

TREATED WASTEWATER REUSE IN INDIA

STATUS AND OPPORTUNITY

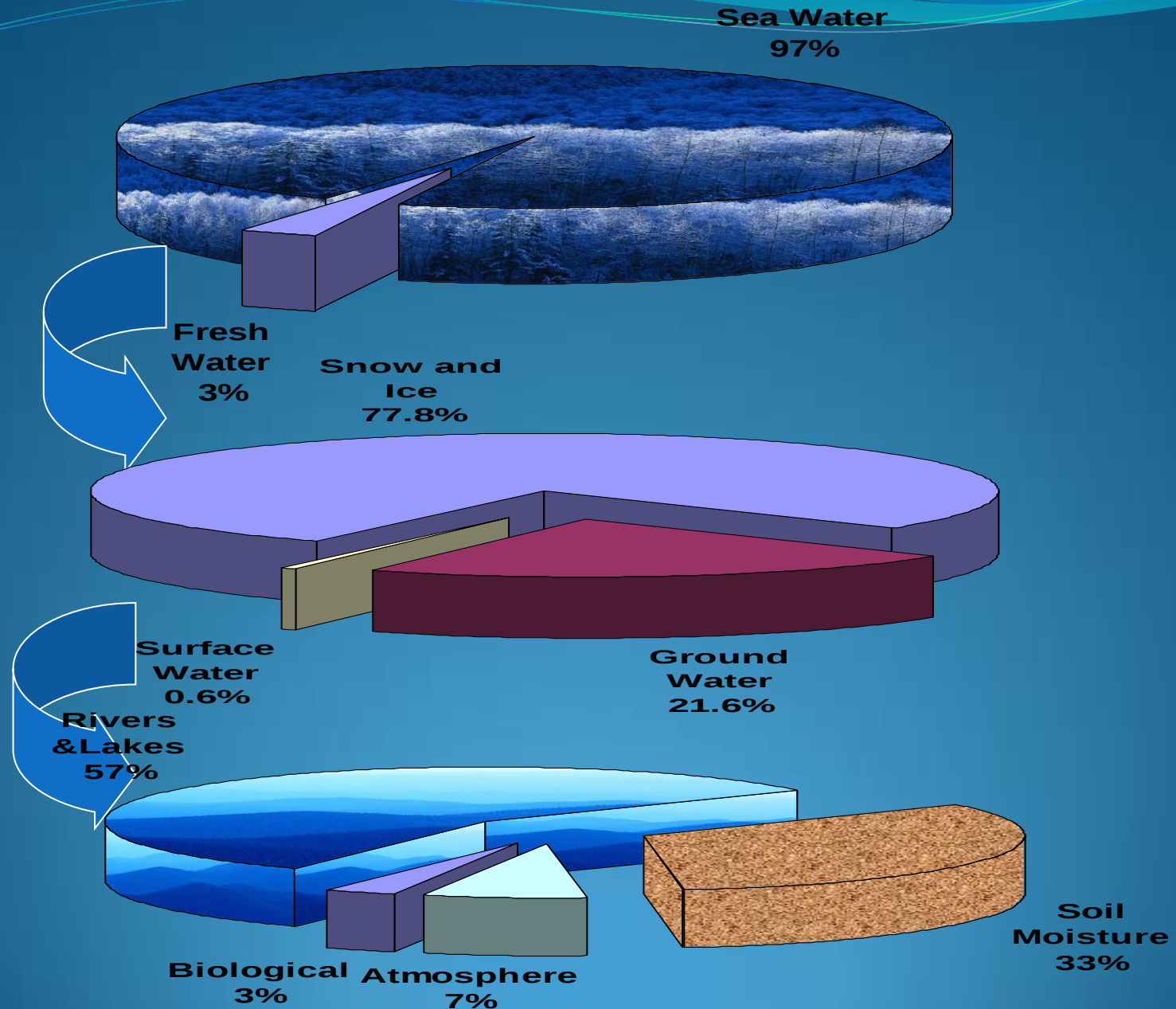
**Environment Protection and Waste Management Sectional Committee, CHD 32
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GLOBAL WATER BUDGET



Water is Precious and scarce Resource

- Only a small fraction (about 3%) is fresh water
- India is wettest country in the world, but rainfall is highly uneven with time and space
 - extremely low in Rajasthan and high in North-East
 - On an average there are only 40 rainy days
- To sustain our growing demand for agriculture and other uses we abstract the water from every possible sources
- Out of 4000 BCM rainfall received, about 600 BCM is put to use so far
- Water resources are over-exploited resulting in major WQ problems

Water use in India (Year 2000)

Sector	Water use in BCM	percent
Irrigation	541	85.33
Domestic	42	6.62
Industry	8	1.26
Energy	2	0.32
Other	41	6.47
Total	634	100.00

Major Water Quality Issues

Common issues of Surface and Ground water

- Pathogenic (Bacteriological) Pollution
- Salinity
- Toxicity (micro-pollutants and other industrial pollutants)

Surface Water

- Eutrophication
- Oxygen depletion
- Ecological health

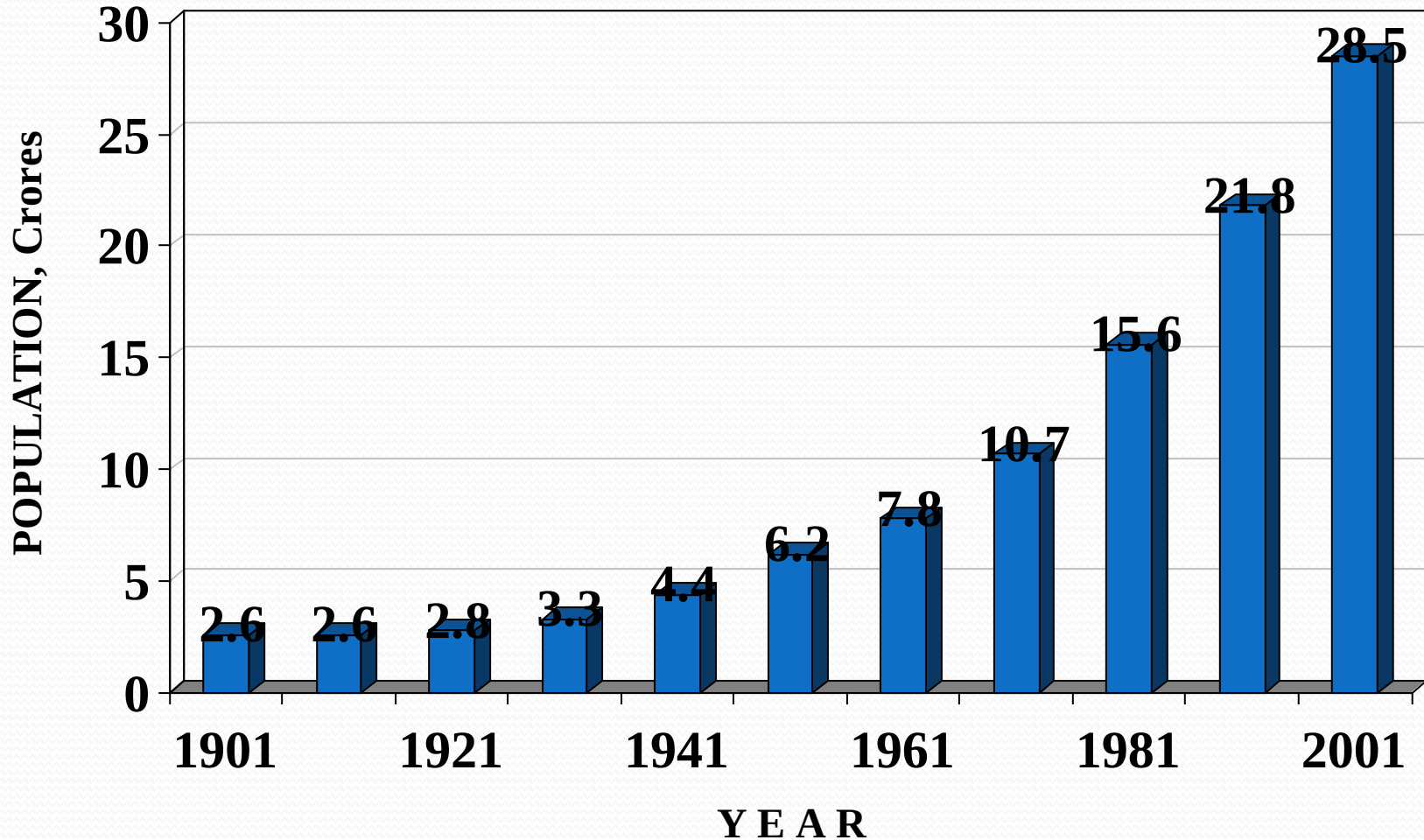
Ground Water

- Fluoride
- Nitrate
- Arsenic
- Iron
- Sea water intrusion

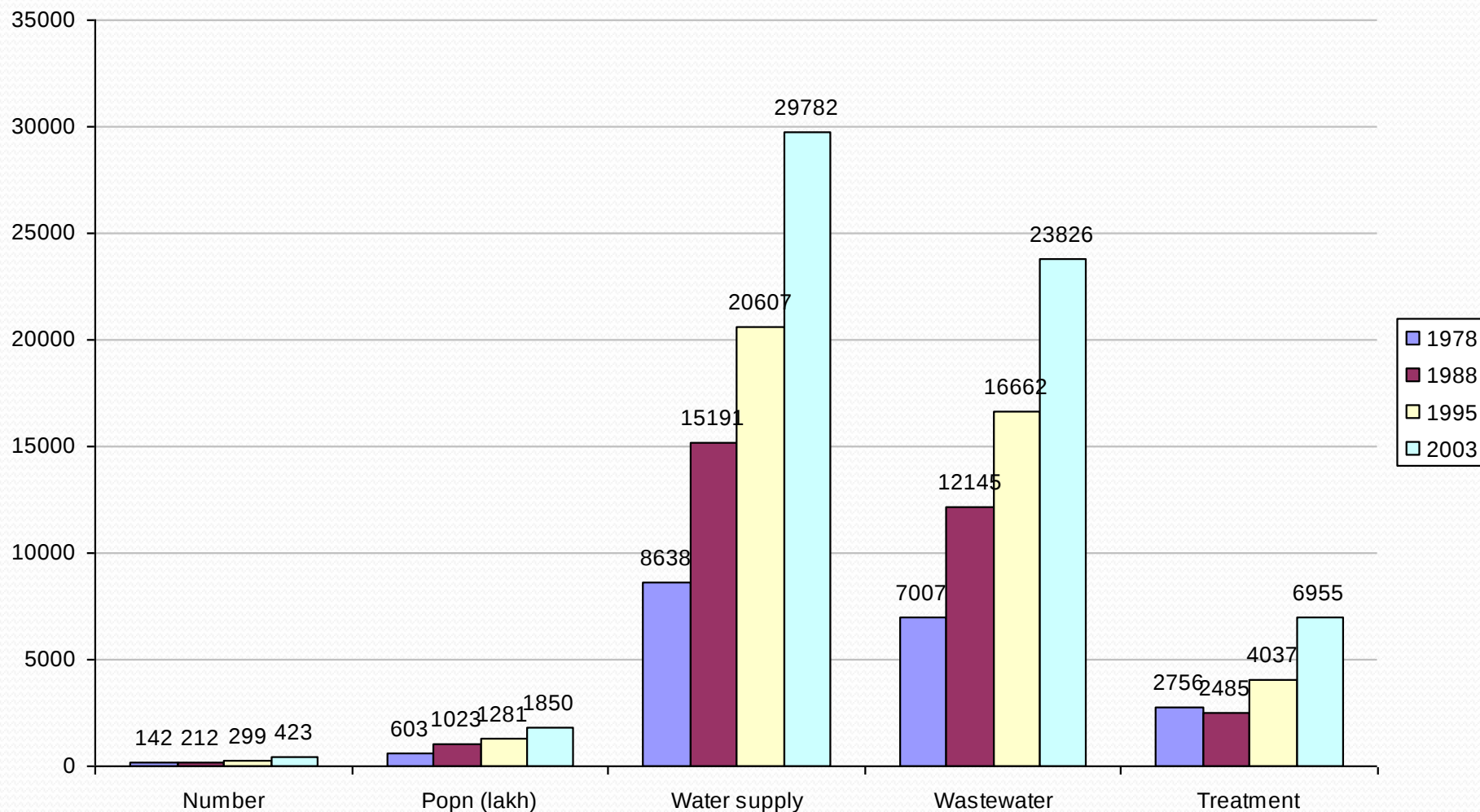
Major Factors Responsible for WQ Degradation

- ☀ Domestic: 423 class I cities and 499 class II towns harboring population of 20 Crore generate about 29000 mld of wastewater of which only 7044 mld is treated.
- ☀ Industrial: About 57,000 polluting industries in India generate about 15250 mld of wastewater out of which nearly 60% (generated from large & medium industries) is treated.
- ☀ Non-point sources also contribute significant pollution loads mainly in rainy season. Pesticides consumption is about 1,00,000 tonnes/year of which AP, Haryana, Punjab, TN, WB, Gujarat, UP and Maharashtra are principal consumers.
- ☀ Domestic sewage is the major source of pollution in India in surface water which contribute pathogens, the main source of water borne diseases along with depletion of oxygen in water bodies.
- ☀ Sewage alongwith agricultural run-off and industrial effluents also contributes large amount of nutrients in surface water causing eutrophication
- ☀ A large part of the domestic sewage is not even collected. This results in stagnation of sewage within city, a good breeding ground for mosquitoes and contaminate the groundwater, the primary source of drinking water in many cities.

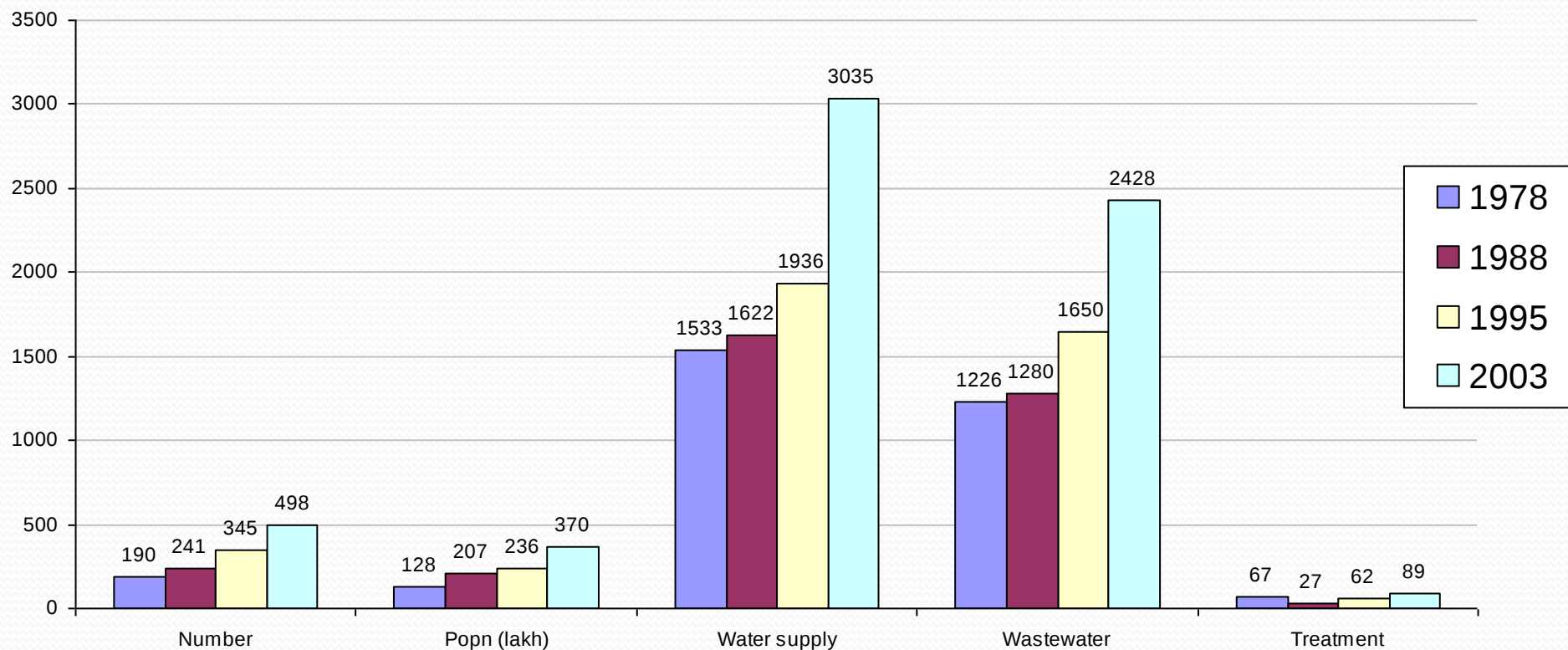
Increase in Urban Population



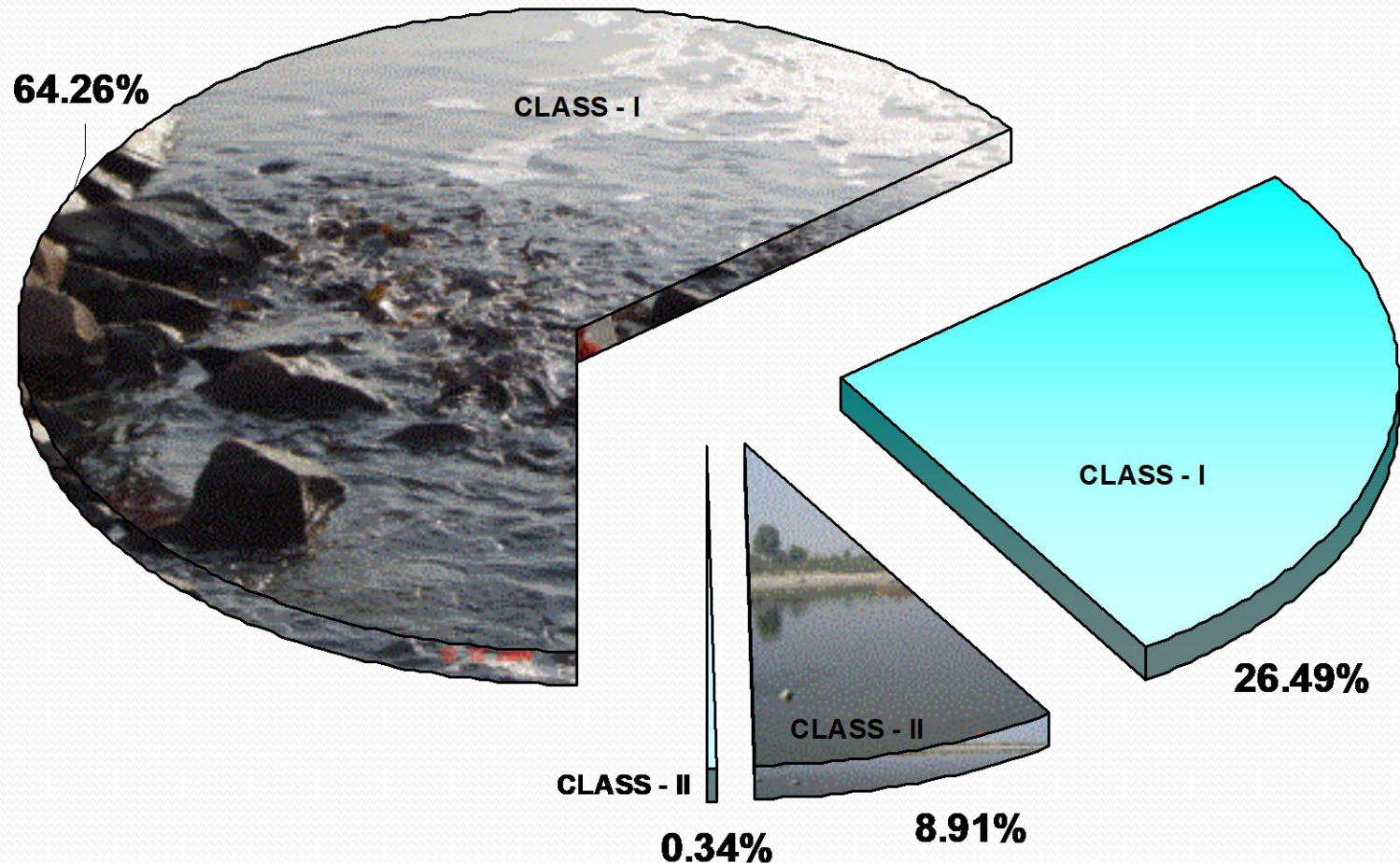
Water supply and sewage disposal status in class I cities



Water supply and wastewater generation and treatment in class II towns of India



WASTEWATER GENERATION AND TREATMENT (mld) IN CLASS - I AND CLASS - II CITIES IN INDIA



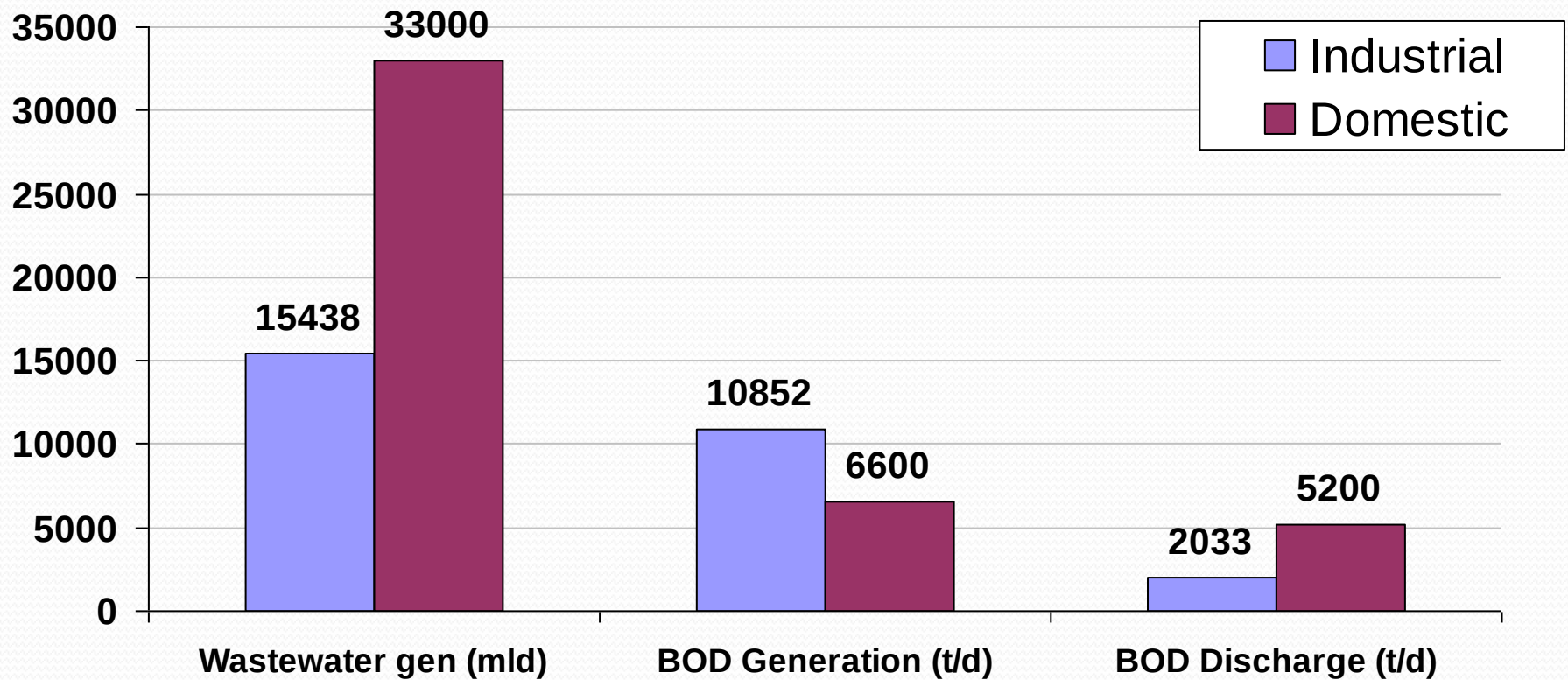
■ Generation (C-I) - 23826

■ Treatment (C-I) - 6955

■ Generation (C-II) - 2428

■ Treatment (C-II) - 89

Comparision of pollution load generation from domestic and industrial sources



Existing Policies and Regulations

• Policies

- Conservation' Provisions in India's Constitution
- The Policy Statement for Abatement of Pollution (1992)
- The National Conservation Strategy and Policy Statement on Environment and Development, 1992
- The National Environment Policy, 2006
- The National Water Policy, 2002

• Laws

- The Water (Prevention & Control of Pollution) Act, 1974
- Water Cess Act, 1977
- Environment (Protection) Act, 1986
- CGWA
- WQAA

• Initiatives

- Development of standards and Water quality criteria
- National River Action Plan (NRAP)
- Environment Impact Assessment
- Special Drive for 17 categories of polluting industries
- Pollution Control in Small-Scale Industries
- Charters on Corporate Responsibility on Environment Protection
- Special Drives for Industries Discharging into Rivers and Lakes
- Incentives for Control of pollution

LIST OF SELECTED LAWS RELATED TO ENVIRONMENT.

CENTRAL LAWS

A. Water pollution

1. The River Board Act, 1956.
2. The Merchant Shipping (Amendment) Act, 1970.

B. Air Pollution

3. The Indian Boiler's Act, 1923.
4. The Factories Act, 1948.
5. The Industries (Development and Regulation) Act, 1951.
6. The Mines and Minerals (Regulation and Development) Act, 1947.

C. Radiation

7. The Atomic Energy Act, 1962.
8. Radiation Protection Rules, 1971.

D. Pesticides

9. The Insecticide Act, 1968.
10. The Factories Act, 1948.
11. The Poison Act, 1919.

E. Others

12. The Indian Fisheries Act, 1897.
13. The Urban Land (Ceiling and Regulation) Act, 1976.
14. The Ancient Monument and Archaeological Sites and Remains Act, 1958.

STATE LAWS.

A. Water Pollution.

1. Orissa River Pollution Prevention Act, 1953.
2. Maharashtra Prevention of Water Pollution Act, 1969.

B. Smoke Control.

3. The Bengal Smoke Nuisance Act, 1905.
4. The Gujarat Smoke Nuisance Act, 1963.
5. The Bombay Smoke Nuisance Act, 1912.

C. Pest Control.

6. The Andhra Pradesh Agricultural Pest and Disease Act, 1919.
7. The Assam Agricultural Pests and Disease Act, 1954.
8. The UP Agricultural Disease and Pests Act, 1954.
9. The Mysore Destructive Insects and Pests Act, 1917.
10. The Kerala Agricultural Pests and Disease Act, 1958.

D. Land Utilization and Land Improvement.

11. The Andhra Pradesh Improvement Scheme Act, 1949.
12. The Acquisition of Land for Flood Control and Prevention of Erosion Act, 1955.
13. The Bihar Waste Lands (Reclamation, Cultivation and Improvement) Act, 1946.
14. The Delhi Restriction of Uses of Land Act, 1964

Effects of Pollution

- Pathogenic
- Oxygen depletion
- Eutrophication
- Salinity
- Pesticides and industrial toxics
- Ecosystem level



Role of Bureau of Indian Standards in Development of Quality Standards in the field of water and Waste Water (Other than Drinking Water)

Quality Standards for Water and Waste Water (Other than Drinking Water)

- BIS has been developing quality standards for water intended for industrial purposes and for effluents from various activities.
- These activities are dealt by the following two National Committees
- I. CHD 13: Water Quality for Industrial Purposes.
- SCOPE - To formulate Indian Standards for terminology, quality criteria for water for industrial purposes, guidelines for treatment of water, boiler feed water, boiler water, cooling water, deposits on water-side, boiler water treatment compounds, cleaning of boilers, corrosion prevention, specifications for chemicals for use in high pressure boilers, condensate polishing and other issues related to boiler water chemistry.

Quality Standards for Water and Waste Water (Other than Drinking Water)

- **II. CHD 32 Environment Protection and Waste Management**
- **SCOPE :**
- a) To formulate Indian Standards for
 - i) Terminology, methods of sampling and characterization of ambient air, industrial emission, water, sewage, industrial effluents and solid waste (excluding biological and nuclear wastes) and e-waste;
 - ii) Guidelines for control of pollution of air at source, water and land;
 - iii) Codes on waste minimization , recycling, reuse, treatment and disposal of wastes.
- b) **LIAISON** - To co-ordinate with the work of ISO/TC 146 Air Quality, ISO/TC 147 Water Quality, ISO/TC 209 Clean rooms and associated controlled environments

Aspect Wise Quality Standards for Water and Waste Water

Aspect	Water Quality	Effluents
Methods of Test	4	66
Code of Practices, Product Standards, Water Quality Standards	28	10
Terminology	1	2
Others	-	-
Total	33	78

Water Related Diseases

Name of the disease	Causative organism
1. Water-borne diseases Bacterial 1. Typhoid 2. Cholera 3. Paratyphoid 4. Gastroenteritis 5. Bacterial dysentery Viral 1. Infectious hepatitis 2. Poliomyelitis 3. Diarrhoeal diseases 4. Other symptoms of enteric diseases Protozoan 1. Amoebic dysentery	Salmonella typhi Vibrio cholerae Salmonella paratyphi Enterotoxigenic Escherichia coli Variety of Escherichia coli Hepatitis-A virus Polio-virus Rota-virus, Norwalk agent, other virus Echovirus, Coxsackievirus Entamoeba histolytica

2 Water-washed diseases 1.Scabies 2.Trachoma 3.Bacillary dysentery	Various skin fungus species Trachoma infecting eyes E. coli
3 Water-based diseases 1.Schistosomiasis 2.Guinea worm	Schistosoma sp. Guinea worm
4 Infection through water related insect vectors 1.Sleeping sickness 2.Malaria	Trapanosoma through tsetse fly Plasmodium through Anaphelis
5 Infections primarily due to defective sanitation 1.Hookworm	Hook worm, Ascaris

WATER POLLUTION CONTROL STRATEGY

- **Urban sources – National River Action Plan**
- **Industrial Sources – through consent (SPCB)**
- **Special Drives: 17 categories of industries**
- **Industries discharging into rivers and lakes**
- **24 Problem areas action plan**
- **Environmental auditing**
- **Common effluent treatment plants for cluster of SSI units (124)**
- **Promotion of low-waste and no-waste technology**

Use based classification of surface waters in India

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	1.Total Coliforms OrganismMPN/100ml shall be 50 or less 2.pH between 6.5 and 8.5 3.Dissolved Oxygen 6mg/l or more 4.Biochemical Oxygen Demand 5 days 20oC 2mg/l or less
Outdoor bathing (Organised)	B	1.Total Coliforms Organism MPN/100ml shall be 500 or less 2.pH between 6.5 and 8.5 3.Dissolved Oxygen 5mg/l or more 4.Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	1.Total Coliforms Organism MPN/100ml shall be 5000 or less 2.pH between 6 to 9 3.Dissolved Oxygen 4mg/l or more 4.Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
Propagation of Wild life and Fisheries	D	1.pH between 6.5 to 8.5 2.Dissolved Oxygen 4mg/l or more 3.Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1.pH between 6.0 to 8.5 2.Electrical Conductivity at 25oC micro mhos/cm Max.2250 3.Sodium absorption Ratio Max. 26 4.Boron Max. 2mg/l

Constraints in Implementation

- Water scarcity
- Inadequate resources with local authorities
- Polluter pay principle is still not operative
- High organic and dissolved solid bearing wastes
- Large number of SSI
- Problem of O&M of treatment facilities
- Characteristics of effluents

Need for Strengthening

- Massive sincere efforts needed for augmenting sewage treatment facilities
- O&M of STPs
- Use of alternative simpler technology
- Reuse and recycling of WW
- In industries – treatment, reuse of WW and resource recovery, waste minimisation and clean technology
- WW discharge stds and charges on residual polln
- Effective public complaint redressal
- Polln from NPS

Suggested Water Conservation Measures

- Surface Storage
- Conservation of rain water
- Ground water conservation
- Artificial recharge
- Percolation tank method
- Catchment area protection (CAP)
- Inter-basin transfer of water
- Adoption of drip sprinkler irrigation
- Management of crop growing pattern
- Selection of crop varieties
- Nutritional management
- Role of antitranspirants
- Reducing evapotranspiration
- Reducing evaporation
- Recycling of wastewater
- Conservation of water in domestic use

Water Quantity Aspects

- Incentive for water conservation
- Traditional practices of water conservation
- People's participation
- Training and human resource development
- Need for co-ordinated action
- River basin-wise planning
- Location specific stds
- Tackling special problem of As and F

RIVER ACTION PLAN

- **Govt of India identified polluted water bodies, which leads to formulation of action plan for restoration of the water body.**
- **Based on the Recommendations, Ganga Action Plan was launched in 1986 to restore the WQ of the Ganga by interception, diversion and treatment of wastewater from 27 cities/towns located along the river.**
- **Based on the experience gained during implementation of the Ganga Action Plan, Govt of India extends river cleaning programme to other rivers and lakes.**

NATIONAL RIVER ACTION PLAN

River	No. of Towns	River	No. of Towns
Ganga	74	Brahmini	3
Yamuna	21	Chambal	3
Damodar	12	Gomti	3
Godavari	6	Krishna	2
Cauvery	9	Sabarmati	1
Tungabhadra	4	Khan	1
Satluj	4	Kshipra	1
Subarnrekha	3	Tapi	1
Betwa	3	Narmada	1
Wainganga	3	Mahanadi	1
Grand Total		156	

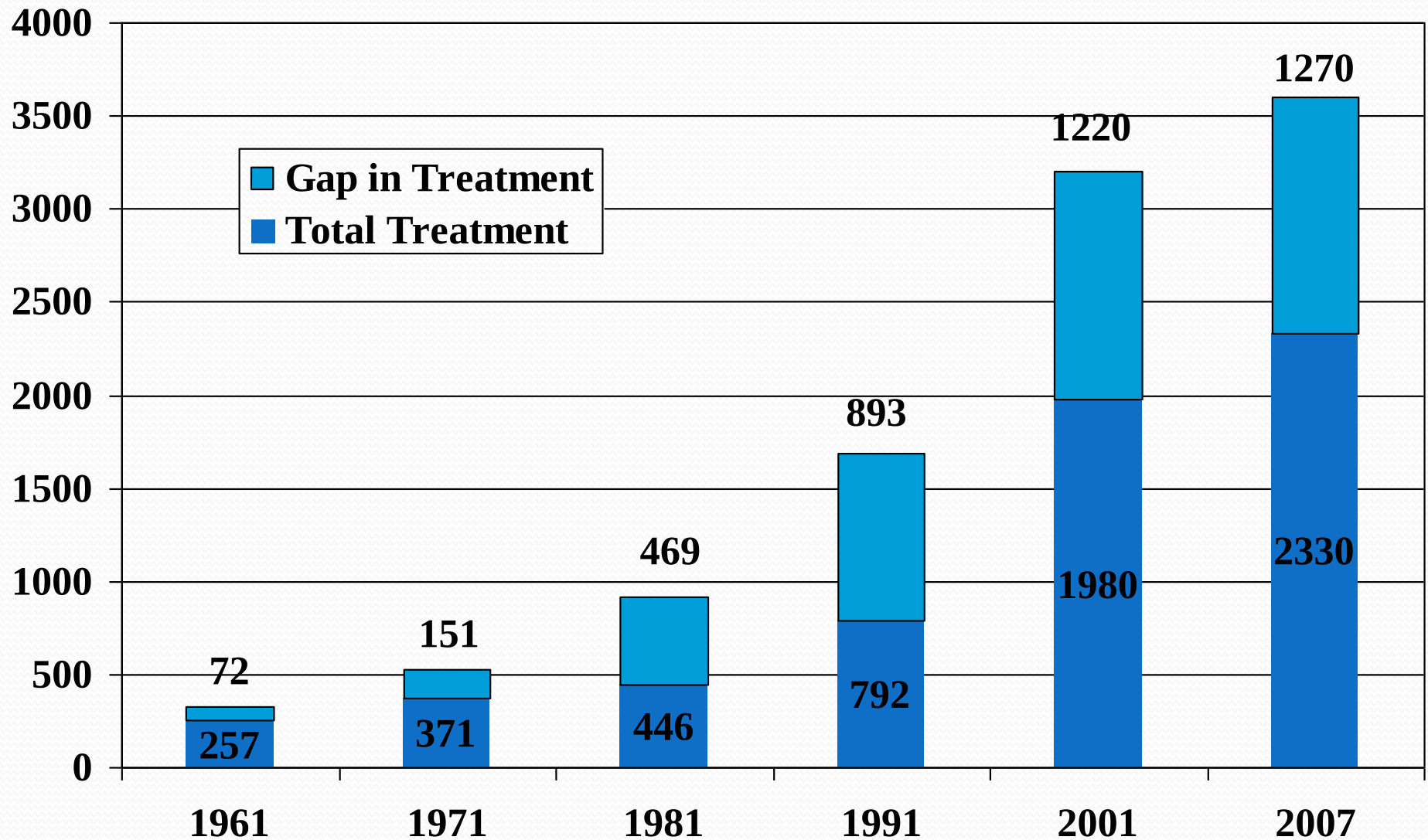
Experience from Ganga Action Plan

- Sewage collection system partial or non-existence
- Interception and diversion of drains - monsoon runoff
- Operation and maintenance of STPs
- Power supply
- Skilled manpower

Experience from industries

- High organic load - distilleries
- High TDS - pharmaceuticals, pesticides, rayon, dye and dye intermediates
- Small scale industries - location (residential areas), inadequate resources, skill etc.
- Problem with CETPs

Decadal Growth of Sewage Generation and Treatment in Delhi (MLD)



Wastewater as Resource

- Water value
 - Water demand is growing
 - Water scarcity
 - Pressure on water resources - GW, SW
 - Wastewater as a substitute of freshwater for irrigation
- Nutrient value
- Energy value

Wastewater Reuse

- Irrigation
 - agriculture
 - landscaping
 - horticulture
- Industrial
 - process
 - cooling
 - boiler feed
- Groundwater Recharge
- Other - recreation etc

Wastewater Reuse

- Agricultural irrigation
 - crop irrigation - crops not eaten raw
 - commercial nurseries
- Landscape irrigation
 - parks
 - school yards
 - golf course
 - cementaries
 - green belts
 - residential

Wastewater Reuse

- Industrial recycling and reuse
 - cooling
 - boiler feed
 - process water
 - heavy construction
- Groundwater recharge
 - groundwater replenishment
 - salt water intrusion control
 - subsidence control

Wastewater Reuse

- Recreational and environmental uses
 - lakes & ponds
 - marsh enhancement
 - stream flow augmentation
 - fisheries
 - wetlands

Wastewater Reuse

- Non-potable urban uses
 - fire protection
 - air conditioning
 - toilet flushing
- Potable reuse
 - blending in water supply
 - through surface water storage
 - through groundwater recharge

Wastewater Reuse - Water Quality Problems

- Irrigation - salinity, SAR
- Industrial cooling
 - scaling
 - metallic corrosion
 - biological growth
 - fouling

Water Quality classification for irrigation

Water class	Percent sodium	EC, 25 C	Boron		
			Sensitive crop	Semitolerant crop	Tolerant crop
Excellent	<20	<250	<0.33	<0.67	<1
Good	20-40	250-750	0.33-0.67	0.67-1.33	1-2
Permissible	40-60	750-2000	0.67-1	1.33-2	2-3
Doubtful	60-80	2000-3000	1-1.25	2-2.5	3-3.75
Unsuitable	>80	>3000	>1.25	>2.5	>3.75

Total dissolved solids

Class	TDS	Class	SAR	
Fresh water	0-1000	Excellent	<10	
Brackish	1000-10000	Good	10-18	
Salt water	10000-100000	Fair	18-26	
Brine	>100000	Poor	>26	

Mineral water quality

Cations	Concentration, mg/l	Anions	Concentration, mg/l
Sodium	1.3	Fluoride	0.15
Potassium	2	Chloride	2
Calcium	37	Sulphate	34
Magnesium	22	Bicarbonate	196
Strontium	0.15	Silicic acid	20.8
		Boric acid	0.07
		TDS	325
			40

Wastewater Reuse - Groundwater Recharge

- Surface spreading
- Direct injection
- Water quality problem
 - fate of contaminants
 - chemicals
 - pathogens
 - colours, dyes

Wastewater Reuse - Guideline for groundwater recharge through surface spreading

- Treatment - source control of toxics, tertiary treatment using activated charcoal, disinfection
- Depth - percolation through undisturbed soil unsaturated aquifer 10-50 ft
- Retention time in GW - 6-12 months
- Maximum % of reclaimed WW - 20-50%
- Monitoring - extensive

Wastewater Reuse - Guideline for groundwater recharge through direct injection

- Treatment - source control of toxics, tertiary treatment using chemical coagulation, clarification and granular media filtration, activated charcoal adsorption, volatile removal, reverse osmosis, disinfection
- Depth - not applicable
- Retention time in GW - 12 months
- Maximum % of reclaimed WW - 20%
- Monitoring - extensive

Wastewater Reuse

- Recreational and environmental uses
 - lakes & ponds
 - marsh enhancement
 - stream flow augmentation
 - fisheries
 - wetlands

Economic Value of the Waste Water Generated from Class I Cities and Class II Towns.

Nutrients/Organic Matter Average Concentration (mg/l)	Nitrogen 48	Phosphat e 11	Potassium 21	Organic matter 400	Value of water
Class I Cities: Nutrients, T/D Nutrients, T/Y Total Value, Rs.in Mill.	1143.6 417431	262 95661 6957	500 182626	9530 3478596 522	- - 2174
Class II Towns: Nutrients, T/D Nutrients, T/Y Total Value, Rs.in Mill.	116.5 42538	26.7 9748 709	50.9 18610	971 354488 53	- - 221.5

Note: Nutrient concentrations are taken from the average of Indian cities. The values of nutrients and organic matter have been computed by assuming @ Rs. 10000/t (4000/t) of nutrients and @ Rs. 150/t (59/t) of organic matter. The value of water for irrigation is also an appreciable amount and have been computed @ Rs.250/mld (100/mld) Sengupta, 1984, (the values are based on the prevailing costs during 1984, which might have been increased appreciably and present cost was taken as 2.5 times the cost of 1984).

Major challenge in implementation

- Water Act, 1974 – consent – standards (based on MINAS)
- MINAS – BAT – Economic viability (economic burden/turnover = 0.03 to 0.1)
- Implementation of MINAS
- MINAS is technology based
- No technology which is economically viable can make wastewater completely free from pollution
- Some residual pollution is bound to be there in treated effluent
- In order to minimise its impact on receiving water body it is essential that the treated effluent gets dilution
- Dilution is also important for assimilation of pollution
- Difficulty in achieving targeted WQ even after meeting MINAS
- Example of the Yamuna

Major Guiding Principles

- Combating Water scarcity problem
- Wastewater as a resource
- Prevent pollution rather than control.
- Use the precautionary principle.
- Apply the polluter-pays-principle
- Apply realistic standards and regulations
- Balance economic and regulatory instruments
- Establish mechanisms for cross-sectoral integration.
- Encourage participatory approach with involvement of all relevant stakeholders.
- Give open access to information on water pollution.
- Promote interstate co-operation on water pollution control
- Experience from the Ganga Action Plan
- Experience from industries

Action Plan

- Massive effort on sewage collection and treatment
- Major Efforts on Prevention of Pollution
- Economic Instrument for Pollution Control
- Financing Wastewater Management
- Selection of Technology
- Institutional Arrangement
- Information System
- Need for Coordinated Action
- River basin wise planning
- Location specific standards
- Tackling special problems of Arsenic and Fluoride pollution
- Reuse/recycling of treated industrial waste and resource recovery
- Waste minimization and clean technologies
- Incentives for Water conservation

Framework for Action Plan

- Identification of problem
- Definition of long-term and short-term objectives of pollution control
- Identification of options
- Arrangement for finance
- Operation and maintenance plan
- Management arrangement
- Monitoring of performance and success of the project

Waste Mangement

- Water resource protection – SW & GW
- Human health protection
- Environment protection
- Tourism promotion
- Property value
- Social aspects: villages where WQ is bad are socially neglected

Resources Needs

- Financial resources
- Environment resources
- Physical resources – energy, land etc
- Human resources
 - Resources are scarce and getting scarcer
 - Associated cost
 - Efficient use is must

Financial Aspects

- Funding
 - Govt – loan
 - Beneficiaries – residents
 - Market

Beneficiaries in Waste Management

- Environment
- Water resources: water supply and irrigation
- Public health
- Tourism
- Industries
- Local bodies
- Public (residents)

Economic instruments

- Pricing
- Pollution charges
- Marketable permits
- Subsidies or removal of subsidies
- Deposit refund system
- Enforcement incentives
- Non-compliance fees (fines)

Basis for Pollution Charges

- Volume
- Type of pollutants – toxics, biomagnification
- Treatment cost
- Regional water scarcity
- Dilution in receiving water

Conclusions

- Major emphasis on “polluter pay principle”
- Public-private partnership in waste management
- Reform of regulatory system
- Reform of institutional system
- Emphasis on water conservation
- Maintenance of minimum water level in water bodies to sustain ecosystem and assimilative capacity



THANK YOU