic bags or containers	Autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent to registered or authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making, whichever is possible. Plastic waste should not be sent to landfill sites.
White (Translucent)	**Waste sharps including Metals:** Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades, or any other contaminated sharp object that may cause puncture and cuts. This includes both used, discarded and contaminated metal sharps	Puncture proof, Leak proof, tamper proof containers	Autoclaving or Dry Heat Sterilization followed by shredding or mutilation or encapsulation in metal container or cement concrete; combination of shredding cum autoclaving; and sent for final disposal to iron foundries (having consent to operate from the State Pollution Control Boards or Pollution Control Committees) or sanitary landfill or designated concrete waste sharp pit

Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Blue	**(a) Glassware:** Broken or discarded and contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes.	Cardboard boxes with blue colored marking	Disinfection (by soaking the washed glass waste after cleaning with detergent and Sodium Hypochlorite treatment) or through autoclaving or microwaving or hydroclaving and then sent for recycling.
	(b) Metallic Body Implants		

NOTE:

1) CHEMICAL TREATMENT SHOULD BE DONE BY USING AT LEAST 1% HYPOCHLORITE OR EQUIVALENT AGENT
2) MUTILLATION /SHREDDING SHOULD BE DONE TO PREVENT REUSE.
3) THERE WILL BE NO CHEMICAL PRETREATMENT BEFORE INCINERATION.
4) CHLORINATED PLASTIC BAGS SHOULD NOT BE INCINERETED
5) DISPOSAL BY DEEP BURIAL IS PERMITTED ONLY IN RURAL AREA WERE COMMON FACILITIES OF BIOMEDICAL WASTE MANAGEMENT IS NOT AVAILABLE.

DEEP BURIAL

1. A pit or trench should be dug about 2 meters deep. It should be half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.
2. Must be ensured that animals do not have any access to burial sites. Covers of galvanised iron/wire meshes may be used.
3. On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.
4. Burial must be performed under dedicated supervision.
5. The deep burial site should be relatively impermeable and no shallow well should be close to the site.
6. The pits should be distant from habitation, and sited so as to ensure that no contamination occurs of any surface water or ground water. The area should not be prone to flooding or erosion.
7. The location of the deep burial site will be authorised by the prescribed authority.
8. The institution shall maintain a record of all pits for deep burial.

Incinerators

It is a controlled combustion process where waste is completely oxidized and harmful microorganisms present in it are destroyed/denatured under high temperature.

A. Operating Standards

1. Combustion efficiency (CE) shall be at least 99.00%.
2. The Combustion efficiency is computed as follows:

$$C.E. = \frac{\%CO_2}{\%CO_2 + \%\ CO} \times 100$$

3. The temperature of the primary chamber shall be 800 ± 50 ºC.
4. The secondary chamber gas residence time shall be at least 1 (one) second at 1050 ± 50 ºC, with minimum 3% Oxygen in the stack gas.

B. Emission Standards

Sl. No.	Parameter	Standards	
(1)	(2)	(3)	(4)
		Limiting concentration in mg Nm^3 unless stated	Sampling Duration in minutes, unless stated
1.	Particulate matter	50	30 or $1NM^3$ of sample volume, whichever is more
2.	Nitrogen Oxides NO and NO_2 expressed asNO_2	400	30 for online sampling or grab sample
3.	HCl	50	30 or $1NM^3$ of sample volume, whichever is more
4.	Total Dioxins and Furans	0.1ngTEQ/Nm^3 (at 11% O2)	8 hours or $5NM^3$ of sample volume, whichever is more
5.	Hg and its compounds	0.05	2 hours or $1NM^3$ of sample volume, whichever is more

C. Stack Height: Minimum stack height shall be 30 meters above the ground and shall be attached with the necessary monitoring facilities as per requirement of monitoring of 'general parameters' as notified under the Environment (Protection) Act, 1986 and in accordance with the Central Pollution Control Board Guidelines of Emission Regulation Part-III.

Hazardous Waste Management

- **Ministry of Environment & Forests, Government of India, notified the Hazardous Waste (Management & Handling) Rules: July 28, 1989 under the provisions of the Environment (Protection) Act, 1986**
- **Amended in the year 2000 and 2003**
- **Further amended "Hazardous Wastes (Management, Handling and Transboundary Movement) Rules,2008**
- **Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.**
- **Enforcement agency of the Rules : State Pollution Control Boards**

Hazardous Waste Management

- The primary objective of these rules is to evolve a regulatory mechanism and specify the procedures to be adopted for safe and proper handling and management of hazardous wastes.

- The primary aim is to ensure appropriate collection, reception, treatment, storage and disposal of hazardous wastes listed in schedule I, II & III of the H.W. Rules.

Hazardous Waste Definition

- **By "Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016:**
- **any waste which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger or is likely to cause danger to health or environment, whether alone or in contact with other wastes or substances, and shall include :**

Hazardous Waste Definition

- **(i) waste specified under column (3) of Schedule I;**
- **(ii) waste having equal to or more than the concentration limits specified for the constituents in class A and class B of Schedule II or any of the characteristics as specified in class C of Schedule II;**
- **and (iii) wastes specified in Part A of Schedule III in respect of import or export of such wastes or the wastes not specified in Part A but exhibit hazardous characteristics specified in Part C of Schedule III;**

Schedule- I (rules 3 (1))

List of processes generating hazardous wastes

S.No.	Processes	Hazardous waste
1.	Petrochemical processes and pyrolytic operations	1.1 Furnace or reactor residue and debris 1.2 Tarry residues and still bottoms from distillation 1.3 Oily sludge emulsion 1.4 Organic residues 1.5 Residues from alkali wash of fuels 1.6 Spent catalyst and molecular sieves 1.7 Oil from wastewater treatment
2.	Crude oil and natural gas production	2.1 Drill cuttings excluding those from water based mud 2.2 Sludge containing oil 2.3 Drilling mud containing oil
3.	Cleaning, emptying and maintenance of petroleum oil storage tanks including ships	3.1 cargo residue, washing water and sludge containing oil 3.2 cargo residue and sludge containing chemicals 3.3 Sludge and filters contaminated with oil 3.4 Ballast water containing oil from ships

4.	**Petroleum refining or reprocessing of used oil or recycling of waste oil**	**4.1 Oil sludge or emulsion** **4.2 Spent catalyst** **4.3 Slop oil** **4.4 Organic residue from processes** **4.5 Spent clay containing oil**
5.	**Industrial operations using mineral or synthetic oil as lubricant in hydraulic systems or other applications**	**5.1 Used or spent oil** **5.2 Wastes or residues containing oil** **5.3 Waste cutting oils**
6.	**Secondary production and / or industrial use of zinc**	**6.1 Sludge and filter press cake arising out of production of Zinc Sulphate and other Zinc Compounds.** **6.2 Zinc fines or dust or ash or skimmings in dispersible form** **6.3 Other residues from processing of zinc ash or skimmings** **6.4 Flue gas dust and other particulates**
7.	**Primary production of zinc or lead or copper and other non-ferrous metals except aluminium**	**7.1 Flue gas dust from roasting** **7.2 Process residues** **7.3 Arsenic-bearing sludge** **7.4 Non-ferrous metal bearing sludge and residue.**

8.	**Secondary production of copper**	**8.1 Spent electrolytic solutions** **8.2 Sludge and filter cakes** **8.3 Flue gas dust and other particulates**
9.	**Secondary production of lead**	**9.1 Lead bearing residues** **9.2 Lead ash or particulate from flue gas** **9.3 Acid from used batteries**
10.	**Production and/or industrial use of cadmium and arsenic and their compounds**	**10.1 Residues containing cadmium and arsenic**
11.	**Production of primary and secondary aluminum**	**11.1 Sludges from off-gas treatment** **11.2 Cathode residues including pot lining wastes** **11.3 Tar containing wastes** **11.4 Flue gas dust and other particulates** **11.5 Drosses and waste from treatment of salt sludge** **11.6 Used anode butts** **11.7 Vanadium sludge from alumina refineries**
12.	**Metal surface treatment, such as** **etching, staining, polishing, galvanizing, cleaning, degreasing,** **plating, etc.**	**12.1 Acidic and alkaline residues** **12.2 Spent acid and alkali** **12.3 Spent bath and sludge containing sulphide, cyanide and toxic metals** **12.4 Sludge from bath containing organic solvents** **12.5 Phosphate sludge** **12.6 Sludge from staining bath** **12.7 Copper etching residues** **12.8 Plating metal sludge**

13	**Production of iron and steel including other ferrous alloys.**	**13.1 Sludge from acid recovery unit** **13.2 Benzol acid sludge** **13.3 Decanter tank tar sludge** **13.4 Tar storage tank residue**
14	**Hardening of steel**	**14.1 Cyanide,nitrate,nitrite containing sludge** **14.2 Spent hardening salt**
15	**Production of asbestos or asbestos-containing materials**	**15.1 Asbestos containing residues** **15.2 Discarded asbestos** **15.3 Dust/particulates from exhaust gas treatment**
16	**Production of caustic soda and chlorine**	**16.1 Mercury bearing sludge** **16.2 Residue/sludge and filter cakes** **16.3 Brine sludge containing mercury**
17	**Production of mineral acid**	**17.1 Residues, sludge or filter cakes** **17.2 Spent catalyst**

18	**Production of nitrogenous and complex fertilizers**	**18.1 Spent catalyst** **18.2 Spent carbon** **18.3 Sludge/residue containing arsenic** **18.4 Chromium sludge from water cooling tower**
19	**Production of phenol**	**19.1 Residue/sludge containing phenol**
20	**Production and/or industrial use of solvents**	**20.1 Contaminated aromatic, aliphatic or napthenic solvents may or may not be fit for reuse** **20.2 Spent solvents** **20.3 Distillation residues**
21	**Production and/or industrial use of paints,pigments,lacquers,varnishes and inks**	**21.1 Process wastes, residues & sludges** **21.2 Fillers residues**
22	**Production of plastic raw materials**	**22.1 Residues of additives used in plastic manufacture** **22.2 Residues and waste of plasticisers** **22.3 Non-polymerized residues** **22.4 Residues from acrlonitrile production** **22.5 residues from vinyl chloride monomer production**

23	**Production and/or industrial use of glues,cements,adhesives and resins**	**23.1 Wastes/ residues (not made with vegetable or animal materials)**
24	**Production of canvas and textiles**	**24.1 Chemical residues**
25	**Industrial production and formulation of wood preservatives**	**25.1 Chemical residues** **25.2 Residues from wood alkali bath**
26	**Production or industrial use of synthetic dyes, dye-intermediates and pigments**	**26.1 Process waste sludge/residues containing acid or other toxic metals or organic complexes** **26.2 Dust from air filtration system**
27	**Production of organo-silicone compounds**	**27.1 Process residue**

28	**Production/ formulation of drugs/pharmaceuticals & health care product**	**28.1 Process residues and wastes** **28.2 Spent catalyst/spent carbon** **28.3 Off specification products** **28.4 Date-expired, Discarded and off-specification drugs/medicines** **28.5 Spent organic solvents**
29.	**Production and formulation of pesticides including stock-piles**	**29.1 Process residues and wastes** **29.2 Chemical sludge containing residue pesticides** **29.3 Date-expired and off-specification pesticides**
30	**Leather tanneries**	**30.1 Chromium bearing residues and sludge**
31	**Electronic Industry**	**31.1 Process residues and wastes** **31.2 Spent etching chemicals and solvents**
32	**Pulp & paper industry**	**32.1 Spent chemicals** **32.2 Corrosive waste arising from use of strong acid and bases** **33.3 Process sludge containing absorbable organic halides (AOx)**

33	**Handling of hazardous chemicals and wastes**	**3.1 Empty barrels/containers/liners contaminated with hazardous chemicals /wastes** **33.2 Contaminated cotton rags or other cleaning materials**
34	**De-contamination of barrels / containers used for handling of hazardous wastes/chemicals**	**34.1 Chemical-containing residue arising from decontamination.** **34.2 Sludge from treatment of waste water arising out of cleaning / disposal of barrels /containers**
35	**Purification and treatment of exhaust air, water and wastewater from the processes in this schedule and common effluent treatment plants**	**34.1 Flue gas cleaning residue** **34.2 Spent ion exchange resin containing toxic metal's** **34.3 Oil and grease skimming residues**

36	**Purification process for organic compounds or solvents**	**36.1 Any process or distillation residue** **36.2 Spent carbon or filter medium**
37	**Hazardous waste treatment processes, e.g. pre-processing, incineration and concentration**	**37.1 Sludge from wet scrubbers** **37.2 Ash from incinerator and flue gas cleaning residue** **37.3 Concentration or evaporation residues**
38.	**Chemical processing of Ores containing heavy metals such as Chromium, Manganese, Nickel, Cadmium etc.**	**38.1 Process residues** **38.2 Spent acid**

Wastes having constituents listed in Schedule-II, if their concentration is equal to or more than the limit indicated in the said schedule

Schedule II

Li … Limits

Class A: Bas … cteristic Leaching Pro … ation (STLC)]

Class	Constituents	Concentration in mg/l
(1)	(2)	(3)
A1	Arsenic	5.0
A2	Barium	100.0
A3	Cadmium	1.0
A4	Chromium and/or Chromium (III) compounds	5.0
A5	Lead	5.0
A6	Manganese	10.0
A7	Mercury	0.2
A8	Selenium	1.0
A9	Silver	5.0
A10	Ammonia	50*
A11	Cyanide	20*
A12	Nitrate (as nitrate-nitrogen)	1000.0
A13	Sulphide (as H_2S)	5.0
A14	1,1-Dichloroethylene	0.7
A15	1,2-Dichloroethane	0.5
A16	1,4-Dichlorobenzene	7.5
A17	2,4,5-Trichlorophenol	400.0
A18	2,4,6-Trichlorophenol	2.0
A19	2,4-Dinitrotoluene	0.13
A20	Benzene	0.5
A21	Benzo (a) Pyrene	0.001
A22	Bromodicholromethane	6.0
A23	Bromoform	10.0
A24	Carbon tetrachloride	0.5
A25	Chlorobenzene	100.0
A26	Chloroform	6.0
A27	Cresol (ortho+ meta+ para)	200.0
A28	Dibromochloromethane	10.0
A29	Hexachlorobenzene	0.13
A30	Hexachlorobutadiene	0.5
A31	Hexachloroethane	3.0
A32	Methyl ethyl ketone	200.0
A33	Naphthalene	5.0
A34	Nitrobenzene	2.0
A35	Pentachlorophenol	100.0
A36	Pyridine	5.0
A37	Tetrachloroethylene	0.7
A38	Trichloroethylene	0.5

(1)	(2)	(3)
A39	Vinyl chloride	0.2
A40	2,4,5-TP (Silvex)	1.0
A41	2,4-Dichlorophenoxyacetic acid	10.0
A42	Alachlor	2.0
A43	Alpha HCH	0.001
A44	Atrazine	0.2
A45	Beta HCH	0.004
A46	Butachlor	12.5
A47	Chlordane	0.03
A48	Chlorpyriphos	9.0
A49	Delta HCH	0.004
A50	Endosulfan (alpha+ beta+ sulphate)	0.04
A51	Endrin	0.02
A52	Ethion	0.3
A53	Heptachlor (& its Epoxide)	0.008
A54	Isoproturon	0.9
A55	Lindane	0.4
A56	Malathion	19
A57	Methoxychlor	10
A58	Methyl parathion	0.7
A59	Monocrotophos	0.1
A60	Phorate	0.2
A61	Toxaphene	0.5
A62	Antimony	15
A63	Beryllium	0.75
A64	Chromium (VI)	5.0
A65	Cobalt	80.0
A66	Copper	25.0
A67	Molybdenum	350
A68	Nickel	20.0
A69	Thallium	7.0
A70	Vanadium	24.0
A71	Zinc	250
A72	Fluoride	180.0
A73	Aldrin	0.14
A74	Dichlorodiphenyltrichloroethane (DDT), Dichlorodiphenyldichloroethylene (DDE), Dichlorodiphenyldichloroethane (DDD)	0.1
A75	Dieldrin	0.8
A76	Kepone	2.1
A77	Mirex	2.1
A78	Polychlorinated biphenyls	5.0
A79	Dioxin (2,3,7,8-TCDD)	0.001

Class B: Based on Total Threshold Limit Concentration (TTLC)

Class	Constituent	Concentration in mg/kg
(1)	(2)	(3)
B1	Asbestos	10000
B2	Total Petroleum Hydrocarbons (TPH) (C5 - C36)	5,000

Note:

(1) The testing method for list of constituents at A1 to A61 in Class-A, shall be based on Toxicity Characteristic Leaching Procedure (TCLP) and for extraction of leachable constituents, USEPA Test Method 1311 shall be used.
(2) The testing method for list of constituents at A62 to A79 in Class- A, shall be based on Soluble Threshold Limit Concentration (STLC) and Waste Extraction Test (WET) Procedure given in Appendix II of section 66261 of Title 22 of California Code regulation (CCR) shall be used.
(3) In case of ammonia (A10), cyanide (A11) and chromium VI (A64), extractions shall be conducted using distilled water in place of the leaching media specified in the TCLP/STLC procedures.
(4) A summary of above specified leaching/extraction procedures is included in manual for characterization and analysis of hazardous waste published by Central Pollution Control Board and in case the method is not covered in the said manual, suitable reference method may be adopted for the measurement.
(5) In case of asbestos, the specified concentration limits apply only if the substances are in a friable, powdered or finely divided state.
(6) The hazardous constituents to be analyzed in the waste shall be relevant to the nature of the industry and the materials used in the process.
(7) Wastes which contain any of the constituents listed below shall be considered as hazardous, provided they exhibit the characteristics listed in Class-C of this Schedule :

1.	Acid Amides
2.	Acid anhydrides
3.	Amines
4.	Anthracene
5.	Aromatic compounds other than those listed in Class A
6.	Bromates, (hypo-bromites)
7.	Chlorates (hypo-chlorites)
8.	Carbonyls
9.	Ferro-silicate and alloys
10.	Halogen- containing compounds which produce acidic vapours on contact with humid air or water e.g. silicon tetrachloride, aluminum chloride, titanium tetrachloride
11.	Halogen- silanes
12.	Halogenated Aliphatic Compounds
13.	Hydrazine (s)

14.	Hydrides
15.	Inorganic Acids
16.	Inorganic Peroxides
17.	Inorganic Tin Compounds
18.	Iodates
19.	(Iso- and thio-) Cyanates
20.	Manganese-silicate
21.	Mercaptans
22.	Metal Carbonyls
23.	Metal hydrogen sulphates
24.	Nitrides
25.	Nitriles
26.	Organic azo and azooxy Compounds
27.	Organic Peroxides
28.	Organic Oxygen Compounds
29.	Organic Sulphur Compounds
30.	Organo- Tin Compounds
31.	Organo nitro- and nitroso compounds
32.	Oxides and hydroxides except those of hydrogen, carbon, silicon, iron, aluminum, titanium, manganese, magnesium, calcium
33.	Phenanthrene
34.	Phenolic Compounds
35.	Phosphate compounds except phosphates of aluminum, calcium and iron
36.	Salts of pre-acids
37.	Total Sulphur
38.	Tungsten Compounds
39.	Tellurium and tellurium compounds
40.	White and Red Phosphorus
41.	2-Acetylaminofluorene
42.	4-Aminodiphenyl
43.	Benzidine and its salts
44.	Bis (Chloromethyl) ether
45.	Methyl chloromethyl ether
46.	1,2-Dibromo-3-chloropropane
47.	3,3'-Dichlorobenzidine and its salts
48.	4-Dimethylaminoazobenzene
49.	4-Nitrobiphenyl
50.	Beta-Propiolactone

CLASS C : Based on hazardous Characteristics

Apart from the concentration limit given above, the substances or wastes shall be classified as hazardous waste if it exhibits any of the following characteristics due to the presence of any hazardous constituents:

Toxicity

A waste exhibits the characteristics of toxicity if the leachate from the representative sample by Toxicity Characteristics Leaching Procedure (TCLP) test method (as followed by USEPA, vide No: S.W 46, till Indian standards are notified by MoEF / CPCB) contains any of the contaminants listed in Table below in excess of the concentration limits mentioned there upon.

PROCEDURE FOR HANDLING HAZARDOUS WASTES

- **Responsibilities of the occupier for handling of hazardous wastes**
  - **The** occupier shall be responsible for safe and environmentally sound handling of hazardous wastes generated in his establishment.
- **Grant of authorization for handling hazardous wastes**
  - Every person who is engaged in generation, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer or the like of the hazardous waste shall require to obtain an authorization from the State Pollution Control Board.
- **Power to suspend or cancel an authorization**
- **Storage of Hazardous Waste**

PROCEDURE FOR RECYCLING, REPROCESSING OR REUSE OF HAZARDOUS WASTES

- Procedure for grant of registration
- Conditions for sale or transfer of Hazardous Wastes for recycling
- Standards for recycling
- Utilization of hazardous wastes
- Import and export (transboundary movement) of hazardous wastes
- Import or export of Hazardous Waste for recycling, recovery and reuses

- **TREATMENT, STORAGE AND DISPOSAL FACILITY FOR HAZARDOUS WASTES**

- **PACKAGING, LABELLING, AND TRANSPORT OF HAZARDOUS WASTE**

Cross-section of a secure landfill double liner system