Ganga Water Pollution and the Role of Ganga Action Plan : A Case Study of Uttar Pradesh

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INTRODUCTION

The problem of water pollution and efforts in pollution reduction has recently received wider attention as a result of increasing impurities in our holy river. Water pollution not only lowers quality of water to a state unsuitable for consumption, but also affects the quality of life of those who interact with the polluted water. Generally, water gets polluted by organic and inorganic pollutants (organic mostly from domestic sewage, and inorganic from industrial sources) from various human activities and to some extent by natural activities (geo-chemical pollution, erosion, etc.).

Ganga is the mighty and holy river of India, supporting various life-forms along its basin, one of the largest in the world. For centuries, human beings co-existed with the river without any disharmony. Various social processes that are occurring along its course, intensive developmental efforts and agricultural practices and consequent changes in the production processes, increasing population and urbanisation all have turned the water of the river, unholy.

The major source of pollution to Ganga are domestic pollution load (including sewage and sewer waste water), industrial effluent discharge and non-point sub-surface run-off from the agricultural fields. The modes of interacting with

Ganga water are drinking (oral exposure), bathing (dermal) and for other human activities. Keeping the high pollution load which is enormously increasing every year, the government started the Action Plan for Prevention and Control of Pollution in River Ganga, commonly known as Ganga Action Plan.

The Ganga Action Plan has been prepared on the basis of the survey made by Central Pollution Control Board in 1982-83 on the townwise pollution load and industrial pollution load in river Ganga. The Ganga Action Plan was initiated in the year 1986. As the action plan had been in operation for more than seven years, it could be normally expected that considerable pollution reduction had taken place in the river.

The present study is an attempt to examine the various aspects of Ganga Water Pollution reduction programme or in other words known as Ganga Action Plan (GAP), and its role in pollution reduction. For this it is necessary, not only to understand the programme and its various dimensions, but the actual pollution load and changes over time is also need to be examined. The effort has been to collect as much data as possible,as a preliminary exercise, in understanding the intricacies of the Ganga cleaning process. This, we hope would serve as database for a future analysis on water quality of Ganga vis-a-vis quality of life along its banks.

Objectives

The major objectives of the present study are :

- To understand the water consumption and waste water generation in the Ganga basin and major tributaries.
- To analyse the major sources of pollution to river Ganga in the State of Uttar Pradesh.
- To review the process of Ganga pollution reduction through Ganga Action Plan, its various schemes, relative stages of completion and level of pollution load handled by the schemes. This also encompasses the efforts to reduce the industrial pollution.
- To relate the water quality data with pollution load and implementation of the schemes on the basis of twenty parameters of water quality (including physical, biological, bacteriological, toxicological, etc.)

Sources of Data :

There are three types of data and they were collected from different sources as below :

- Pollution load - Some of the data on pollution load have been provided by the Central Pollution Control Board and remaining from the implementing agencies of

Ganga Action Plan at various places in Uttar Pradesh. The industrial pollution load and polluting industries data have been collected from the Uttar Pradesh State Pollution Control Board, Lucknow.

Ganga Action Plan and the schemes implementation : The major data on the schemes and their process of completion yearwise and town-wise and the expenditure data on the schemes was provided by Ganga Project Directorate, New Delhi, after great difficulty. The details regarding completed schemes and capacities etc., was collected from the implementing agencies at various towns in Uttar Pradesh. Some of the data could not be used as the scope of the study is restricted.

Water Quality Data : The water quality data has been collected from the Central Pollution Control Board (Physical, Biological and Bacteriological parameters) and Industrial Toxicology Research Centre, Lucknow (Toxicological parameters - Heavy metals and pesticides).

A brief review of the studies :

There are very few studies on water pollution or even enviornmental issues, especialy in India, within the environmental - health economics. Most of the studies conducted in the west deal with the social costs aspects, social damage vis-a-vis benefits, environmental pollution and resource planning, health impact analysis, cost of pollution reduction vis-a-vis production techniques. They remain within the framework of neo-classical economics. Kneese & Bower (1968) on the management of water quality suggests the economics, technological and institutional modes under various real and imaginary conditions. Baumol and Oates (1979) describes the role of economics with its relation to environmental policy and its modification for bringing the quality of life to a sustainable state of living. Knesse (1970) describes the various aspects of environmental economics with special reference to problem of water pollution, its effects, calculates the social damage costs- explicit and implicit short run and long run, and also costs of prevention of pollution in various situations through modelling.

Narendra Singh (1976) critically reviews the various aspects of neo-classical economic framework, question of ideology and the process of environmental protection. He brings out the limitations of such a framework for environmental studies.

A few studies on Ganga water pollution are also available. These studies highlight the various dimensions of Ganga Water Pollution Reduction Programme (i.e. Ganga Action Plan), Shukla (1991) highlights the role of Indo-Dutch Sanitary Project in preventing and protecting the tannery workers being exposed to the tannery effluents. It also encompasses the efforts made by the Indo-Dutch project especially at Kanpur to improve working conditions and hence effects on the occupational health. Shankar (1992) critically reviews the functioning of the Ganga Action Plan vis-a-vis process of pollution reduction. He also refers to inherent contradictions in water quality improvement data. Mehta (1993) reviews the role of Ganga Action Plan, especially reduction of industrial effluents discharge through policy measures. He attributes the lack of effectice functioning of Ganga Action Plan to the increased red tapism and enforcement of schemes in careless manner. He attributes the industrial pollution reduction success to the "Ganges Case". Banerjee (1989) analyses the various aspects of Ganga Pollution and their etiology, Government's role and people's participation and performance appraisal in a critical manner.

LIMITATIONS :

1. The major problem ~~left~~ felt while analysing Ganga pollution reduction is the paucity of information on the health status and quality of life. It is, therefore, not possible to comment on the impact of the serious pollution load on the status of the people living along the river stretch. On the basis of these data, specific analysis of proving relative efficiency of schemes, social costs in terms of quality of life and deterioration in health status was also not possible.

2. The study has given major thrust on the pollution load, process of pollution reduction (both domestic and industrial) - physical completion of schemes vis-a-vis huge cost incurred, and the water quality data analysis. Paucity of time and dearth of database did not permit stastical analyses which could have been made.

3. Data on the disease patterns, monitoring data of quality of life aspects etc. were not available.

4. The major problem was with regard to data collection. The data reported in this study were collected with great difficulty after much persuasion. Even after that some of the data were not made available to the researcher on some technical ground. The secrecy attached to such public programme data has been most "revealing".

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- CHAPTER II -

GANGA WATER POLLUTION :

NATURE & EXTENT

The Ganga :

The Ganga is among the first ten mighty rivers in the world on the basis of average annual run-off measured in terms of thousand million cubic meters. It has the largest river basin in our country over one-fourth of its total surface area. It's basin has a total population of nearly 45 million, of which about 50 percent live in Uttar Pradesh, 10 percent in Bihar and 40 percent in West Bengal.

The total length of the Ganga from Gangotri to its outfall into the sea (measured along the Hoogly) is 2525 Km.[1] Of its total length, 1450 Km is in Uttar Pradesh, 445 Km in Bihar, 520 Km in West Bengal. It also forms the boundary between U.P. and Bihar for a length of 110 km. The Ganga in the upper plain passes through important cities of Uttar Pradesh like Kanpur, Allahabad, Varanasi and then enters Bihar in the Middle region.

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1. K.L. Rao., India's Water Wealth, Orient Longman, New Delhi. 1975; P. 245-255

In the upper plain region, it receives the Ram Ganga and Gomti from north and the Yamuna (which itself has got tributaries like Chambal, Betuwa, Ken etc.) from south. In the middle region man important tributaries like Ghaghara, Gandok, Son and Kosi join. In the lower part of the basin only Mahanadi joins later, 100 km downstream from Rajmahal the river bifurcates into two distributaries, Bhagirathi which further downstream is known as Hoogly draining through India and discharges into the Bay of Bengal; the Padma which drains through Bangladesh and joins Brahmaputra river further sub dividing itself into small distributaries. After passing through the dense forests of Sunderbans, the combined river system empties into the Bay of Bengal.

Ganga Basin :

The Ganga basin covers the states of Uttar Pradesh, Haryana, Bihar, West Bengal, Rajasthan, Madhya Pradesh, Himachal Pradesh, and the union territory of Delhi. Before discussing any specific state, it is important to know about the various aspects related to water use in the Ganga basin.

In Table-2.1, annual consumption of fresh water and generation of waste water in the Ganga basin has been described. The fresh water consumption is maximum in Uttar Pradesh (79.691

TABLE- 2.1
ANNUAL CONUMPTION OF FRESH WATER AND GENERATION
OF WASTE WATE IN THE GANGA BASIN
(MILLION CUBIC METERES)

	CONSUMPTION OF FRESH WATER				GENERATION OF WASTE WATER		
STATE	IRRIGATION USE	DOMESTIC USE	INDUSTRIAL & OTHER USE	TOTAL ANNUAL CONSUMPTION	FROM IRRIGATED FIELDS	FROM OTHER SOURCES	TOTAL ANNUAL GENERATION
HARYANA	8706 (98.6)	56 (0.06)	63 (0.08)	8.825	1.741 (98.8)	21 (0.2)	1.762
UTTAR PRADESH	74.907 (94.06)	1,692 (2.12)	3.042 (3.82)	79.641	14.981 (96.60)	528 (3.40)	15.509
BIHAR	21.625 (95.24)	793 (3.49)	289 (1.27)	22.707	4.325 (97.13)	128 (2.87)	4.453
WEST BENGAL	11.267 (90.82)	680 (5.48)	459 (3.70)	12.406	2.253 (87.67)	317 (12.33)	2.570
RAJASTHAN	10.465 (97.77)	187 (1.75)	51 (0.48)	10.703	2.093 (96.59)	74 (3.41)	2.167
MADHYA PRADESH	6.898 (94.98)	296 (4.07)	69 0.95)	7.263	1.380 (92.74)	108 (7.26)	1.488
HIMACHAL PRADESH	135 (95.07)	0.06 (4.23)	001 (0.70)	142	027 (93. 10)	002 (6.90)	29
DELHI	481 (50.63)	443 (46.63)	26 (2.74)	950	96 (21.52)	350 (78.48)	446
GANGA BASIN	134.484 (94.29)	4.153 (2.91)	4.000 (2.80)	142.637	26.896 (94.62)	1.528 5.38)	28.424
PERCENT OF TOTAL CONSUMPTION	94.28	2.91	2.80	100.00	18.86	1.07	19.93

(Parenthesis figures shows the percent of total annual consumption / wastewater generation)

Source: GANGA BASIN REPORT (Part II - Entire Ganga Basin)
ADSORBS/7/1982-83 (CPCB, New Delhi)

million cubic meter) out of the total annual consumption in the Basin (142.637 million cubic meter). The rate of Himachal Pradesh consume the least. Same as in the case of waste water generation, the maximum, almost above 50% of the total waste water of Ganga Basin comes from the State of U.P. (15.509 million cubic meter) out of the 28.424 million cubic meter, Himachal Pradesh, again contributes the least waste water to the total waste water generated in Ganga basin. Another salient feature about the table is Delhi contributes relatively more waste water from other sources, quite unlike from the other states where the waste water generation is more from agricultural and irrigated fields. Lastly, the maximum water is consumed and maximum waste water is generated from Irrigation (i.e. Irrigated field and agricultural purposes) in the Ganga basin.

Table-2.2 shows the domestic water supply (both rural and urban) in the Ganga basin with the per capita water supply and the B.O.D. (Biological Oxygen Demand) flux in waste water indicating the organic pollution. Looking at the table, it clearly shows that maximum water supply goes into the urban areas as urban water supply. Uttar Pradesh has maximum domestic water supply in the Ganga basin, 40.74 percent of the total. Delhi consumes maximum per capita water (urban water supply) from the Ganga basin. Himachal Pradesh has the least quantum of Domestic water supply, per capita urban water supply and BOD flux in waste

TABLE- 2.2

DOMESTIC WATER SUPPLY AND URBAN WASTE WATER GENERATION IN THE GANGA BASIN

	Annual Water Supply (Million Cubic Metres)			Urban Supply		Waste water generation from urban areas	
STATE	Total Supply	Rural Domestic	Urban Domestic	Per capita (Litre per day)	Annual flow (Million cubic meteres)	Rate of flow (Litres per second)	BOD flux in Waste Water (Kilogrmas per second)
ARYANA	56.082 (1.35)	30.144 (1.63)	25.938 (1.13)	71	20.751 (1.36)	0.658 (1.36)	0.359 (1.58)
TTAR PRADESH	1692.171 (40.74)	768.132 (41.50)	924.039 (40.13)	163	528.084 (34.56)	16.745 (34.56)	12.616 (55.44)
IHAR	793.470 (19.10)	585.931 (31.65)	207.539 (9.01)	101	128.274 (8.39)	4.068 (8.39)	1.238 (5.44)
EST BENGAL	679.794 (16.36)	215.526 (11.64)	464.268 (20.16)	175	317.056 (20.75)	10.054 (20.75)	4.387 (19.28)
AJASTHAN	186.830 (4.50)	94.800 (5.12)	92.030 (3.10)	120	73.624 (4.82)	2.335 (4.82)	0.602 (2.64)
ADHYA PRADESH	296.252 (7.13)	147.779 (7.98)	148.473 (6.45)	109	107.934 (7.06)	3.423 (7.06)	0.637 (2.81)
IMACHAL PRADESH	6.109 (0.15)	3.630 (0.20)	2.479 (0.11)	69	1.984 (0.13)	0.063 (0.13)	0.022 (0.10)
ELHI	443.119 (10.67)	5.119 (0.28)	438.00 (19.02)	223	350.400 (22.93)	11.111 (22.93)	2.894 (12.72)
ANGA BASIN	4153.827 (100)	1851.061	2302.766	154	1528.107	48.457	22.755

aranthesis figures shows percent of Total Ganga Basin

OURCE : GANGA BASIN REPORT (PART-II- ENTIRE GANGA BASIN)
ADSORBS / 7 1982-83 CPCB, New Delhi.

water. The BOD* flux in the waste water signifies the presence of organic pollution load. The relatively higher flow of urban waste water from Uttar Pradesh (16.745 litres per second) Delhi (11.111 litres per second) and West Bengal (10.054 litres per second) shows the magnanimity of urban waste water discharge to the river. The BOD flux is highest in Uttar Pradesh i.e. 12.616 kg per second (55.44% of the Total BOD flux in waste water in Ganga basin). Delhi's contribution to the BOD flux in waste water is also quite significant which is 2.891 kilograms per second (12.72% of the total Ganga basin). The table shows the astonishing urban waste water flow and maximum BOD flux in waste water contributed to the Ganga basin (finally discharged in river Ganga) by Uttar Pradesh. Other states like Himachal Pradesh, Haryana, Rajasthan and Madhya Pradesh do not contribute very significant BOD flux in waste water and waste water from urban area as the quantum of the domestic water supply is quite less in relation to states like Uttar Pradesh, Bihar, West Bengal and Union Territory of Delhi. The Table-2.2, not only explains the

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* BOD (Biological Oxygen Demand) : Any waste discharged to the water need (requires) oxygen for their biological oxidation in the receiving water(river, stream, etc..). The demand for oxygen for the oxidation decrease the oxygen level of the receiving water, hence signifying the pollutedness of water. Higher the BOD of the waste (or waste water), more the polluted water. For realistic evaluation of the oxygen depletion in water source (degree of pollution), the BOD is the most indicative measurement",

Chapter-I, Vol III, CIACCIO "WATER & WATER POLLUTION HADBOOK".

quantum of BOD flux in waste water from areas, but also shows the dichotomy of Domestic water supply in the Ganga basin.

Table-2.3 describes the urban organic pollution (BOD discharge), its origin and destination of discharge with the BOD content in waste water in Ganga basin. The maximum BOD discharge comes from the state of Uttar Pradesh, which is 1090.000 kg per day (55.44%) of the total Ganga basin. In Uttar Pradesh, the maximum BOD discharge is contributed by the industrial sources (65.9% of the total BOD discharge of Uttar Pradesh). Maximum BOD content in waste water is indicated in Uttar Pradesh state which is 737 milligram per litre. The destination of BOD discharge in surface water in Uttar Pradesh is relatively higher than the discharge to land in all other states/ Union Territories in Ganga basin. In Uttar Pradesh out of the total BOD discharge, 815.000 kg/day (74.8% of total BOD discharge in Uttar Pradesh) is discharge to land (shows the huge land (surface), pollution which finally goes to water sources through seepage and surface run-off). Direct urban BOD discharge destination to surface water to the tune of 275.000 kg/day shows the magnanimity of urban organic pollution load. The reason for the maximum organic pollution load comes from state of Uttar Pradesh is, the direct 275.000 kg/day BOD discharge plus unsurmountable surface and sub-surface run-off from BOD discharged to land (815.00 kg/day).

TABLE- 2.3

ORIGIN AND DESTINATION OF URBAN ORGANIC POLLUTION (BOD) DISCHARGE

(Figures in parenthesis indicate percent of the total BOD Discharge)

STATE	ORIGIN OF BOD DISCHARGE (KG Per day)		TOTAL BOD DISCHARGE	DESTINATION OF BOD DISCHARGE (Kilogram Per Day)		BOD CONTENT IN WASTE WATER
	DOMESTIC	INDUSTRIAL	(Kg /day)	SURFACE WATER	LAND	(Mg / per litre
HARYANA	19.335 (62.4)	11.665 (37.6)	31.000 (1.58) *	31.000 (100)	0 (0)	545
UTTAR PRADESH	371.626 (34.1)	718.274 (65.9)	1090.000 (55.44)	275.000 (25.2)	815.000 (74.8)	737
BIHAR	56.172 (52.5)	50.828 (47.5)	107.000 (5.44)	99.000 (92.5)	8.000 (7.5)	304
WEST BENGAL	266.076 (70.2)	112.924 (29.8)	379.000 (19.28)	379.000 (100)	0 (0)	436
RAJASTHAN	40.712 (78.3)	11.288 (21.7)	52.000 (2.64)	51.000 (92.1)	1000 (0.9)	258
MADHYA PRADESH	43.591 (79.3)	11.409 (20.7)	55.000 (2.80)	30.000 (54.5)	25.000 (46.5)	166
HIMACHAL PRADESH	1.900 (100)	0 (0)	1.900 (0.10)	1.900 (100)	0 (0)	350
DELHI	242.565 (97.0)	7.435 (3.0)	250.00 (12.72)	172.000 (69.0)	77.500 (31.0)	261
TOTAL GANGA BASIN	1027.830 (52.3)	938.070 (47.7)	1965.900	1039.400 (52.9)	926.500 (47.1)	461

SOURCE : GANGA BASIN REPORT (PART-II- ENTIRE GANGA BASIN)
ADSORBS / 7 1982-83 CPCB, New Delhi.

* Figures under this head (in parenthesis) shows the percent of total Ganga Basin.

In other states, the BOD discharge and destination of BOD, differs from the state of Uttar Pradesh because of relatively higher BOD discharge from industrial source and higher BOD discharge destination to land. The cause of high BOD discharge from Industrial source in Uttar Pradesh, may be due to the presence of industries like paper and pulp, food and beverages, sugar, distilleries etc. As the annual waste water generation shows the waste water which includes both organic, inorganic pollutants plus surface run-off etc.

Table-2.1, which shows irrigation use of fresh water and waste water generation from agricultural source has to be compared to Table-2.4 (Irrigation water, its salt load and annual waste water generation from irrigated fields in the Ganga basin) for getting a wider view of waste water generation from non-point agricultural sources and irrigation fields through sub-surface seepage and overland run-off. The state of Uttar Pradesh bears the maximum salt in irrigation water and waste water from irrigation fields, 57.70% of the 41742 million kilograms per annum and 4818,000 tonnes per year in waste water out of 6347,000 tonnes per year respectively. The state of Uttar Pradesh also contributes substantially in this regard as evident from the table.

TABLE-2.4

IRRIGATION WATER, ITS SALT LOAD AND ANNUAL WASTE WATER GENERATION FROM IRRIGAED FIELDS IN THE GANGA BASIN

STATE	IRRIGATION WATER (Million Cubic Meteres Per Annum) SURFACE WATER	GROUND WATER	TOTAL SUPPLY	SALT LOAD IN IRRIGATION WATER (Million Kilograms Per Per Annum) IN SURFACE WATER	IN GROUND WATER	TOTAL SALT	SALT CONCENTRATION IN IRRIGATION WATER (Milligrams Per Litres)	ANNUAL GENERATION OF WASTE WATER DISCHARGE FROM IRRIGATED FIELDS (Million Cubic Metres) FOR ENTIRE AREA	PER Sq. KM (Cubic Metres)	SALT LOAD LOAD IN WASTE WATER (Tonnes Per Year)
HARYANA	4371	4335	8706 (6.47)	874 (5.14)	2168 (8.76)	3042 (7.30)	349	1741 (6.47)	254569	608000
UTTAR PRADESH	44551	30456	74907 (55.70)	8911 (52.42)	15178 (61.34)	24089 (57.70)	322	14981 (55.70)	180596	4818000
BIHAR	15601	6024	21625 (16.08)	3120 (18.35)	3012 (12.18)	6132 (14.69)	384	4325 (16.08)	156216	1226000
WEST BENGAL	8521	2746	11267 (8.38)	1704 (10.02)	1373 (5.55)	3077 (7.37)	273	2253 (8.38)	174071	615000
RAJASTHAN	7010	3455	10465 (7.78)	1402 (8.25)	1728 (6.98)	3130 (7.50)	299	2093 (7.78)	161136	626000
MADHYA PRADESH	4607	2291	6898 (5.13)	921 (5.42)	1145 (4.63)	2066 (4.95)	300	1380 (5.13)	149173	413000
HIMACHAL PRADESH	95	40	135 (0.10)	19 (0.11)	20 (0.08)	39 (0.09)	289	27 (0.10)	238938	8000
DELHI	244	237	481 (0.36)	49 (.29)	118 (.48)	167 (0.40)	347	96 (0.36)	181132	33000
GANGA BASIN	85000	49484	134484	17000	24742	41742	310	26896	175419	6347000

(PARANTHESES FIGURES SHOWS THE PERCENT OF THE TOTAL GANGA BASIN)

SOURCE : GANGA BASIN REPORT (PART-II- ENTIRE GANGA BASIN) ADSORBS / 7 / 1982-83 (CPCB, New Delhi.)

From the data on the aspects of water use and waste water generation, it is apparent that the state of UP take a relatively upper position and , hence it becomes important to look at the ethiology and dynamics of waste water generation. Since the excessive pollution load in ganga basin is by and large the contribution of Uttar Pradesh, and analysis of the various aspects of human activity in terms of domestic and industrial sectors is attempted in the following sections.

<u>The Uttar Pradesh Stretch of River Ganga</u> :

The state of Uttar Pradesh is developing industrially and is also favoured for large investment by the centre. The major cities which are situated on the main stretch of river Ganga are Haridwar, Kanpur, Allahabad and Varanasi. The major tributaries are Ram Gangea, Yamuna, Kali, Gomti and Ghaghara. In our discussion, the tributary Ghagara is omitted as it joins the main stretch of Gangas in Bihar state. Ram Ganga, Gomti, and Yamuna are considered for our purposes as these cover the major area of Uttar Pradesh majority of the small scale industries, light engineering, sugar and chemical factories are situated in northern part i.e. Tarai region of Uttar Pradesh. Before going into the industrial sector, we would examine the domestic pollution load in Ganga.

The Ram Ganga which has 32493 km basin area with the annual average discharge 15258 million cubic meters is the first major tributary of the river Gomti with the basin area 30437 km and annual average discharge of 7390 million cubic meters. River Yamuna covering a basin area of 366 km has an annual average discharge of 93 million cubic meters.*

The Haridwar city of Uttar Pradesh has made its mark on the industrial map of India for the production of Antibiotics (at Rishikesh) and Heavy electricals (BHEL, Ranipur). Kanpur has a number of polluting industries such as Textile industries, Tanneries, dying and bleaching establishments. Allahabad, although known for its religious importance, has also got light engineering industries. Varanasi has silk, light engineering and diesel locomotive workshop of railways. Apart from these places, there are number of small industrially growing towns in northern and Tarai area famous for engineering equipments, sugar factories distilleries, alcohol factories etc. These are scattered through out the river basins in clusters.

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* K.L. Rao, "India's Water wealth" Orient Longman, New Delhi (1975). P. 245-255

The Annual Average Discharge for Major Cities in Uttar Pradesh Stretch of River Ganga basin :

CITY	BASIN AREA (km)	ANNUAL AVERAGE DISCHARGE (MILLION CUBIC METERS)
HARIDWAR	95522	23900
KANNAUJ	240510	39520
ALLAHABAD	358207	152000
VARANASI	441789	153000

SOURCE : K.L Rao, India's Water Wealth, Orient longman, New Delhi, 1975. pp - 255

The major causes of water pollution according to available literature (GANGA BASIN REPORT-II, 1982-83, (CPCB, New Delhi) etc.) are attributed, mainly to domestic pollution load, sewage and sewer water which amounts to around 80% of the total pollution load, Secondly, industrial effluent load, residues and industrial discharges amounts fourteen percent of the total population load but these are highly toxic with irreversible effects. Third cause is geochemical which constitutes six percent of total pollution load. Agricultural run-off which includes pesticides and Fertilizers subsurface run-off is not reliably quantified because of non-point discharge to the river.

Table-2.5 highlights the quantum of sewage and waste water from the various cities on the banks of the Ganges in the state of Uttar Pradesh. The domestic pollution load reflects the municipal sewage and the waste water which come to the water source, through Drains etc. Sewage is obtained from the disposal of wastes from lavatories, bathrooms, kitchens, laundries, laboratories, less capital intensive factories, etc. This sewage water also includes the waste disposed in factories and trade premises and water used in dwellings, hospitals and schools. Sewage water or waste water is cloudy dilute aqueous solution containing mineral, organic and inorganic matter. They include large and small particles of solid matter floating, and in suspension and colloidal and pseudo-colloidal dispersions. Domestic pollution load or sewer water and waste water primarily is composed of spent water which comprise urine, faces, soapy waste, food materials, paper and dirty water. Apart from these inert materials, sewage also contains living matters, especially bacteria, viruses and protozoa/Sewage water or Domestic pollution load may vary considerably in composition and strength from place to place due to marked differences in the habits and habitats of the people, level of awareness about environmental sanitation, diet intake of the people, water supply and composition of the industrial or factories waste into the sewer water. The industrial waste will profoundly effect the quality, composition and toxic content of sewer water. Unlike, what seems to be, "the

TABLE-2.5

DETAILED DOMESTIC POLLUTION LOAD IN UP STRETCH

Category	Place/ City	Population (lacs) 1981 Census		Estimated Sewage & Waste Water Generated (In Million Litres Per Day)
Class I	Haridwar Rishikesh	1.46 .29	1.75	33.3
	Farrukhabad & Fatehgarh		1.61	9.3
	Kanpur		16.39	360
	Allahabad		6.50	110
	Mirzapur		1.28	20
	Varanasi		7.97	147
Class II	Bijnor		0.57	3.69
	Mughal-Sarai		0.69	6.20
	Ghazipur		0.61	5.70
	Ballia		0.62	4.21
Class III	Uttar Kashi		0.10	0.85
	Joshi Math		0.09	0.5
	Gopeshwar		0.10	0.53
	Tehri		0.12	0.55
	Deva Prayag		0.02	0.14
	Narendra Nagar		0.04	0.17
	BHEL (Ranipur)		0.30	0.53
	Shrinagar		0.09	0.59
	Muni-ke-Reti		0.20	0.22
	Bageshwar		0.04	0.33
	Mandawar		0.12	0.41
	Anupshahar		0.15	1.15
	Saidpur		0.13	0.86
	Ramnagar		0.22	1.97
	Chunar		0.21	1.04

SOURCE : (a) Details of Class I cities were taken from Ganga Project Directorate Data 1992.
(b) Details of Class II and Class III cities were taken from the Ministry of Environment, 1985 " An Action Plan for prevention of Pollutio of the Ganga", Appendix A/2 & A/3, (based on 1981 census data)

actual solid content of sewage is vary more less. The total dry solid matter (organic and inorganic constitutes only about 0.1 per cent of the total. The remaining 99.9 per cent is composed of water.[2] The ratio of carbon to nitrogen in settled sewage is always lesser than that of industrial wastes, since the trade wastes constitutes much organic matter. The nitrogen in sewage is usually present in.

Two forms : Ammonical nitrogen and organically bound nitrogen, mainly derived from proteinaceous matters. Other inorganic constituents such as sulphates and bicarbonates of calcium and sodium are present in considerable amount in sewage. Present-day sewage contains appreciable amount of synthetic detergents, phosphates of sodium , fats, soaps, proteins carbohydrates and even the trace amounts of metals such as Copper, Chromium, Zic, Manganese, Lead and Nickel.

In Veselov's[3] classification sewer waters are divided into two groups : those containing organic pollutants and those containing inorganic pollutants; Organic pollutants in sewer

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2 N. Manivasakam; Environmental Pollution, National Book Trust, New Delhi; 1992 P. 52.

3. E.A. Veselov ; quoted in V.V. Metelev, A.I. Kanav. and N.G. Zasokhova; 'Water Toxicology, Amerind Publishers, New Delhi, 1983. pp.6

water include the following, substances : (1) primary products of animal origin; (2) primary products of plant origin; (3) products of heat treatment of solid fuels (coke, peat and wood); (4) Crude oil petroleum products; and their components; (5) organic acids; (6) Ketones and alcohols; (7) phenols; (8) organic dyes and their components; (9) substances acting on the surface (including washing agents); (10) pesticides (including insecticides herbades, fungicides, nematocides, zoocides, replants, chemosterilants, stimulators and inhabitors of plant growth and defoliants, etc.).

Inorganic pollutants include; (1) hydrogen sulphide and sulphureous compounds; (2) inorganic acids and alkalis; (3) inorganic poisons; (4) salts of sodium, calcium, magnesium and ammonia (chlorides, sulphates and nitrates); and (5) suspended mineral substances.

Sewer waters devoid of specific toxic substances usually contain organic pollutants, primarily material from food industries. As a result of putrefaction processes and decomposition, poisonous gases like- Hydrogen sulphide, methane and acetic and lactic acids gets accumlated.

Generally sewer water contains not only protein, carbohydrates, dissolved solid, synthetic detergents etc. but also the biological pollutants like pathogenic bacteria, viruses and algae. Pathogenic bacteria creates several diseases through contaminated water supplies; among them, cholera, dysentery, typhoid fever, gastroenteritis are the most common ad severe. Other diseases such as leptospiroses, brucellosis , and tularenia are less common. Some diseases such as blucellosis, tularenia and tuberculosis are common to man and certain animals and they may, therefore, be transmitted through water, polluted by animal discharges.

Viruses are infections agent of both plant and animal cells. Nearly seventy-six viruses are pathogenic to man (Derby et. al. (1960) cited in Manivasakam- "Environmental Pollution "). Among them, enteroviruses, adenoviruses, polioviruses, Infectious hepatitis viruses and coxsackle viruses are the most common viruses present in polluted waters and sewage. Poliomyclitis viruses is most important and dreaded among them. Other parasites found in sewage and sewer water are of considerable importance. Eggs of nematode worms and tapeworms are common in crude sewage.

INDUSTRIAL POLLUTION IN THE UTTAR PRADESH STRETCH OF RIVER GANGA

Industrial effluents which constitute only fourteen percent of the total pollution load on the river Ganga appears to be quantitatively less but infact this are highly toxic in nature. Toxcity is in terms of the degree of inorganic pollutants and organic chemicals mixed with various hazardous compounds. The greater health hazards are caused by the industrial effluent discharge to the river water. An assessment of the possible health risks can be made only on the basis of pollutants discharged and this is dependent on hid type of industries located along the Ganga.

Another significant feature about the industrial pollution as mentioned earlier in Table-2.3, is the relatively high BOD discharge from the industrial origin constituting 65.9% of the total BOD discharge in the state of Uttar Pradesh. This is probably because of the location of diverse industrial production centers with high BOD discharge like paper and pulp food and beverages sugar, distilleries etc. These polluting industries are located in Uttar Kashi, Haridwar, Rishikesh, Bijnore, Farrukabad, Kanpur, Unnao, Allahabad, Varanasi and Ghazipur. As mentioned in Table-2.6 (Town-wise/Nature of Industries, Effluent Discharge in million liter per day to the main stretch of River Ganga in Uttar Pradesh, the major industries creating significant effluent discharge to the river are sugar, paper, tannaries, distilleries, alcohol and chemical, fertilizer, pharmaceuticals, engineering, textiles, food and beverages, dyeing and bleaching and thermal power station. Maximum effluent discharge is from the pharmaceutical industry at

TABLE-2.6

TOWN WISE / NATURE OF INDUSTRIES, EFFLUENT DISCHARGE TO MAIN GANGA STRETCH OF UP.
IN PARANTHESIS THE NUMBER OF INDUSTRIES, (DISCHARGE UNIT-MILLION LITRES PER DAY)

	Sugar	Paper	Tannery	Drycell	Alchol & Chemical	Fertilizers	Pharmac-euticals	Engineering	Aircraft MANU	Textile	Food	Defence Arms	Dying & Bleaching	Card Board Manu.	Carpet	Thermal Power St.	Mill	Total Effluent Load
UTTARKASHI	-	-	-	-	0.020 (1)	-	-	-	-	-	-	-	-	-	-	-	-	0.020 (1)
HARIDWAR	2.500 (1)	-	-	-	-	-	-	50.000 (1)	-	-	0.025 (1)	-	-	-	-	-	-	52.525 (3)
RISHIKESH	-	-	-	-	-	-	70.000 (1)	-	-	-	-	-	-	-	-	-	-	70.000 (1)
BIJNORE	1.000 (1)	-	-	-	-	-	-	-	-	-	-	-	-	2.500 (1)	-	-	-	3.500 (2)
FARRUKHABAD	3.000 (1)	-	-	-	-	0.050 (1)	-	0.090 (2)	-	-	-	-	-	-	-	-	-	3.140 (4)
KANPUR	-	0.338 (5)	12.227 (146)	-	0.337 (4)	8.900 (1)	-	-	0.790 (1)	13.741 (29)	1.218 (7)	2.440 (2)	0.040 (2)	0.075 (2)	-	3.000 (2)	-	43.106 (201)
UNNAO	-	-	1.472 (17)	-	0.270 (3)	-	-	-	-	-	-	-	-	-	-	-	-	1.682 (20)
ALLHABAD	-	-	-	0.070	-	-	-	6.095 (4)	-	-	-	-	-	-	-	-	-	6.165 (5)
VARANASI	1.250 (1)	1.510 (4)	-	-	-	12.072 (1)	0.820 (3)	11.300 * (1)	-	-	-	-	-	0.430 (2)	0.030 (1)		.330 (1)	27.742 (14)
GHAZIPUR	1.050 (1)	-	-	-	1.170 (2)	-	-	-	-	-	-	-	-	-	-	-	-	2.220 (3)
NATURWISE EFFLUENT QUANTUM	8.800 (5)	1.848 (9)	13.639 (163)	0.070 (1)	1.797 (10)	21.022 (3)	70.820 (4)	67.485 (8)	0.790 (1)	13.741 (29)	1.243 (8)	2.440 (2)	0.040 (2)	3.005 (5)	0.030 (1)	3.000 (2)	0.330 (1)	210.100 (254)

SOURCE : GANGA PROJECT DIRCTORATE DATA UPTO 21-01-1991. ADSORBS / 7 / 1982-83 (CPCB, New Delhi.)

'* DISEAL LOCOMOTIVE ENGINEERING WORKSHOP.

Rishikesh which is 70 million litres per day. The second maximum discharge is from BHEL (Bharat Heavy Electricals Limited, Ranipur) at Haridwar which is 50 mld. Third maximum discharge from Kanpur is of highly toxic nature. This consists of more compounds, discharges from tanneries, textiles, bleaching and dying industries. Varanasi makes fourth in the total effluent discharge place. Out of the total effluent discharge of 27.742 mld from Varanasi 11.300 mld comes from diesel locomotive workshops and 12.072 mld comes from a fertilizer industry. In other places the quantum of effluent is small, but they also contribute to the pollution load dumping hazardous pollutants and compounds to the main river stretch of Ganges.

In terms of maximum effluent discharge (Ref. Table-2.5), pharmaceutical industries contribute the maximum 70.820 mld. Engineering industries occupy the second rank (For constituent of effluent, refer Table-2.7) with 67.485 mld. Textiles and tanneries has 13.741 mld and 13.639 mld respectively. This is comparatively more hazardous because of its constituents (which have relatively more health risks). The brief discription of constituents of effluent from various industries will give an insight into the toxic characteristics and possible health hazards., Table-2.7 is an effort to highlight these constituents.

TABLE-2.7

RIVER WISE / NATURE WISE NUMBER OF WATER POLLUTING INDUSTRIES IN THE U.P. STRETCH

Main River. Tributory	Sub-Tributory	INDUSTRY SUGAR	PAPER	TANNERY	DISTILLIARY	CHEMICAL	FERTILIZER	PHARMA-CEUTICALS	ENGINEERING	TEXTILE	MISC.	TOTAL
1. GANGA		3	12	-	3	3	3	4	7	29	7	71
	1.1. CHHUINYA	-	01	-	-	-	-	-	-	-	3	04
	1.2. ISHAN	1	2	-	-	-	-	-	-	-	-	3
	1.3. PANDU	-	2	1	-	18	1	2	6	43	12	85
	1.4. BAGAD/MAHAVA	1	1	-	1	-	-	-	-	-	-	03
	1.5. NON	-	1	-	-	2	-	-	1	2	2	8
	1.6. RIND	-	4	-	-	5	1	-	1	1	7	19
	1.7. NARAINI	2	-	-	-	-	-	-	-	-	-	2
	1.8. BANGANGA	1	-	-	-	-	-	-	-	-	-	1
	1.9. MALAN	1	01	-	-	-	-	-	-	-	1	3
TOTAL-1 =		09	24	01	04	28	05	06	15	75	32	199
2. KALI		9	12	-	3	3	-	1	6	6	13	53
TOTAL-2=		09	12	-	3	3	-	1	06	06	13	53
3. RAMGANGA		3	3	-	2	-	-	-	-	-	-	08
	3.1. SONT	2	1	-	1	-	-	-	-	-	-	04
	3.2. KURKA	-	1	-	-	-	-	-	-	-	-	01
	3.3. KHAKRA	1	1	-	1	-	-	-	-	-	-	03
	3.4. GARRA	2	2	-	1	-	-	-	-	-	-	05
	3.5. DHANDI/DHELA	-	2	-	-	-	-	-	-	-	4	06
	3.6. BHALLA/KOSI	1	6	-	1	-	-	-	-	-	2	10
	3.7. GAGAN	1	1	-	1	-	-	-	-	-	-	3
	3.8. BHAKHARA	2	-	-	-	-	-	-	-	-	-	2
	3.9. KICHHA	2	1	-	1	-	-	-	-	-	1	5
	3.10. ARIL	1	-	-	1	-	1	-	-	-	-	3
	3.11. DEORANIA	1	-	-	1	3	-	-	-	-	2	7
	3.12. SHANKHA	-	-	-	1	1	-	-	-	-	-	2
	3.13. RAJERA	-	1	-	-	-	-	-	-	-	1	2
	3.14. SANDHA/DEOHA	1	-	-	-	1	-	-	-	-	-	2
TOTAL-3=		17	19	-	11	5	1	-	-	-	10	63
4. YAMMUNA		2	25	3	1	4	-	7	23	67	27	159
	4.1. HINDON	1	42	-	-	7	-	7	24	9	26	116
	4.2. KALI	4	14	-	1	3	-	-	-	-	3	25
	4.3. KRISHNA	3	16	-	3	-	-	-	-	-	-	22
	4.4. DHAUDLA	-	-	-	-	4	-	-	-	-	-	4
	4.5. KARWAN	-	3	-	-	4	-	3	7	3	6	26
	4.6. BETWA	-	-	-	-	-	-	-	-	-	1	1
	4.7. SAUGAR	-	-	-	-	1	-	-	-	-	-	1
	4.8. EAST KALI	1	-	-	-	-	-	-	-	-	-	1
TOTAL-4=		11	100	03	05	23	00	17	54	79	63	355
5. GOMTI		4	2	-	1	-	1	-	2	-	2	12
	5.1. SAI	2	4	15	-	-	-	1	2	-	2	26
	5.2. SARAIN	3	-	-	2	-	-	-	-	-	-	5
	5.3. KATHANA	2	-	-	-	-	-	-	-	-	-	2
	5.4. RETH	1	-	2	-	-	-	-	-	-	-	3
TOTAL-5=		12	6	17	03	-	1	01	4	-	4	48
TOTAL(1+2+3+4+5) =		58	161	21	26	59	07	25	79	160	122	718

'SOURCE : GANGA PROJECT DIRCTORATE DATA UPTO 21-01-1991 AND UTTAR PRADESH STATE POLLUTION CONTROL BOARD, LUCKNOW

The main stretch of river Ganga has got backward linkages with its tributaries like Yamuna, Ram Ganga, Kali, Gomti and also nine sub-tributaries of main river Ganga itself. If this is considered, it will be a partial effort to understand the problem of water pollution by industrial effluents in Uttar Pradesh stretch of river Ganga basin. In order to place the problem in a wider framework, the naturewise/riverwise number of polluting industries have to be examined (Table-2.7). This table give data on both tributary wise number of various water polluting industries as well as industry wise effluent discharge in various tributaries. When tributary wise data is examined, it can be seen that the maximum polluting industries are discharging effluent in the tributaries of River Yamuna (355 industries, maximum = paper industry-100), the second highest number of polluting industries are discharging in tributaries of main river Ganga (199 industries - maximum textile industry - 75). River Ram Ganga has 63 polluting industries, followed in rank by river Kali with 53 and finally river Gomti with 48 industries.

In terms of industries, the maximum number of industrial units discharging the effluent on river Yamuna and its tributaries (100 units) belong to paper industries (Total number of units 161). Textile industries also contribute substantially to the pollution load. Out of 160 textile industrial units 79 discharge their effluent in to river Yamuna and its tributaries. The total number of industries discharging their effluent in either of these tributaries is 718 (or constituents of effluent, refer Table-2.7).

It is also necessary to examine the constituents of effluent (identification of pollutants) in order to understand their implication for health.

Table-2.8 attempts to discuss the constituents of effluent (based on available literature, as it has not yet become possible to have effluent index of each industry) from some of the major industries. Some of the major industries are paper, sugar, chemical, alcohol, and distillaries, tanneries, electroplating, fertilizers, textile, food and bewerages, etc. Generally on the upper northern are of Uttar Pradesh has a large number of electroplating (not mentioned in table, as unidentified by Uttar Pradesh. State Pollution Control Board (SPCB) Lucknow, distillaries etc. In Kanpur and Agra, the number of tanneries discharge low BOD waste with high toxicity.

As mentioned earlier, another source of water pollution is the non-point source of run-off from agricultural fields. The waste water generation from agricultural fields contains sub-surface run-off including fertilizers, pesticides and other organic compounds. Generally the non-point run-off contains relatively high salts and pesticides residues. These fertilizers

TABLE: 2.8

INDUSTRY WISE : CONSTITUENTS OF EFFLUENT

NAME OF THE INDUSTRY	MAJOR CONSTITUENTS
TEXTILE	: MINERAL, ACIDS, FATS, OILS, GREASE, DYES, SYNTHETIC DETERGENTS, etc.
ENGINEERING	: OILS,GREASE, HEAVY METALS, SOLID WASTES, etc.
PAPER	: COLORS, COLLOIDAL & DISSOLVED SOLIDS, FrEE CHLORINE, etc.
PULP	: SUSPENDED SOLIDS, KJELDAHL NITROGEN, AMMONIA NITROGEN, RESIDUAL PULPING LIQUOR, STARCH, MERCAPTANS etc.
TANNERY/ LEATHER	: SULFIDES, CHROMIUM, PHENOLS, TANNIC ACID, TARTARIC ACID, AMINES SUGAR, STARCHES, OILS, FATS, GREASE, DYES, SOLVENTS, LIME, MINERAL ACIDS etc.
FOOD & BREWERAGE	: HIGH SUSPENDED SOLIDS, HIGH BOD, PROTEINS, FATS, LACTOSE, etc.
DYEING	: HIGH COD, COLOURS, SUSPENDED SOLIDS, DISOLVED SOLIDS, BOD etc.
BLEECHING	: SOLID WASTES, DECOLORING AGENTS, SULFATE, FREE CHLORINE, HYDROGEN PEROXIDE.
ALCOHOL	: FERMENTED STARCHES, HIGH BOD, NITRATES & POTASH, SUSPENDED SOLIDS, COLOUR, etc.
CHEMICAL	: MINERAL ACIDS, PHENOLS, AMMONIA, ORGANIC ACIDS, NITRO COMPOUNDS etc.
FERTILIZER	: CHROMATE, AMMONIA, SULFATE, POTASSIUM CHLORIDE, PHOSPHATE, ZINC, OILS, FLORIDES etc.
SUGAR	: PROTIENS, SUGARS, SUSPENDED & DISSOLVED SOLIDS, HIGH BOD, COLOUR etc.
DRY CELL	: LEAD, CADMIUM, POLY CHLORINATED BIPHENOLS, MINERAL ACIDS, etc.
PHARMACEUTICALS	: HIGH SUSPENDED & DISSOLVED SOLIDS, VITAMINS, ORGANIC MATTER etc.
THERMAL POWER PLANTS	: IRON, COPPER, MERCURY, VANEDIUM, CHROMIUM, ZINC, PHENOLS, SULFATES, SULFITES, BORON, FLUORIDE, etc.
ELECTRO PLATING	: CHROMIC ACID, CYANIDE, FLUOBORATE, SULFAMATE, NITRATE, AMMONIA ORGANICS, ZINC OXIDE, COPPER CYANIDE, SODIUM CYANIDE, NICKEL CHLORIDE & SULPHIDE etc.
SYNTHETIC FIBER MANUFACTURING	: SYNTHETIC DETERGENTS, ANTI-STATIC LUBRICANTS, DYE, SOFTENERS & ESTERS, ACIDS, SULFANATED OILS, HYDROGEN PEROXIDE & CHLORIDE, CHLORINE, BISULFITE, TETRASODIUM PYROPHOSPHATE etc.

SOURCE/ REFERENCES : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE LKO, SITTING, MARSHALL : "ENVIRONMENTAL SOURCES & EMISSIONS HAND BOOK " NEMERROW, NELSON C." LIQUID WASTES OF INDUSTRY : THEORIES, PRACTICES & "TREATMENT ".

are urea, phosphate, nitrates, ammonia, potassium, sulphates etc. and other compounds of these which by interaction results in hazardous compounds. Nitrogen, phosphorus and potassium are generally used excessively. The ground water contamination takes place through leaching and sub-surface run-off takes the fertilizers and pesticides contents to the river water. Increasing nitrate run-off is of prime concern to health as the presence of these in drinking water may cause methemoglobinemia in infants ("blue babies"). Exececssive increase of nitrogen and phosphorus (increase in nutrients) will stimulate the growth of algea, further worsening the water quality due to increase in biochemical oxygen demand. In other words, the excessive increase in nitrates or other nutrients will lead to Entrophication. Pesticide resqdues also add to the agricultural run-off. Insecticides include chlorinated hydrocarbons, organophosphorus compounds, inorganic fluorine compounds and mercuric compounds. Among them chlorinated hydrocarbons are commonly used, DDT, BHC, Dieldrin, aldrin, endrin, heptchlor, methoxy chlor, chlordane, tetradifon, mirex, and toxaphene are the important chlorinated hydrocarbons. DDT, the most commonest insecticide is least soluble in water but more soluble in fats and oils.

Among the organophosphorus compounds, the important ones like parathion, malathion and TEPP (Tetra Ethyl Pyrophosphate), are very toxic to man and animals.

Herbicides are the chemicals which kills plants. Both selective herbicides (ferrous sulphate killing dandelions only etc) and non-selective herbicides (e.g. sodium arsenite, sulphuric acid and certain oils) kills all plants. The most commonly employed are 2,4-D (2,4-Dichlorophenox acetic acid and 2,4-5T (2,4-5 Trichlorophenoxy acetic acid. Though these are excellent weedkiller but are highly toxic. Fungicides are used to eradicate fungal diseases of plants. The common fungicides include sulphur, organic mercuric compounds such as methyl mercury and copper compounds. Lastly, generally among used pesticides, Rodenticides which are used to kill mice and rats. The important Rodenticides are norbormide, strychrine and sodium fuoracetate. These all pesticides are highly toxic to man and their persistence in water and human body is longer with multisystemic effects on the body.

Farm animal wastes and residues which get sedimented also contribute as an important component of agricultural non-point sub-surface run-off.

Out of all the major source of pollutants, two can be tapped efficiently with proper control and treatment facilities. These are domestic pollution load and industrially discharged effluent. Both can be controlled to a large extent with political and people's involvement. Environment Protection Act of 1986 is an attempt in this direction not withstanding its limitations.

The Ganga action plan was evolved to contain the pollution load with respect to both domestic and industrial sources.

The following chapters will attempt to highlight the Ganga Action Plan and its modus Operandi.

CHAPTER - III

GANGA ACTION PLAN - AN OVER VIEW

The Ganga Basin Report 1982-83, a comprehensive survey highlighted the sources and quantum of pollution load in the Ganga Basin Area. This Report formed the basis of an Action Plan for the prevention of pollution of the Ganga, prepared by the Department of Environment in December 1984. Later in February 1985, the Central Ganga Authority (with the Prime Minister as Chairman) was set up by the participant. This high level body was instrumental in determining policies and programmes, allocating resources and mobilising public support for the accomplishment of the Action Plan. In June 1985, the Ganga Project Directorate was established as a special wing of the Department of Environment to appraise and clear the projects prepared by the field level agencies, release funds, and coordinate the various activities under the Action Plan on a continuing basis.

On June 14, 1986, the Ganga Action Plan (GAP) was formally launched by the late Prime Minister Rajiv Gandhi at Varanasi. This Plan, considered as the "peoples plan", aimed at cleaning the Ganga from Rishikesh to Ulberia (West Bengal) by implementing pollution prevention and Central Programmes in 27 class I cities on the banks of Ganga. The Action Plan for pollution prevention has been undertaken in three major states of India through which river Ganga passes. The GAP is operative through, six major heads, viz (a) Interception & Diversion of waste water and sewage water (SEW), (b) Sewage Treatment Plants (STP), (c) Low Cost Sanitation (LCS), (d) Electric Crematoria

(CRE), (e) River Front Facilities and relative improvements (RFF), (f) other schemes for biological conservation of aquatic species, river quality monitoring etc. (OTH). The schemes were aimed to intercept, divert and treat waste water from the major 27 class I cities on the banks of Ganga.

It is important to look into the Action Plan and its components, before going into the actual functioning of the Action Plan schemes. "The immediate reduction of pollution load (leading eventually to total prevention) on the river and the re-establishment of self-sustaining treatment plant systems thus emerge as the two objectives of the Action Plan in the Phase"[1]. Accordingly, the following have been identified as the components of the Action Plan[2] :-

1- Renovation (cleaning/desilting/repairing) of existing trunck sewers and outfalls to prevent the overflow of sewage into Ganga.

2- Construction of interceptors to divert flow of sewage and other liquid waters into Ganga.

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1. Quoted from Page. 4, (4.0) Action Plan) "An Action Plan for Prevention of the Ganga" Department of Environment, Government of India, Revised July 1985.

2. Ibid, July 1985 Government of India

3- Renovation of existing sewage pumping stations and sewage treatment plants to recover the maximum possible resources specially energy to operate the pumping and treatment plants and derive the maximum possible revenue to cover at least the operation and maintenance cost of these plants.

4- Arrangements for bringing human and animal wastes from location proximate to the sewage/sullage digesters for sanitary disposal, production of energy and manure.

5- Providing sullage or sewage pumping stations at the outfall points of open drain, to divert the discharge from the river into the nearest sewers and treatment plants.

6- Alternative arrangements to prevent discharges of animal and human wastes from cattle sheds located on the river banks.

7- Low cost sanitation schemes in areas adjoining the river to reduce or prevent the flow of human wastes into the river.

8- Biological conservation measures based on proven techniques for purification of streams.

9- Pilot projects to establish cost effective systems for diversion of wastes now flowing into the river, their treatment and resource recovery.

10- Pilot projects to establish feasibility of technology applications in the treatment of wastes and resources/energy recovery.

These components became the premise of the schemes adopted to prevent and control the pollution load. There are 261 schemes which are operating under the six major heads. The main activities of these schemes are the following :

1- Interception and diversion schemes : These Schemes implement the main components (number 1, 2, 3, 4 & 5) of the Action Plan. They are constructing trunck sewers (renovating, in case it is existing), laying sewers (renovating, in case it is existence), diverting the flow of sewer water to the small pumping station and further from there to main pumping stations (in case, the pumping stations are non-functional, renovating or construction of new pumping stations in order to ensure the proper diversion system), the interception of the open drains taking the sewer water to the river and divert their flow to the pumping stations through new main sewer system (in case existing, renovation of the sewer system). These schemes are given relatively more weightage as the interception and diversion of the sewer water and sewage are considered to be the major source of pollution. The total number of schemes for interception and diversion under Ganga Action Plan are 88, out of which 40 are in Uttar Pradesh, 17 in Bihar and 31 in West Bengal. Out of these, 60 have been completed - 31 out of 40 in Uttar Pradesh, 15 out of 17 in Bihar and 14 out of 31 in West Bengal (Refer Table-3.1). The major works undertaken under these schemes are laying sewers, installation of small pumping station and main pumping stations, construction of the infrastructure for interception and diversion of sewage water (Renovation, in case it is existing).

2- Sewage Treatment Plants : The schemes of Sewage Treatment Plants are aimed at implementing the components of the Action which specify the disposal of sewage with feasible prospects of production of energy and manure (components - 3, 4, 5, 9 & 10). The scheme also incorporate the renovation of the existing treatment plants which discharge effluents into the river, but are unable to recover the energy and manure. The Sewage Treatment Plants aim to treat the sewage water (after few processes through aeration & filtration, the sullage is separated and taken to digester), and to separate sullage which produce the gas when taken to digester. The sludge flown into the sludge drying bed, is later used as manure, while the treated water is used in Agricultural fields for irrigation propose. The scheme of sewage treatment plants, under the Ganga Action Plan, has

TABLE- 3.1

LIST OF COMPLTED SCHEMES UNDER GANGA ACTION PLAN .

Distribution of completed schemes by type and state :
(As on 1.10.92)

Type of Scheme	Uttar Pradesh	Bihar	West Bengal	Total
1. Sewage Interception & diversion (SEW)	31 (40)	15 (17)	14 (31)	60 (88)
2. Sewage Treatment Plants (STP)	6 (13)	0 (7)	1 (15)	7 (35)
3. Low Cost Sanitation (LCS)	11 (14)	7 (7)	22 (22)	40 (43)
4. Electic Crematorium (CRE)	2 (3)	7 (8)	15 (17)	24 (28)
5. River Front Facilities (REF)	7 (8)	3 (3)	24 (24)	34 (35)
6. Other Schemes (OTH)	23 (28)	3 (3)	1 (1)	27 (32)
TOTAL :	80 (106)	35 (45)	77 (110)	192 (261)

Note : Figures in brackets represent the total no. of schemes

Source : Ganga Project Directorate Data, Upto 21.01.91

been assigned a major role in reduction of pollution load. The total number of schemes under Sewage Treatment Plants are 35, out of which 7 have been completed. There are 13 STP's schemes in U.P., out of which 6 has been commissioned, in Bihar out of 7 schemes none has been implemented and in West Bengal out of 15 schemes only one scheme of STP has been implemented (Refer Table-3.1).

Renovation and agumentation of capacity is also a component of scheme under sewage treatment plants. The constructed Sewage Treatment Plants are based on the established aerobic treatment techniques including activated sludge tricking filter etc., but in a few locations in the State of U.P., the new techniques of Sewage Treatment Plants (such as Up-flow Anaerobic Sludge Blanket (UASB) Treatment technology is being used in Jajmau, near Kanpur and Mirzapur as part of the Indo-Dutch Integral Sanitation Project) are being used in construction of new Plants. As stated above the renovation and capacity agumentation of STP's also falls under this head of scheme.

3- Low Cost Sanitation - As in many towns the sewage network is not extensive, the numerous schemes of low cost sanitation facilities involving construction of public toilet complexes, construction of new pour flush latrines and conversion of dry latrines, specifically on the river banks in almost all locations are taken up under the Ganga Action Plant. These schemes aim to provide the people with an alternative location for defecation, instead of river ghats (resultant increase in non-point domestic pollution load) and its direct flowing in to river water. There are 43 schemes under this category, out of which 40 has been implemented, 11 out of 14 schemes of low cost sanitation have been implemented in the state of Uttar Pradesh, in Bihar seven schemes have been implemented and in West Bengal, all schemes of low cost sanitation i.e. 22 have been implemented (Refer Table-3.1).

4- Electric Crematorium : In order to prevent the throwing of dead bodies in to the river, construction of Electric Crematorium has been given a special place among the schemes under Ganga Action Plan. The total number of crematorium schemes are 28 out of which 24 have been constructed, 2 out of 3 in U.P., 7 out of 8 in Bihar and 15 out of 17 crematoriums in West Bengal (Refer Table-3.1).

5- River Front Facilities : Under the Ganga Action Plan, schemes have been taken up at certain locations for the development of the river front areas for preventing the pollution of the river. These relate to river front development, protection of slopes of ghats, construction of the ghats (including beautification) construction of the community toilets, improvement of lanes and by-lanes, provision of street lighting, etc.

6- Other Schemes : Other Schemes include construction of Cattle Sheds, bio-monitoring of the water quality, construction of Dhobi Ghats, river side development schemes, etc., and any other scheme which aims to reduce pollution load (why it is mentioned in a vague manner, because it is not made clear by the Ganga Project Directorate that what are the schemes included in "other schemes". 32 such schemes out of which 27 have been implemented. In Uttar Pradesh 23 out of 28, in Bihar all the 3 schemes and in West Bengal only one has been implemented (Refer Table Number 3.1).

IMPLEMENTATION & MONITORING OF THE SUCCESSFUL COMPLETION OF THESE SCHEMES

The various State Governments agencies (e.g. in U.P. Jal Nigam, in Bihar, Bihar State Water and Sewage Board and in West Bengal Calcutta Metropolitan Development Agency) have been entrusted with the implementation of these schemes except in Jajmau (Kanpur) and Mirzapur of Uttar Pradesh, where the Indo-Dutch Sanitary Project is giving consultancy for the construction/implementation of the schemes.

STATE-WISE SCHEMES COMPLETED BETWEEN 1985-86 UPTO 1992-93 :

Under the Ganga Action Plan, 261 Schemes have been sanctioned out of which only 192 could be completed since 1985-86. As the stated objectives of the schemes have been already mentioned earlier, it will be pertinent also to look at the trends in the completion of these schemes. This will help us in understanding the process of Ganga Pollution reduction (Refer Table-3.2) :

Ganga Action Plan Schemes in Uttar Pradesh :-

The total number of completed schemes are 80 out of the 106 schemes sanctioned. Looking at the process of completion, maximum schemes are completed are in the years 1988-89 and 1989-90, which are 24 in each year. No schemes have been completed during 1992-93. The maximum schemes completed are 31 under the head of Interception and Diversion of Sewage & Waste Water, which has been given relatively more importance. Only two electric cremation have been completed so far.

The maximum schemes of Interception and Diversion of Sewage and Waste Water (i.e. 14) has been implemented during 1988-89 shows the urgency and importance felt to intercept and divert waste water under GAP. (Refer Table-3.3)

TABLE - 3.2

DISTRIBUTION OF COMPLETED SCHEMES BY TYPE AND YEAR
UNDER GANGA ACTION PLAN (As on 1.10.92)

Scheme Type	No. of Schemes Sanctioned	Number of Schemes completed during 85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	Total
STATE : UTTAR PRADESH										
CRE	3	0	0	0	0	0	1	1	0	2
LCS	14	0	0	1	4	6	0	0	0	11
OTH	28	0	1	7	2	9	3	1	0	23
REF	8	0	0	0	1	5	0	1	0	7
SEW	40	2	3	3	14	3	5	1	0	31
STP	13	0	0	0	3	1	2	0	0	6
STATE TOTAL	106	2	4	11	24	24	11	4	0	80
STATE : B I H A R										
CRE	8	0	0	0	0	5	0	1	1	7
LCS	7	0	0	0	1	6	0	0	0	7
OTH	3	0	0	0	0	3	0	0	0	3
REF	3	0	0	0	0	3	0	0	0	3
SEW	17	0	0	1	9	3	0	0	2	15
STP	7	0	0	0	0	0	0	0	0	0
STATE TOTAL	45	0	0	1	10	20	0	1	3	35
STATE : WEST BENGAL										
CRE	17	0	0	0	0	8	5	2	0	15
LCS	22	0	0	3	9	8	1	1	0	22
OTH	1	0	0	0	0	0	0	1	0	1
REF	24	0	1	0	1	12	7	3	0	24
SEW	31	0	0	0	1	7	1	5	0	14
STP	15	0	0	0	0	1	0	0	0	1
STATE TOTAL	110	0	1	3	11	36	14	12	0	77
GRAND TOTAL	261	2	5	15	45	80	25	17	3	192

Source : Ganga Project Directorate, New Delhi.

TABLE - 3.3.

YEAR-WISE EXPENDITURE ON VARIOUS TYPES OF SCHEMES

[Rupees in Lakhs]

SCHEME TYPE	EXPENDITURE DURING							TOTAL
	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	
CRE	0.00	81.06	325.59	494.86	249.76	67.26	56.11	1274.64
LCS	0.00	210.04	833.46	433.59	260.53	117.13	118.26	1973.01
O&M	0.00	0.00	2.63	18.83	113.04	196.59	106.83	437.92
OTH	0.00	141.47	220.42	244.90	309.89	118.24	66.88	1101.80
REF	0.00	78.08	235.67	420.95	326.66	106.51	114.54	1282.41
SEW	114.03	957.49	2045.81	2431.22	2273.09	1699.84	1771.92	11293.40
STP	0.00	427.27	791.91	1238.54	1370.11	1810.29	2532.99	8171.11
GRAND TOTAL	114.03	1895.41	4455.49	5282.89	4903.08	4115.86	4767.53	25534.29

SOURCE : GANGA PROJECT DIRECTORATE, NEW DELHI.

Ganga Action Plan Schemes in Bihar :

The total number of schemes completed are 35, out of the sanctioned 45 schemes. The emphasis is again on interception and diversion of sewage & waste water, 15 out of 17 such schemes were completed. The maximum number of schemes regarding Interception & Diversion were completed during 1988-89, i.e. 9. No sewage treatment plants out of total seven sanctioned plants have been completed till 1992-93.

The maximum number of schemes are completed during 1989-90 which includes six low cost sanitation schemes out of the total 7 sanctioned schemes. No schemes have been implemented during 1985-86, 1986-87 and 1990-91 the state (Refer Table-3.3)

Ganga Action Plan Schemes in West Bengal :

The total number of schemes completed are 77 out of the total sanctioned 110. West Bengal, has maximum sanctioned schemes compared to other states; the schemes of low cost sanitation (22), Electric Crematoria (17), sewage treatment plants and river front facilities (2). All the 24 schemes for river front facilities have been implemented.

Maximum number of schemes are completed during 1988-89 i.e. 36. Surprisingly only one Sewage treatment plant, out of 15 sanctioned STPS has been completed in 1989-90.

Although it is not possible to bring out a clean picture regarding the emphasis given on each scheme it is possible to say that the sewage interception and diversion schemes have been given more importance in Uttar Pradesh and Bihar. (Refer Table-3.3)

A MACRO VIEW OF THE YEAR-WISE EXPENDITURE INCURRED ON GANGA ACTION PLAN SCHEMES FROM 1985-86 TO 1991-92

Table 3.4 depicts the year-wise expenditure incurred on the schemes and for their operation and maintenance in three states. This table has to be viewed in relation to the data on distribution of completed schemes by type and year (Table-3.4) in all the three states under GAP :

The year 1985-86, being the year of initiation of GAP, except for UP, no other states have incurred any expenditure. In UP an amount of 114.03 lakhs has been spent for two schemes of interception and diversion of sewage.

In 1986-87, out of the total amount of 1895.41 lakhs incurred for five schemes 957.49 lakhs was spent for sewage interuption and diversion (SEW). There is a quantum leap in 1987-88 as far as expenditure is concerned. However about 50% of this was spent again for interception and sewage (SEW) in UP. (2045.81 lakhs out of 4455.49 lakhs).

TABLE - 3.4

DISTRIBUTION OF COMPLETED SCHEMES BY TOWN AND YEAR
IN THE STATE OF UTTAR PRADESH (As on 1.10.92)

Scheme Type	No. of Schemes Sanctioned	Number of Schemes completed during								Total
		85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	
Allahabad	18	0	1	1	3	3	1	0	0	14
F-bad & F-garh	4	0	0	0	0	3	0	0	0	3
Haridwar	20	0	3	4	3	5	2	2	0	19
Kanpur	20	0	0	0	5	2	2	1	0	10
Mirzapur	10	0	0	0	0	2	0	0	0	2
Varanasi	34	2	0	6	8	9	6	1	0	32
STATE TOTAL	106	2	4	11	24	24	11	4	0	80

Source : Ganga Project Directorate, New Delhi.

The year 1988-89 was a peak year with respect to expenditure as well as completion of schemes. A major share is again covered by SEW. The amount of 1238.54 lakhs which about one fourth of the total expenditure, incurred for implementing three Sewage Treatment Plants (STP).

A Similar trend is observed for the expenditure in 1989-90. However in to 1990-91 and 1991-92, Sewage Treatment Plants had incurred more expenditure unlike the previous years. However only two STPS are completed in 1990-91 which involved an expenditure of 1810.29 lakhs while, in 1991-92, although no STPS were completed, this activity incurred an expenditure of 2532.99 lakhs which shows that such schemes are highly capital intensive.

To sum up, the maximum expenditure from 1985-86 upto 1991-92 was on schemes of interception and diversion of sewage which was RS. 11293.40 lakhs. It shows the relatively higher importance assigned to these schemes under Ganga Action Plan. The Sewage plants, only seven were completed so far (six in U.P. and one in West Bengal) takes the second highest share of the total allocation i.e. Rs.8171.11 lakhs.

Viewed from the view point of relative asset creation, this expenditure does not match with physical completion of the work. The schemes of Low Cost Sanitation (40 schemes completed out of 43 schemes) takes the next place in expenditure with an amount of Rs.1973.01 lakhs. For River Front Facilities (34 schemes completed out of 35 total sanctioned schemes), an expenditure Rs.1282.41 lakhs was incurred. For the electric crematorium schemes (24 out of 28 schemes completed) the amount incurred was Rs.1274.64 lakhs. Lastly, the other schemes (27 completed out of the total 32 sanctioned schemes), the total expenditure incurred was Rs.1101.80 lakhs. For the operation and maintenance of the assets created which was an important activity for the sustenance of GAP schemes, an amount of Rs.437.92 lakhs was spend.

The above discussion and analysis gives a macro view of the process of assets creation and expenditure involved on the Ganga Action Plan. As the present study is focusing on the state of Uttar Pradesh, the micro level data pertaining to that state would be discovered in the following schemes.

GANGA ACTION PLAN SCHEME AND UTTAR PRADESH

Table-3.4 shows the town-wise number of schemes completed during the period from 1985-86 to 1992-93. As already mentioned, out of 106 schemes only 80 schemes have been completed upto 1992-93 in the state of U.P. At Allahabad, the total number of schemes sanctioned were 18, out of which 14 have been completed. The maximum number of schemes sanctioned and completed in Varanasi were (32 out of 34), while in Haridwar out of the 20 schemes 19 were completed, in Kanpur only 10 schemes were completed out of 20 sanctioned schemes.

The maximum number of schemes were completed during 1987-88 to 1990-91 70 schemes out of a total of 80 schemes were created during these years.

SCHEME WISE BREAK UP OF THE MAJOR TOWNS:

Table-3.5 shows the type-wise completed schemes in all the major towns under Ganga Action Plan. The maximum number of schemes sanctioned in Varanasi are (34), out of which 32 were completed. In Varanasi, maximum number of schemes for Interception and Diversion of Sewage (10) were completed. At Allahabad, significant number of Interception and Diversion of Sewage schemes (9) were completed. However, no Sewage Treatment Plants have been constructed so far. This shows the relative importance assigned to this type of schemes.

At Kanpur, where the domestic pollution load is reported to be the highest, out of the total 20 sanctioned schemes only 10 schemes (Three Interception and Diversion , Two schemes of Sewage Treatment Plant, Low Cost Sanitation and other

TABLE - 3.5

DISTRIBUTION OF COMPLETED SCHEMES BY TOWN AND TYPE IN STATE OF UTTAR PRADESH (As on 1.10.92)

Town	No. of Schemes Sanctioned	Number of Schemes completed type-wise						
		SEW	STP	LCS	CRE	RFF	OTH	Total
Allahabad	18	9	0	2	0	1	2	14
F-bad & F-garh	4	0	0	2	0	1	0	3
Haridwar	20	8	2	2	1	0	6	19
Kanpur	20	3	2	2	1	0	2	10
Mirzapur	10	1	0	0	0	1	0	2
Varanasi	34	10	2	3	0	4	13	32
STATE TOTAL	106	31	6	11	2	7	23	80

Source : Ganga Project Directorate, New Delhi.

schemes each) were completed. However, two schemes of Sewage Treatment Plants have not started working so far. At Mirzapur, out of 10 schemes sanctioned, only one scheme of Interception and Diversion of Sewage and River Front Facilities each have been completed. At Haridwar, substantially high number of schemes were completed (maximum schemes are for interception and diversion of sewage).

It is evident that with substantially high number of interception and diversion of sewage water schemes (31 out of total 80 completed schemes) and only six Sewage Treatment Plants, the process of waste water treatment is not the priority. The emphasis is on interception and diversion (finally dumping the sewage water to the river) and not on the treatment of waste water. Therefore, the Interception and Diversion of Sewage Water, has been the only major activity carried out by GAP to reduce the ganga water pollution. The table on the impact of the Ganga Action Plan Schemes (Refer Table-3.6) would help in understanding how much pollution reduction has taken place.

Impact of GAP Schemes (Town-wise & Year-wise quantity of waste water intercepted and diverted/ treated (in the paranthesis))

Table- 3.6 shows the process of pollution reduction (as measured in terms of catering of the domestic pollution load) due to implementation of GAP Schemes.

TABLE - 3.6

IMPACT OF GAP SCHEMES
TOWN-WISE & YEAR-WISE QUANTITY OF WASTE WATER INTERCEPTED AND DIVERTED/ TREATED IN THE STATE OF UTTAR PRADESH (As on 1.10.92)

City	Total Waste Water from Class-I Towns	Quantity to be intercepted / diverted	Capacity commissioned for waste water inteception diversion / treatment (mld) during							
			1986	1987	1988	1989	1990	1991	1992	Total
Haridwar-Rishkesh	33.3	33.3	18	-	-	14	- (6)	- (18.3)	-	32 (24.3)
F-bad & F-garh	9.3	2.7	-	-	-	-	-	-	-	-
Kanpur Jajamau MPS	360	160	-	-	-	111	9	5	-	125
Allahabad	110	90	-	-	80	10	-	-	-	90
Varanasi	147	125	-	-	22 (22)	3	23	-	77 (80)	125 (102)
Mirzapur	20	20	-	-	-	-	-	-	-	-
TOTAL UTTAR PRADESH	680	431	18	-	102 (22)	138	32 (6)	5 (18)	77 (80)	372 (126)

NOTE : Figures in parenthesis represent the quantity being treated out of the total quantity intercepted and diverted

SOURCE : GANGA PROJECT DIRECTORATE, NEW DELHI.

One can see that country to the claims, out of 431 mld waste water to be intercepted and diverted from the total waste water generated i.e. 680 mld from the UP stretch, only 325 mld has been intercepted and diverted so far. Kanpur , where the domestic pollution load is maximum, only 125 mld (maximum quantum of interception and diversion performed during 1989 which is 111 mld) has been handled so far. In relation to the schemes implemented, total domestic pollution load and actual waste water interception and diversion till 1992, the progress and impact has been quite tardy and contrary to the success story. At Varanasi, where the sewage waste water is still going to the Ganga the figures in table- 3.6 shows complete interception and diversion of waste water which depicts the inherent contradictions.

Regarding treatment of waste water , so far only 126 mld out of 680 mld total waste water generated has been taken into consideration for treatment. This shows the grim picture regarding the process of pollution reduction, and also raises questions on the feasibility and efficacy of these schemes as well as the process of implementation.

In order to understand the complete process of pollution reduction it is also necessary to examine the cost aspects (sanctioned cost and expenditure and place-wise, scheme-wise total expenditure incurred in the state of Uttar Pradesh).

Table-3.7 shows the difference between expenditure incurred and sanctioned cost of the completed scheme in Uttar Pradesh, which means that the maximum possible amount has been spent on almost all schemes under G.A.P.

<u>Expenditure on Various Types of Schemes in Uttar Pradesh :</u>

Table-3.8, gives the scheme wise expenditure in UP as on 1-4-93 (Six Months later than the data reported in table 3.7). Till 1989-90, the expenditure was relatively higher on the Interception and Diversion of Sewage and as per data, total expenditure on such schemes in the sate of UP was RS. 3109 Lakhs. This figure is relatively less than the expenditure incurred on sewage treatment plants which is RS. 4480 lakhs. This may be due to recent intensive activity in the construction of sewage treatment plants in Allahabad, Kanpur and Mirzapur. For the 23 out of 28 Schemes under `other schemes' the total expenditure is Rs. 921 lakhs. On low cost sanitation schemes, the total expenditure incurred is Rs. 773 lakhs. River Front Facilities incurred an expenditure of Rs. 670 lakhs. Finally the least among all, an amount of Rs. 140 Lakhs has been incurred on electronic Crematorium construction schemes. The total expenditure incurred has been Rs. 10093 lakhs till 1-04-93 since the implementation of GAP Schemes.

TABLE - 3.7

DISTRIBUTION OF COMPLTED SCHEMES BY TYPE, SANCTION COST AND EXPENDITURE.
IN THE STATE OF UTTAR PRADESH (As on 01-10-92)

(Sanctioned cost / Expenditure in Rupees lakhs)

		SEW	STP	LCS	CRE	RFF	OTH	TOTAL
No	:	31	6	11	2	7	23	80
Sanc Cost	:	1919.04	498.95	496.82	125.56	519.96	680.63	4240.96
Expdir	:	1974.11	533.79	498.62	110.21	487.79	682.93	4287.45

SOURCE : GANGA PROJECT DIRECTORATE, GOI, NEW DELHI.

TABLE- 3.8

GANGA ACTION PLAN

Expenditure on various types of Schemes in Uttar Pradesh

(As on 1.4.92)

Scheme Type	Rupees Lakhs
1. Interception & diversion	3109
2. Sewage Treatment Plants	4480
3. Low Cost Sanitation	773
4. Electic Crematorium	140
5. River Front Facilities	670
6. Other Schemes	921
TOTAL :	10093

Sorce : Ganga Project Directorate, GOI, New Delhi.

Town-wise expenditure on the Ganga Action Plan Schemes as on 1-04-93 : Table 3.9 shows the town- wise expenditure incurred on the various schemes up to 1-04-93. Varanasi occupied the first place with the maximum expenditure of Rs. 4274.86 lakhs. Kanpur, which has maximum domestic pollution load and where only 10 schemes out of 20 sanctioned schemes are completed,the total expenditure is Rs. 2066.10 lakhs. Mirzapur, where the Sewage Treatment Plant is being constructed with new treatment technology (UASB Technology) under the Dutch consultancy, an expenditure of Rs. 756.79 lakhs has been incurred. The amount incurred for completion of schemes in Farrukhabad & Fatehgarh is only RS. 169.46 lakhs.

GANGA ACTION PLAN AND INDUSTRIAL POLLUTION REDUCTION

Ganga Action Plan do not have any specific schemes to reduce the industrial effluent discharge into river Ganga. In fact GAP is trying to enforce the Water Pollution Act, 1974 and Environment Protection Act 1986 through putting legal pressure to the gross polluting industries identified by State Pollution Control Board (SPCB) in all the three states. In case of Uttar Pradesh the SPCB has identified 254 Industries (Refer Table 2.6, Chapter II), but surprisingly Ganga Project Directorate (through different standards of identification) is providing data only on 68 gross polluting industries along the main stretch. It

TABLE- 3.9

Town-wise Expenditure on GAP Schemes in Uttar Pradesh

(As on 1.4.93)

Town	Expenditure Till 03/93
Allhabad	1521.49
F-Bad & F-Garh	169.46
Haridwar	1312.58
Kanpur	2066.10
Mirzapur	756.79
Varanasi	4274.86

SOURCE : GANGA PROJECT DIRECTORATE, NEW DELHI.

mentions 34 industries in UP, 5 in Bihar and 29 in West Bengal. Many of the 254 industries identified by State Pollution Control Board on different standard do not have any necessary treatment facilities for their effluents discharge. The Ganga Action Plan through State Pollution Control Board intend to enforce Anti-Pollution laws by asking these small scale but high effluent discharging industries to install Effluent Treatment Plants or other anti-pollution devices according to their quantum of discharge. But as the violations are rampant in this regard the only way to enforce laws is to take legal action against the defaulting industries. The legal procedure needs the political will and stern action against the polluting industries and this seem to be lacking. This is one of the reasons for the slow and retarded progress in industrial pollution reduction.

This chapter shows that despite huge expenditure incurred on different schemes, little has been achieved in terms of pollution reduction even with regard to domestic pollution. However, it is necessary also to look into the specific parameters of water quality before arriving at a definite conclusion in this regard.

- CHAPTER - IV

IMPACT OF GANGA ACTION PLAN ON THE WATER QUALIT

Water quality monitoring is an organised effort to analyse the water samples, at certain sampling stations on the given parameters of water quality.

Under Ganga pollution reduction and prevention plan, the water quality has been monitored at intervals on certain parameters to prove the effectiveness of the various pollution reduction schemes. An over view of the water quality monitoring data, in comparison to domestic and industrial pollution load quantum would give an indication of the efficacy of the implemented schemes. An effort of this kind will be made in the present Chapter after presenting the data on the water quality with regard to different pollution reduction schemes, given in Chapter-I and Chapter-II respectively.

Before assuming the claims on river water quality improvement on the basis of the samples collected from certain sampling stations, it will logical to look at the aspects of water quality parameters in general. The water quality parameters will be chosen keeping the desired standard (water use, standard `B' outdoor organised bathing, under Ganga Action Plan) in consideration.

WATER QUALITY PARAMETERS :-

In any of river water pollution control and reduction plan, there are certain objectives which govern the complete package of schemes such as techniques of pollution reduction schemes, interrelatedness of the schemes, water quality desired standard to be achieved, etc. This objective of water quality standard to be achieved by the complete pollution reduction plan, plays the determining role in visualising the water quality parameters. Other aspect which influence the parameters of water quality is the quantum of diversified pollution load from the various sources. Keeping the pollution load and the desired water quality standard certain qualitative and quantitative parameters have to be choosen.

In actual practice out of hundred of water quality parameters existing, only some of the parameters with regard to water standard to be attained and pollution load are chosen the analysis. The Federal Water Pollution Control Administration & Storet System of Data Collection, Processing, Analysis and Reporting includes 424 such parameters in six major groups (general physical and chemical, microbiological, organic materials, treatment related observation s etc.)[1]

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(1) CIACCIO, LEONARD. L "WATER AND WATER POLLUTION HAND BOOK" VOL. III, PP. 976

The emphasis on the organic and in organic pollution monitoring water quality quantum and relatively highly pollutants from the discharge from industrial sources or high pollution load (organic pollutants in the waste water) from domestic sources. The parameters are set to find out the degree or precent of violation from the desired standard of water quality. As the water quality differs from the upstream, and downstream of the particular place on town, the variation in the water quality parameters also depicts the contribution made by discharges from that place or town in further deteriorating the water quantity.

WATER QUALITY MONITORING IN THE STATE OF UTTAR PRADESH UNDER THE GANGA ACTION PLAN :

To start with the monitoring of Ganga water quality has been done by the Central Pollution Control Board, through their state level Boards in all the three states, Uttar Pradesh Pollution Control Board in the state of UP specifically. The parameters for water quality monitoring chosen by the Central Pollution Control Board can be broadly divided as :

1. Physical Parameters : PH, Turbidity, Temperature

2. Parameters for mineral constituents : conductivity Total Alkalinity, Chloride, Sulphates, Calcium, Magnesium, Hardness (as CaCo3)

3. Parameters as Indicators of Organic Pollution : Dissolved Oxygen, Biochemical Oxygen demand, Chemical Oxygen demand, Nitrates+ Nitrates, Total kjeldahl Nitrogen (Total organic Nitrogen)

4. BACTERIOLOGICAL PARAMETERS : Faecal Coliform, Total Coliform.

The Parameters which have been taken by the CPCB are aimed at identifying the mineral content and organic pollution.

The other set of water quality parameters have been identified by the industrial Toxicology Research Centre to determine the concentration range of the major heavy metals and pesticides in the Ganga water. The main objective of these parameter is to identify the concentration of these heavy metals being discharged from the industrial origin and pesticides from the agricultural non-point sources. These parameters are s follows :

Heavy Metals :

Arsenic (Ar)
Cadmicim (Cd)
Chromium (Cr)
Copper (Cu)
Ferrous (Fe) "Iron"

Lead (Pb)

Manganese (Mn)

Nickel (Ni)

Mercury (Hg)

Zinc (Zn)

Pesticides

ORGANOCHLORINE	: DDT
	: BHC
	: Endo Sulfan
ORGANOPHOSPHORUS	: Malathion
	: Methyl Parathion
	: Dimethoate
	: Ethion

The sampling stations on the main stretch have been established on those places upstream and downstream - where the pollution prevention and reduction GAP schemes are being implemented. The CPCB has been also given emphasis on the pollution level of tributeries through monitoring their water quality. As the tributary pollution doesn't fall into the scope of the study, the sampling stations on the main river stretch are being listed (from upstream) as follows :

RISHIKESH, UPSTREAM HARIDWAR

HARIDWAR DOWNSTREAM

GARMUKTESHWAR

KANNAUJ UPSTREAM

KANNAUJ DOWNSTREAM

KANPUR UPSTREAM

KANPUR DOWNSTREAM

ALLAHABAD UPSTREAM

ALLAHABAD DOWNSTREAM

VARANASI UPSTREAM

VARANASI DOWNSTREAM

TRIGHAT AT GHAZIPUR

WATER QUALITY MONITORING ON THE SELECTED PARAMETERS ON THE SAMPLING STATION :

Water quality has been monitored every year during various phases of river and seasonal fluctuations. For the analysis of each parameters the annual mean has been taken in case of parameters of Central Pollution Control Board. To have the wider view the range of concentration of the heavy metals and pesticides has been taken for analysis in case of the parameters of Industrial Toxicology Research Centre Data.

The parameters which have been taken from the list of the parameters are as follows:

- Physical indicators of organic pollution and Bacteriological parameters (Monitored by Central Pollution Control Board) :

1. PH
2. DISSOLVED OXYGEN (DO)
3. BIOLOGICAL OXYGEN DEMAND (BOD)
4. NITRATES + NITRITES
5. FAECAL COLIFORM
6. TOTAL COLIFORM

- HEAVY METALS & PESTICIDES (MONITORED BY INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW) :

HEAVY METALS :

7. CADMIUM (Cd)
8. CHROMIUM (Cr)
9. COPPER (Cu)
10. IRON (Fe)
11. LEAD (Pb)
12. MANGANESE (Mn)
13. MERCURY (Hg)

PESTICIDES

Organochlorine -

14. DDT

15. BHC

16. ENDOSULFAN

Organophosphorus -

17. MALATHION

18. METHYL PARATHION

19. DIMETHOATE

20. ETHION

The water quality monitoring Data for the Central Pollution Control Board is available from 1983 upto 1989, while for Industrial Toxicology Research Centre, it is available from 1986-87 to 1990-91. As the limited Data on the water quality parameters are available, it is difficult to analyse the impact of pollution reduction efforts.

WATER QUALITY ANALYSIS ON THE STATION-WISE

YEARLY WATER QUALITY MONITORING OF THE PARAMETERS :

The water quality analysis is based on the water quality monitoring data available for each parameters at various stations. First, the Central Pollution Control Board Data for physical, organic pollution and bacteriological parameters and the stationwise and yearwise fluctuations are taken for analysis.

PH : AS PARAMETER OF WATER QUALITY :

PH is the concentration of hydrogen ions in any solution. PH denotes the intensity of the acidity or alkalinity of a solution*.

PH value being as an indicator of the acidity and alkalinity, has a great significance in water quality analysis. Many important chemical and biochemical reactions only take place at a certain PH value or within a narrow PH range. PH is of great practical importance in industry for controlling of large - scale operations involving various processes.

PH is defined by the relationship :-

$$PH = -\text{Log}_{10}\ {}^{c}H = \frac{1}{\text{Log}_{10}\ {}^{c}H}$$

(Where ${}^{c}H$ = that concentration of hydrogen ion (gramme per litre), so that ${}^{c}H = 10^{-PH}$. It is important to realise that PH scale (the lowest known PH is minus 0.3 strong Acid case and 14.5 in highly alkaline solution. PH is a logarithmic one and not an arithmetical or linear scale. Thus, an increase in PH value by one unit means a tenfold decrease in hydrogen ion concentration (i.e. in the intensity of the acidity).

KLEIN, LOUIS., ``RIVER POLLUTION-2 causes and effects", Chapter-16. Page 182.

PH value and the various ranges affects innumerable biochemical and biological conditions conducive for the growth of various typical micro-organisms. The majority of bacteria and other micro-organisms are killed by markedly acid or alkaline conditions and usually flourish best in a fairly neutral environment. It has been observed that major growth take place optimally close to 7.0 PH value*.

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* To show the range of PH value for the growth of some major bacteria are as follows :

Organism	PH range	Optimum PH value or range for growth
B. Coli	4.4 - 7.8	6.5
B. Pyocyaneum	5.6 - 8.0	6.8
B. Subtilis	4.8 - 8.5	6.7
B. Tuberculosis	4.5 - 8.0	6.0 - 6.5
B. Dysenteriae	5.5 - 8.6	7.3
Vibro Cholerae	6.4 - 7.9	7.2
Streptococci	5.5. - 8.0	6.5
B. Anthracis	6.0 - 8.5	7.2
Anaerobic bacteria	5.0 - 9.0	6.0 - 8.2

Reduction in bacterial numbers caused by acidic conditions is a decrease in the rate at which a pollution stream undergoes self purification

KLEIN, LOUIS. "Ibid". Page 185.

The PH range for the standard `B' i.e. organised outdoor bathing is 6.5 - 8.5. Any deviations above or below this PH range signifies the water quality unfit for bathing purposes.

Water Quality Analysis - PH As Parameter :

Referring to the Table (4.1) which shows that significant reduction has taken place - especially at Rishikesh and Haridwar as on 1989. The problem is more severe at the down stream stretches like Allahabad and Varanasi where the annual mean PH values have increased even after the implementation of GAP. On the other hand in Kannauj and Kanpur, the reduction has not been substantial. However, by and large, based on the data, it can be mentioned that standard `B' has been maintained at various stations.

DISSOLVED OXYGEN : ASs THE PARAMETER OF WATER QUALITY -

Oxygen is vital for the respiration of nearly all biological life, and it is essential that water should be well aerated for the continued survival of aquatic life. Aeration involves atmospheric oxygen diffusing, or passing from the air, through the water surface into ponds, streams, rivers, sea, etc. Oxygen is not very soluble in water but does exist in solution as dissolved oxygen.

TABLE- 4.1

PH (ANNUAL MEAN)

YEAR / STATION	1983	1984	1985	1986	1987	1988	1989
RISHIKESH	7.8	7.7	8.1	8.2	8.1	7.7	7.0
HARIDWAR D/S	8.0	7.7	8.1	8.2	8.4	8.0	7.1
GARMUKTESHWAR	7.8	7.7	8.1	8.2	8.3	8.0	7.6
KANNAUJ U/S	8.1	8.0	7.7	7.8	8.7	8.0	7.5
KANNAUJ D/S	N/A	N/A	N/A	8.2	8.0	7.9	7.5
KANPUR U/S	8.1	7.9	7.7	7.6	7.9	7.8	7.5
KANPUR D/S	8.0	8.0	7.6	7.3	7.9	7.7	7.5
ALLAHABAD U/S	7.8	7.5	7.6	7.7	7.9	8.3	8.5
ALLAHABAD D/S	7.9	7.6	7.8	7.6	7.4	8.2	8.5
VARANASI U/S	7.7	7.7	7.6	7.8	8.2	8.6	8.4
VARANASI D/S	7.8	7.6	7.9	7.7	8.3	8.5	8.3
TARIGHAT (MRIZAPUR)	7.7	7.7	8.0	7.8	8.2	8.6	8.4

SOURCE : CENTRAL POLLUTION CONTROL BOARD, NEW DELHI

Dissolved oxygen is perhaps the most commonly employed parameter of water quality. The solubility of atmospheric oxygen in fresh water ranges from 14.6 mg/litre at 0 C to 7.1 mg/litre at 35 C under one atmosphere (unit of pressure) of pressure. Low levels of dissolved oxygen adversely affect fish and other aquatic life, with the total absence of dissolved oxygen leading to anaerobic conditions with attendent odour and esthetic problems.

Dissolved oxygen, is an important prerequisite for the survival of aquatic life and maintaining the freshness (freshness is determined by aeration of flowing water, more the aerated water, more fresher it will be) of water. Lower the dissolved oxygen, more polluted will be the water. Generally, if the organic wastes is discharged to water, the dissolved oxygen content of water helps in biologically degrading that pollutants through aerobic processes. The dissolved oxygen content of water in case of Bathing Standard (organised outdoor bathing) "B" is 5 mg/litre or more, but not less than 5 mg/litre in any case.

Water Quality Analysis - Dissolved Oxygen as parameter :

On the basis of Table 4.2, dissolved oxygen content in the Ganga water has been monitored from 1983 to 1989 at twelve stations, Rishikesh on the extreme upstream and Trighat at extreme downstream. The dissolved oxygen (as the annual mean) on

TABLE- 4.2

DISSOLVED OXYGEN (1983-89) Annual mean
(In Mg / Litre)

YEAR / STATION	1983	1984	1985	1986	1987	1988	1989
RISHIKESH	8.2	8.3	8.2	8.1	7.1	7.1	6.7
HARIDWAR D/S	7.8	8.1	8.0	8.0	7.1	6.8	6.2
GARMUKTESHWAR	7.8	7.8	8.0	7.9	6.9	7.5	6.9
KANNAUJ U/S	8.1	8.1	8.0	8.0	7.4	7.4	7.5
KANNAUJ D/S	N/A	N/A	N/A	7.6	7.6	7.3	7.6
KANPUR U/S	7.4	8.1	8.1	8.0	8.1	7.5	8.0
KANPUR D/S	7.0	7.7	7.7	7.2	6.4	5.2	6.2
ALLAHABAD U/S	6.9	7.1	7.0	6.7	7.7	7.6	8.8
ALLAHABAD D/S	6.9	6.6	6.2	6.5	8.0	7.4	8.2
VARANASI U/S	6.3	6.3	7.3	6.1	8.1	8.6	8.1
VARANASI D/S	5.6	6.8	6.6	7.3	8.1	8.1	7.6
TARIGHAT	5.8	7.0	7.1	6.3	8.0	8.4	8.1

SOURCE : CENTRAL POLLUTION CONTROL BOARD, NEW DELHI

the all monitoring stations varied from 5.6 mg/litre to 8.8 mg/litre over the years.

The trend in dissolved oxygen (D.O.) at the various stations is quite different from that of PH levels. We find that over the years the DO levels at the upstream stations have declined while the downstream stations reached higher levels. In Kanpur, upstream DO levels are higher than the down stream levels which might be due to the presence of polluting industries and maximum domestic pollution load. It can be seen that over all picture regarding DO levels is not being encouraging while also raising questions about the reliability of such data. For instance, the DO content at Varanasi upstream is higher than Rishikesh, Kanpur, Kannauj which is quite surprising and questionable.

BIOLOGICAL OXYGEN DEMAND - AS A WATER QUALITY PARAMETER :

Biological oxygen demand is defined as the amount of oxygen (mg/litre) required by the bacteria while stabilising decomposable organic matter under aerobic conditions. In other words, Biological oxygen demand is the dissolved oxygen consumed by the chemical and microbiological action to decompose the organic pollution through oxidation process. Since BOD (Biological Oxygen Demand) is an indirect measure of the amount of biologically degardable organic material, it is an indicator of the amount of dissolved oxygen that will be depleted from water during natural biological assimilation of organic pollutants. The BOD is one of the most widely used test in water quality examination. BOD and DO are inversely related - higher the BOD lower will be dissolved oxygen (DO) content of Water - as in aerobic conditions the oxygen will be depleted from the water. It has also been deduced from the Biochemical reactions taking place in water and when the organic pollutants (may be in the form of waste water, domestic waste, etc.) goes to the water, the biochemical oxidation demands oxygen, represented in the form of BOD, for their degradation. So this means that higher the organic pollution higher will be the Biological Oxygen demand (BOD), thus lowering the Dissolved Oxygen (DO) content resulted by oxygen depletion. The BOD level for the water quality "B" should be 3 mg/litre or less.

Water Quality Analysis, Biological Oxygen Demand As a Parameter:

Referring Table-4.3 the BOD, in general varied between 1.7 mg/ Litre to 15.0 mg/ litre on the upstreams and downstreams stations of towns on the River Ganga over the years. The variations over the years on the towns upto Kannauj (including Kannauj) has been less significant and were between 2.2 mg/litre to 5.4 mg/liter. After Kannauj, there is a sudden increase in BOD, the maximum was at Allahabad Downstream in 1986.

TABLE- 4.3

BIOLOGICAL OXYGEN DEMAND (BOD) (Annual mean)

(In Mg / Litre)

YEAR / STATION	1983	1984	1985	1986	1987	1988	1989
RISHIKESH	2.2	2.0	3.1	2.9	4.8	2.5	1.9
HARIDWAR D/S	1.9	2.2	3.4	3.8	4.1	2.9	2.1
GARMUKTESHWAR	2.8	2.8	3.7	3.9	4.0	4.4	5.4
KANNAUJ U/S	6.5	4.2	2.0	3.9	3.0	2.0	2.9
KANNAUJ D/S	N/A	N/A	N/A	4.3	4.3	3.9	3.1
KANPUR U/S	4.4	3.0	3.4	5.1	2.0	1.7	2.5
KANPUR D/S	9.1	8.3	6.9	9.6	10.7	8.5	4.7
ALLAHABAD U/S	5.3	7.2	8.0	11.6	9.6	2.4	2.9
ALLAHABAD D/S	5.3	7.7	14.1	15.0	10.0	3.0	2.0
VARANASI U/S	10.3	10.5	11.1	13.3	5.4	3.2	2.8
VARANASI D/S	5.9	11.6	12.1	12.2	6.6	3.8	3.9
TARIGHAT	11.6	10.6	11.9	11.8	5.6	3.4	3.1

SOURCE : CENTRAL POLLUTION CONTROL BOARD, NEW DELHI

Based on table 4.3, we get some idea of the level of pollution and the impact of GAP in pollution reduction, Again , the BOD levels have come down in all stations. However it is important to note the steep decline after 1986-87 in some stations. In both Garmukteshwar and Kanpur Downstream, the BOD levels are higher than the normal. It is also necessary to recognise the Varanasi which has higher pollution load shows relatively less BOD levels at Down Stream.

The enormous decline in BOD at all the towns as shown in the data is an effort to show the success of pollution reduction measures and is questionable. Surprisingly, the BOD has reached below 3 mg / litre levels at Allahabad and Varanasi towns, with major organic pollution load.

NITRATES + NITRATES (IN ORGANIC NITROGEN CONTENT) AS A PARAMETER OF WATER QUALITY :

Nitrates and Nitrates are inorganic for of nitrogen. Nitrogen, also with carbon and Phosphorus is one of the three major element nutrients needed to sustain aquatic life. Inorganic Nitrogen (Nitrates + Nitrites), which initially remain in the form of nitrogenous organic matter give rise, later after oxidation of ammonia by aerobic bacteria (Nitrossococcuss & Nitrosomonas) to nitrites. This process is known as

Nitrosifying. Later the Nitrites convert into Nitrates by oxidation process through the help of bacteria (Nitrobater). This complete process is known as Nitrification. Nitrate, the final oxidation product of ammonia, serves as food for plant life and is used by plants for the building up of plant proteins. Excess of Nitrates (Nitrates & Nitrites) leads to the eutrophications (excess of nutrients in water) . This results in excessive growth of aglea and other aquatic flora.

There is no upper limit (maximum permissible concentration) for the standard "B" i.e. bathing (outdoor & organised) standard, but for drinking water 20-40 mg / litre is maximum permissible concentration. Even if concentration remaining below the range, continuous exposure to water (oral intake) can be fatal to health. Water quality analysis : Nitrates + Nitrites as parameter (Refer Table-4.4) The concentration range (present here in form of annual mean) varies between 0.004 mg/ litre as minimum to 6.428 mg/ liter as maximum. This concentration is quite below the hazardous limit (no limit for bathing standard, but exposure by oral intake is hazardous at 20-40 mg/ liter for drinking water), but continuous exposure to lower concentration can also be hazardous to health. Trace of more concentrations are found after Allahabad Upstream and maximum at Varanasi D/s in 1983. After 1983, rest of years , the concentration of nitrates have been again significant on the

NITRATES + NITRITES (Annual mean)

(In Mg / Litre)

YEAR / STATION	1983	1984	1985	1986	1987	1988	1989
RISHIKESH	0.004	0.023	0.026	0.030	0.007	0.104	0.009
HARIDWAR D/S	0.009	0.044	0.010	0.039	0.017	0.020	0.010
GARMUKTESHWAR	0.024	0.035	0.872	0.028	0.014	0.039	0.020
KANNAUJ U/S	0.140	0.359	0.488	0.277	0.240	0.799	0.571
KANNAUJ D/S	N/A	N/A	N/A	0.585	0.416	0.857	0.230
KANPUR U/S	0.503	0.196	0.446	0.131	0.216	0.852	0.187
KANPUR D/S	0.165	0.215	0.520	0.521	0.380	0.889	0.235
ALLAHABAD U/S	1.897	0.287	0.259	0.316	0.830	4.414	4.857
ALLAHABAD D/S	2.301	0.297	0.160	0.309	5.747	4.882	4.475
VARANASI U/S	4.075	0.280	0.289	0.323	0.429	0.476	0.555
VARANASI D/S	6.428	0.291	0.354	0.352	0.738	0.725	0.993
TARIGHAT	6.242	0.307	0.334	0.284	0.521	0.522	0.737

SOURCE : CENTRAL POLLUTION CONTROL BOARD, NEW DELHI

Allahabad and Varanasi and their stations (upstream and downstream). Allahabad Downstream the concentration has been quite significant with sight variations over the years (maximum in 1987) shows the organic pollution discharge in the upstream town (Kanpur)

As the maximum organic pollution load is at Varanasi, not at Kanpur and Allahabad, and if the substantial pollution load at Kanpur can bring the significant concentrations of Nitrates at Allahabad than this is not reflected from this data from Varanasi Downstream and Trighat. This contradiction needs to be explained and further cross checked.

TOTAL COLIFORM COUNT AS A PARAMETER OF WATER QUALITY :

Coliform count depicts the pressure of Bacillus coli (coliform group) in the water and connotes the fecal contamination (fecal contamination of warm blooded animals). A comment from Harold W Wolf in the edited book "Water Pollution Microbiology[1] " says. "Bacteria of the bacillus coli groups are normally inhabitants of the intestinal tract of warm blooded animals and it is believed that under ordinary conditions they do not multiply inside the animal. But outside the animal body in

(1) WATER POLLUTION MICROBIOLOY : Ed. RALPH MITCHEU page 336, 1972, Johon Willey & Sons New York.

water source, they tend to multiply rather die out rapidly. The presence of such bacteria (Bacillus coli) in water may accordingly be considered valued evidence that the water has been polluted with the intestinal discharge of some of the higher animals and the numbers present may be considered a fair index of such pollution". The coliform count, thus can be considered as a parameter of sewage contamination.

Practically the fecal contamination spreads all the diseases. Such as transmitted diseases.

The maximum total coliform count for Bathing standard `B' is 500 MPN (Most Probable Number)/100 ml. As the MPN/100 Ml will be varying considerably, they are presented in log (MPN/ 100 ml), and for 500 MPN /100 Ml the $\log_n$ (MPN/100 Ml) value is 6.214 which will help in gauging the fluctuations.

Analysis of Total Coliform Count (Lon (MPN/100Ml) as the Parameter of Water Quality. : (Refer Table- 4.5)

The variations of total coliform count has been between 4.860 $\log_n$ (MPN/100ml)as minimum and 6.443 $\log_n$(MPN/100 ml) as maximum over the years on various monitoring stations. During 1983 & 1984, the increase in coliform count has been significant after Garmukteshwar, but from 1985, the significant variations

TABLE- 4.5

TOTAL COLIFORM (Annual mean)

(In log (MPN/100 m

YEAR / STATION	1983	1984	1985	1986	1987	1988	1989
RISHIKESH	4.860	5.398	6.295	5.897	6.839	6.721	6.824
HARIDWAR D/S	6.353	5.943	7.238	6.431	6.914	6.846	6.918
GARMUKTESHWAR	5.293	5.652	7.211	7.041	6.905	6.911	6.819
KANNAUJ U/S	5.313	10.100	13.426	10.151	13.187	13.781	10.045
KANNAUJ D/S	N/A	N/A	N/A	12.382	14.811	15.100	9.855
KANPUR U/S	5.273	10.932	14.685	10.619	9.566	11.441	9.237
KANPUR D/S	11.678	13.830	17.298	13.188	15.229	16.443	11.868
ALLAHABAD U/S	9.631	8.540	9.412	8.058	7.719	7.358	7.777
ALLAHABAD D/S	9.815	8.239	9.155	8.555	7.922	8.107	8.660
VARANASI U/S	6.914	8.443	8.919	8.394	7.478	8.328	8.109
VARANASI D/S	6.789	8.399	8.624	8.175	8.385	10.549	10.657
TARIGHAT	7.491	8.408	9.023	8.690	7.568	9.265	9.127

Standard 500 MPN / 100 ml = 6.214 Log (MPN/ 100 ML)

SOURCE : CENTRAL POLLUTION CONTROL BOARD, NEW DELHI

are observed after Rishikesh, showing the increment in the coliform count. This substantial increase signifies the increase in organic sewage water discharge in River Ganga.

In almost all the years, the slight fluctuations in coliform count after Allahabad upstream station to Trighat, with the exceptionally sharp increase at Varanasi Downstream and Trighat, in 1988, are observed. Looking at the coliform count of the all the stations over the years the trends of coliform count at Kannauj upstream has been extraordinary significant showing the excessive fecal contamination to water. Varanasi, over the years, the coliform count has always been higher than the desired count i.e. 6.214 Log_n (MPN/100 Ml). The table gives a picture of Kanpur shows the maximum coliform count and the fluctuations depicting increase in coliform count. The data also shows the steep increase in coliform count between upstream and downstream stations of Kannauj. This may be because of the tributeries contribution to an increase in organic pollution load in main stretch of River Ganga.

FECAL COLIFORM AS A PARAMETER OF WATER QUALITY :

Total Coliform count represent the count of Fecal and nonfecal Coliforms. The need for separating fecal and nonfecal coliforms was felt when there were increasing reports of recoveries of coliform organism from nonfecally contaminated environments. On the basis of various examinations (Refer Wolf, page 338, "Water Pollution Microbiology") it has been found that Fecal coliform organisms may be considered as on indications of fecal pollution by warm blooded animals. It has not been possible to separately decipher that difference in fecal coliforms between human feces and that of other warm blooded animals. Fecal coliform and their presence in water is an indicative of dangerous contamination.

There is no standard for specifically Fecal significance for the Bathing standard "B", but infinitesimal (minute) presence of Fecal coliform e.g. One coliform per 100ml (Refer Wolf., ibid, page 339) doesn't exclude the possibility of acquiring an intestinal infection.

Water Quality Analysis On Various Stations, Fecal Coliform Count As Parameter:

(Refer Table-4.6) Fecal coliform count on the various monitoring station of towns has varied between 4.190 Log_n (MPN/100 Ml) i.e. 66.02 (MPN/ 100 ML) to 15.610 Log_n (MPN / 100 Ml i.e. 6016402.2 (MPN/ 100ML) over the years. The maximum Fecal coliform count has been noticed on the upstream and downstream stations of Kannauj and Kanpur. Before Kannauj, the variations in fecal coliform count has been significant after 1987, on the

TABLE- 4.6

FAECAL COLIFORM (Annual mean)

(In log$_n$ (MPN/100m)

YEAR / STATION	1983	1984	1985	1986	1987	1988	1989
RISHIKESH	N/A	5.081	5.638	5.220	6.353	6.280	6.054
HARIDWAR D/S	N/A	5.768	5.930	5.841	6.510	6.293	6.308
GARMUKTESHWAR	N/A	5.602	5.943	6.412	6.378	6.201	5.849
KANNAUJ U/S	N/A	12.044	13.219	9.854	12.879	12.889	9.149
KANNAUJ D/S	N/A	N/A	N/A	12.105	13.420	14.413	9.209
KANPUR U/S	N/A	13.792	14.685	10.289	8.622	10.056	8.319
KANPUR D/S	N/A	14.086	17.298	12.996	14.782	15.610	11.141
ALLAHABAD U/S	8.046	6.673	7.179	5.894	4.190	5.481	6.385
ALLAHABAD D/S	8.546	6.852	6.974	5.740	4.927	6.303	7.414
VARANASI U/S	6.715	7.317	7.556	5.656	5.204	8.153	7.874
VARANASI D/S	6.683	7.184	6.623	5.841	6.474	10.391	10.110
TARIGHAT	6.380	6.841	6.767	5.677	5.598	9.281	8.798

SOURCE : CENTRAL POLLUTION CONTROL BOARD, NEW DELHI

contrary there has been sharp decline in fecal coliform count in 1987, but extraordinary rise in 1988 at Allahabad, Varanasi and Trighat.

The count of fecal coliform and fluctuations in their count has an increasing trend upto 1985, There is a decline upto 1987 at Allahabad, Varanasi and Trighat. The overall trends from the table indicate the presence of fecal coliform count in River Ganga at a dangerously high level which means water is not fit for human consumption and also for bathing.

So far the data of water quality have been on physical, chemical and bectiological parameters and therefore the statement about the significance of each parameter was required for recognising its role in maintaining the balance in the aqueous system and for understanding the implication for health. All these indicators reflect the type of development both interms of industrialisation and urbanisation that is occurring along the entire stretch of Ganga. Although we can link up urbanisation and the water quality from these indicators, especially with respect to fecal coliform, etc. The linkage with any specific industry or pollutant can not be established from the above parameters. For this, it is necessary to look into the Toxicological parameters. In the following sections, we present only the salient concentration characteristics and the source of the discharge.

HEAVY METALS :

Depending upon the type of industry located along the Ganga, traces of heavy metals have been found from the water. These are Cadmium, Chromium, Copper, Iron, Lead, Manganese and Mercury.

CADMIUM (Cd) :

Cadmium enters into water system as a contaminant and effluent from mining and metallurgy, chemical industries, Scrap metal treatment, electroplating, superphosphate fertilizers and cadmium containing pesticides.

Generally the discharge from these process and industries are merged in domestic waste water as in the case of household electroplating process.

The cadmium concentrations in UP stretch of River Ganga (Refer Table-4.7) has been maximum on Kannauj upstream in 1986 which was 0.063 ug/Ml. Over all the concentration which has not been quite significant above the maximum permissible limit except for the first three years i.e. 1986-89. Concentration above the permissible limit was observed relatively more on Kannauj upstream, Kannauj downstream, Allahabad upstream & downstream during 1986-87. Slight increase in concentration above the limit

TABLE- 4.7
CADMIUM (Cd)
Concentratio range ug/ ml

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	ND-0.007	ND-0.009	ND-ND	ND-0.002	ND-0.040
HARIDWAR D/S	ND-0.003	ND-0.005	ND-ND	ND-ND	ND-ND
GARMUKTESHWAR	ND-0.007	ND-0.003	ND-0.001	ND-ND	ND-ND
KANNAUJ U/S	ND-0.063	ND-0.005	ND-0.003	ND-ND	ND-ND
KANNAUJ D/S	ND-0.008	ND-0.005	ND-0.003	ND-ND	ND-ND
KANPUR U/S	ND-0.006	ND-0.006	ND-ND	ND-ND	ND-ND
KANPUR D/S	ND-0.003	ND-0.013	ND-ND	ND-ND	ND-ND
ALLAHABAD U/S	ND-0.008	ND-0.002	ND-0.002	ND-ND	ND-ND
ALLAHABAD D/S	ND-0.009	ND-0.003	ND-ND	ND-ND	ND-ND
VARANASI U/S	ND-0.003	ND-0.004	ND-ND	ND-ND	ND-ND
VARANASI D/S	ND-0.005	ND-0.012	ND-ND	ND-ND	ND-ND
TARIGHAT	ND-0.004	ND-0.009	ND-ND	ND-ND	ND-ND

SOURCE : CENTRAL POLLUTION CONTROL BOARD, NEW DELHI

0.005 mg/L Maximum permissible limit for the Drinking Water Standard has been observed at kanpur Downstream and Varanasi Downstream. In 1990-91 there is a sudden shoot up of concentration quite above the limit i.e. 0.005 mg/ml was observed in Rishikesh. In remaining two years except Rishikesh, there is no significant concentration of Cadmium on the various station on River Ganga.

CHROMIUM :

Hexavalent chromium compounds are used in metallurgical industry for chrome alloy and chromium metal production, in the chemical industry as oxidising agent in chrome plating and in the production of other chromium compounds used in paints , dyes, explosives, ceramics and paper. Trivalent chromium salts are used in textile dying, in the ceramic and glass industry and in photography. Chromium compounds are also present in some fertilizers and pesticides. It is also profusely used in Tanning industry in Kanpur.

Referring to Table-4.8 the highest value for chromium level exceeding the permissible limits has been reported, during 1986-91 from Garmukteshwar , Allahabad upstream & downstream & Varanasi Downstream. Significant presence of chromium above the limit (Maximum Permissible limit) has been found in Rishikesh, Kannauj D/S, Kanpur U/S and D/S, Varanasi Upstream and Trighat.

TABLE- 4.8
CHROMIUM (Cr)
Concentration range ug/ ml

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	ND-0.128	ND-0.055	0.004-0.084	ND	ND
HARIDWAR D/S	ND-0.020	ND-0.094	ND-0.070	ND	ND
GARMUKTESHWAR	ND-3.742	ND-0.117	0.001-0.070	ND	ND
KANNAUJ U/S	ND-0.063	ND-0.037	ND-0.060	ND	ND
KANNAUJ D/S	ND-0.192	ND-0.036	0.005-0.240	ND-0.019	ND-0.030
KANPUR U/S	ND-0.082	ND-0.017	ND-0.234	ND	ND
KANPUR D/S	ND-0.16	ND-1.55	0.013-0.406	0.010-0.039	ND-0.084
ALLAHABAD U/S	ND-0.069	ND-1.876	0.002-0,146	ND-0.084	ND-0.019
ALLAHABAD D/S	ND-0.103	ND-0.087	0.003-0,29	ND-0.218	ND-0.084
VARANASI U/S	ND-0.10	ND-0.109	0.008-0.482	ND-0.175	ND-0.057
VARANASI D/S	ND-0.296	ND-0.256	0.005-0.54	ND-0.177	ND-0.053
TARIGHAT	ND-0.064	ND-0.092	ND-0.740	ND-0.280	ND-0.074

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW

Drinking Water Standard Maximum permissible limit = 0.05 mg/l
(WHO)

The exceeded value of chromium concentration over the year on almost all the major towns shows the continuous and constant exposure to chromium for the population consuming the River Ganga water.

COPPER :

Copper uses inlcudes electroplating and electrical wiring, the production of alloys, photography, utensil, antifouling paint, art designs, pesticides formulations and textiles. Copper is generally used in construction in roofing material and brass and copper plumbing.

Referring to Table-4.9, Copper traces has been observed in all the stations during the first three years i.e. 1986-89. As there concentration range was quite insignificant and below the maximum permissible limits on all the stations except Varanasi Downstream where the concentrations was relatively high in 1986, in the first three years. Therefore the copper concentration range monitoring in the Ganga water has been dropped from the list of heavy metals after 1989 by the Industrial Toxicology Research centre.

TABLE- 4.9
COPPER (Cu)
Concentration range ug/ ml

YEAR STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	ND-0.040	ND-0.016	ND-0.09	ND	ND
HARIDWAR D/S	ND-0.040	ND-0.017	ND-0.043	ND	ND
GARMUKTESHWAR	ND-0.050	0-001	ND-0.033	ND	ND
KANNAUJ U/S	ND-0.069	ND-0.019	ND-0.041	ND	ND
KANNAUJ D/S	ND-0.061	ND-0.020	ND-0.047	ND	ND
KANPUR U/S	ND-0.022	ND-0.020	ND-0.058	ND	ND
KANPUR D/S	ND-0.069	ND-0.039	ND-0.053	ND	ND
ALLAHABAD U/S	ND-0.052	0.001	0.005-0.084	ND	ND
ALLAHABAD D/S	ND-0.337	0.002	ND-0.058	ND	ND
VARANASI U/S	ND-0.050	ND-0.072	ND-0.033	ND	ND
VARANASI D/S	ND-0.130	ND-0.068	ND-0.031	ND	ND
TARIGHAT	ND-0.069	ND-0.060	ND-0.067	ND	ND

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW

1.0 mg /l = WHO Maximum Permissible limit for Drinking Water Standard

IRON (FERROUS, Fe) :

Iron is predominantly used in production of steel, paint pigments, plastics, polishing agents and electrical materials. Sources of Iron release to the environment from human activities like burning of coke and coal, acid mine drainage, mineral processing, sewage, landfill leachates iron related industries and the corrosion of iron and steel. Iron is also released in aquatic environment from the Geo-Chemical processes (weathering of sulphide ores and igneous, sedimentary and metamorphics rocks, etc).

Referring to Table-4.10, almost at all the location along the Ganga, iron concentration was found to be exceeding the maximum permissible limit. For most of the locations, the increasing trend was observed from 1986-87 to 1988-89. During these years the maximum concentration range was observed at Kanpur upstream, Kinnauj downstream, and Allahabad upstream. During 1989-90 and 1990-91, the maximum concentration range, above limit was observed at Haridwar downstream and Rishikesh. In all the case the ranges were quite above the permissible limit.

TABLE- 4.10
IRON (Fe)
Concentration range ug/ ml

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	0.17-23.14	0.129-18.34	0.183-17.280	0.382-34.758	ND-32.400
HARIDWAR D/S	0.26-23.74	ND-20.40	0.110-23.127	0.638-36.158	ND-23.800
GARMUKTESHWAR	ND-30.54	0.134-21.68	0.161-16.025	ND-8.580	ND-8.580
KANNAUJ U/S	0.18-22.60	ND-6.22	0.28-13.250	ND-22.200	0.920-28.480
KANNAUJ D/S	0.18-22.4	0.054-28.38	1.139-21.150	1.546-13.860	0.939-12.360
KANPUR U/S	0.264-82.8	ND-18.8	0.703-13.590	ND-13.950	N. RECEIVED
KANPUR D/S	0.104-29.20	0.089-5.66	0.80-18.787	0.254-12.000	ND-13.000
ALLAHABAD U/S	0.073-16.99	0.520-20.60	0.495-28.705	0.592-8.200	ND-10.800
ALLAHABAD D/S	0.026-9.38	ND-19.06	0.330-21.60	ND-10.320	ND-10.040
VARANASI U/S	0.17-22.4	ND-21.89	0.186-20.905	0.144-11.678	ND-10.320
VARANASI D/S	0.146-19.18	ND-25.67	0.276-16.845	ND-5.278	ND-10.040
TARIGHAT	0.178-17.66	ND-22.57	0.603-26.105	0.250-17.158	0.379-13.560

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW

Maximum Permissible limit for Drinking Water Standard = 0.3 mg/litre

LEAD :

Major lead uses includes those in production of acid storage batteries, chemical compounds such as alkyl lead additives (tetra methyl and tetra-ethyl lead), in electroplating, metallurgy, construction materials , coatings and dyes, electronic equipment, plastics, veterinary medicines, fuels and radiation shielding, ammunition , corrosive liquid containers , paints, glassware, fabricating storage tank lining, transporting radioactive materials, solders, piping, cable sheathing, roofing and sound attenuators.

Lead reaches the aquatic environment through precipitation, fall out of lead dust, street run-off and industrial and municipal waste water discharges.

Referring to Table-4.11, the violation of the maximum permissible limit i.e. 0.05 mg/l in almost all the years were observed on Haridwar Downstream, Varanasi Upstream and downstream and Trighat station.

MANGANESE :

Manganese, its alloys and manganese compounds are commonly used in the steel industry in manufacturing of metal alloys and dry cell batteries, and in the chemical industry in paints, varnishes, inks, dyes, glass ceramics, matches, fire works and fertilizers.

TABLE- 4.11
LEAD (Pb)
Concentration range ug/ ml

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	0.006-0.072	ND-0.043	ND-0.047	ND	ND
HARIDWAR D/S	ND-0.16	ND-0.099	0.006-0.053	ND	ND
GARMUKTESHWAR	0.006-0.08	ND-0.360	0.006-0.040	ND-0.248	ND-0.248
KANNAUJ U/S	0.009-0.066	ND-0.029	ND-0.066	ND	ND
KANNAUJ D/S	0.008-0.079	ND-0.038	0.009-0.051	ND-0.178	0.004-0.869
KANPUR U/S	0.009-0.034	ND-0.02	0.012-0.042	ND	NR
KANPUR D/S	0.01-0.076	ND-0.048	0.012-0.063	ND	ND-0.410
ALLAHABAD U/S	0.012-0.63	ND-0.036	ND-0.450	ND	ND
ALLAHABAD D/S	0.008-0.147	ND-0.053	ND-0.115	ND-1.850	ND-0.098
VARANASI U/S	0.006-0.254	ND-0.073	0.007-0.101	ND	ND-0.852
VARANASI D/S	0.010-0.138	ND-0.056	0.023-0.103	ND-0.308	ND
TARIGHAT	0.001-0.049	ND-0.077	0.007-0.603	ND	ND

NR = Not Recorded

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW

Maximum Permissible limit for Drinking Water Standard = 0.05 mg/litre

Manganese (Refer Table-4.12), has been second most common and frequently detected metal in river ganga from all the locations over the years (1986-91),. It has found presence of in majority of monitored sample and in all the cases significantly above the maximum permissible limit. The data show that there has been a consistent increase in concentration range violating the permissible limit in all the years except a slight decline in concentration range in 1989-90 in almost all the stations of the Uttar Pradesh stretch of river Ganga.

MERCURY :

Mercury mainly finds its use in chlor-alkali industry producing chlorine, caustic soda and hydrogen, and in paint industry in paints pigments and preservatives, in pulp and paper industry, thermometers, hospitals, plastics and electrical equipments such as mercury switches, batteries, fluorescent and mercury vapour lamps, dental amalgams, therapeutic medicinal compounds and agricultural practices etc. Burning of fossil fuels appears to add large quantities of mercury to the environment. Another major source of entering of mercury compounds to the water system is its excessive use in agriculture. A variety of mercury compounds (both organic and inorganic) are being used to treat seed potatoes, flower bulbs, and especially grain seed (wheat, rice, barley, oates etc.).

TABLE- 4.12
MANGANESE (Mn)

ug/ ml

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	0.003-0.424	0.004-0.410	0.003-0.763	0.020-0.665	ND-1.060
HARIDWAR D/S	0.003-0.356	ND-0.403	0.003-0.373	0.025-0.671	ND-0.930
GARMUKTESHWAR	0.001-0.589	ND-1.594	ND-0.177	ND-0.224	ND-0.224
KANNAUJ U/S	ND-0.748	0.002-0.168	0.002-0.435	ND-0.569	0.040-0.598
KANNAUJ D/S	0.013-0.698	0.004-0.264	0.015-0.299	0.58-0.378	0.045-0.440
KANPUR U/S	0.030-0.34	ND-1.07	0.009-0.402	ND-1.288	ND
KANPUR D/S	0.016-0.90	0.016-0.110	ND-0.524	0.051-0.272	ND-0.700
ALLAHABAD U/S	0.021-0.846	0.022-0.618	0.003-0.476	0.029-0.408	ND-0.542
ALLAHABAD D/S	0.002-0.177	ND-0.638	0.004-0.659	ND-0.380	ND-1.256
VARANASI U/S	0.025-0.778	0.003-0.959	0.009-0.148	0.029-0.314	ND-2.920
VARANASI D/S	0.020-0.386	ND-1.680	ND-0.263	ND-2.080	ND-0.810
TARIGHAT	0.002-0.63	0.025-0.782	0.002-0.432	0.013-1.348	0.043-5.608

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW

Maximum Permissible limit for Drinking Water Standard (WHO, 1984) = 0.1 mg/litre

Increase of concentration range of mercury compounds in water reflects in the form of Bio-concentration (Bio-accumulation) and contamination in aquatic fauna especially fishes etc. because of rapid uptake by these organisms.

The Mercury concentration has been monitored (Refer to Table-4.13) for three year (1986-89) and after that the monitoring was stopped by Industrial Toxicology Research Centre in Uttar Pradesh. Reasons given for this was non-detectable concentration of Mercury in the river .Mercury concentration was found in all the station and in majority of concentration, the maximum permissible limit has been found violated over the three years. The stations where concentration reaches higher above then the limit prescribed are Rishikesh and Haridwar(1987-88), Kannauj Upstream and downstream, Kanpur Upstream and Downstream, Allahabad Upstream and Downstream (in all years) , and Varanasi Downstream (only in year 1987-88).

The overall view from the concentration profile shows the concentration above limits and the possibility of Bio-concentration (Fish contamination to meager level) are also exists.

TABLE- 4.13
MERCURY (Hg)

Concentration range (ug / ml)

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	ND-ND	ND-0.081	ND-ND	ND	ND
HARIDWAR D/S	ND-ND	ND-0.075	ND-ND	ND	ND
GARMUKTESHWAR	ND-ND	ND-ND	ND-ND	ND	ND
KANNAUJ U/S	ND-0.009	ND-ND	ND-0.003	ND	ND
KANNAUJ D/S	ND-0.008	ND-0.002	ND-ND	ND	ND
KANPUR U/S	ND-0.013	ND-0.020	ND-ND	ND	ND
KANPUR D/S	ND-0.009	ND-ND	ND-ND	ND	ND
ALLAHABAD U/S	ND-0.01	ND-0.011	ND-0.014	ND	ND
ALLAHABAD D/S	ND-0.10	ND-0.009	ND-0.043	ND	ND
VARANASI U/S	ND-ND	ND-ND	ND-ND	ND	ND
VARANASI D/S	ND-ND	ND-0.004	ND-ND	ND	ND
TARIGHAT	ND-ND	ND-ND	ND-ND	ND	ND

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW

Maximum Permissible limit for Drinking Water Standard (WHO) = 0.001 mg/litre

The above data show that the industrialisation process along the banks of river Ganga is creating imbalence in the river system. In order to get an holistic view of the entire problem of water pollution, it is also necessary to look into concentration levels of pesticides, mainly from agricultural sources. The use of pesticides in Uttar Pradesh is quite significant and traces of such pesticides are found in river Ganga as a result of agricultural non-point run-off.

The concentration levels of pesticides (Organochlorine and Organophosphorus) monitored on various stations are as follows :

PESTICIDES :-

Organochlorine Pesticides

DDT (DICHLORO-DIPHENYL-TRICHLOROETHANE):

DDT, an organochlorine pesticide has been extensively used throughout the world for public health and agricultural purposes because of its efficiency as a broad spectrum insecticide.

DDT may enter the aquatic environment through its manufacture and application. The pathways for general environmental contamination by DDT include atmospheric dispersion wind and water erosion of soil and transport while sorbed onto soil particles in the silt of water systems (streams, rivers and oceans).

DDT (and its derivatives) referring to Table-4.14 has been one of the most commonly present pesticide in the river water from all the stations throughout the monitoring period (1986-91). Over the years in all the stations, the violation of permissible limit was observed. There has been the increase in concentration range for first two years, later two years a severe decline has been observed above than the limit and again sharp increase in 1990-91.

BHC (BENZENE HEXACHLORIDE):

Benzene Hexachloride is the common name to describe the mixed stereo isomers of 1,2,3,4,5,6- hexa chlorocylohexane (HCH). The gamma-isomer (lindane) is the only hexachlorocylohexane (HCH) isomer possessing significant insecticidal activity. Lindane has been used to control insects in domestic and commercial settings, in numerous agricultural and silvicultural applications and in dips, sprays and dusts for livestock and domestic pets. It is

TABLE- 4.14

ORGANOCHLORINE PESTICIDES DDT (DICHLORO-DIPHEYL-TRICHLOROETHANE) (ppb) (ug/l)

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	0.0134-0.1122	0.0057-0.1773	ND-0.0794	ND-0.1182	ND-0.0049
HARIDWAR D/S	0.0066-0.0952	0.0051-0.0211	ND-0.2214	ND-0.0066	ND-0.0287
GARHMUKTESHWAR	0.0271-0.1160	ND-0.1202	ND-0.1302	ND-0.0005	ND-0.0028
KANNAUJ U/S	0.0114-0.2065	0.0067-0.1208	ND-5.8082	ND-0.0058	ND-0.3384
KANNAUJ D/S	0.0618-0.1142	ND-0.3932	ND-0.2188	ND-0.0020	ND-0.0915
KANPUR U/S	0.0094-0.1875	0.0020-0.2432	ND-0.3719	ND-ND	N-R
KANPUR D/S	0.0325-0.2862	0.0098-03614	ND-0.08315	ND-0.0022	ND-0.1188
ALLAHABAD U/S	0.0175-0.1903	0.0037-0.3553	ND-0.0868	ND-0.0701	ND-0.0123
ALLAHABAD D/S	0.0121-0.1210	ND-0.4842	ND-0.0519	ND-0.0084	ND-0.0166
VARANASI U/S	ND-0.1704	0.0018-0.3834	ND-0.1274	ND-ND	ND-0.0301
VARANASI D/S	0.0154-0.1630	ND-0.1843	ND-0.061	ND-0.0012	ND-0.0107
TARIGHAT	0.0149-0.2544	0.0039-0.8860	ND-0.0274	ND-0.0005	ND-0.0300

NR = Not Recorded

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW

Maximum Permissible limit for fresh water aquatic life = 0.001 ug / litre (USEPA, 1979)

Maximum permissible limit for Drinking water standard (WHO) = 0.000042 ug / litre (ppb) used for controlling ticks and flies on livestock, seed treatment for wireworm control, controlling infestations of stored logs by the logging industry and controlling bed bugs by the pest control industry.

Direct and indirect application of lindane, agricultural run-off and industrial discharges are the principal sources of lindane (gamma-BHC) in surface waters. Other sources include the pulp and paper industry, pesticide packaging and manufacturing plants, farm buildings and warehouse spraying and seed dressing industries.

During the five years, the concentration of all the three isomer (alpha, beta, gamma) of BHC were detected frequently on all the stations (Refer Table-4.15). Lindane (gamma-BHC) which is of more interest from its toxicity profile point of view has been observed in most of the locations and importantly in most of the cases the lindane level were found quite above than the fresh water quatic life standard (USEPA) i.e. 0.01 ug/l (ppb). In all the water monitoring samples almost all locations, the maximum permissible limit for drinking water source standard (WHO) was also found violated.

During the 1986-89, on the whole there has been a decline in the samples exceeding permissible limits, but in last two years residue level of lindane were observed increasing and

TABLE- 4.15

BHC (BENZENE HEXACHLORIDE) (ppb) (ug/ l)

YEAR STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	0.0120-0.1300	0.0112-0.1805	0.0066-0.0474	ND-0.0647	ND-0.0994
HARIDWAR D/S	0.0097-0.0875	0.0055-0.2392	0.0034-0.0526	0.0021-0.3371	ND-0.0522
GARMUKTESHWAR	0.0176-0.2042	0.0112-0.237	ND-0.3271	ND-0.0263	ND-0.0217
KANNAUJ U/S	0.0299-0.2455	0.0133-0.1156	0.0078-0.0851	ND-0.2293	ND-0.1453
KANNAUJ D/S	0.0263-0.2666	0.0062-0.0867	0.0052-0.0829	ND-0.2082	0.0024-0.1269
KANPUR U/S	0.0433-0.2261	0.0113-0.1533	0.0015-0.0983	ND-0.1581	NR
KANPUR D/S	0.0473-0.5119	0.0151-0.7135	0.0060-0.0470	ND-0.3230	ND-0.1999
ALLAHABAD U/S	0.0345-0.1858	0.0082-0.7207	ND-0.1873	ND-0.2068	ND-0.1045
ALLAHABAD D/S	0.0291-0.6197	ND-0.2139	0.0051-0.0673	ND-0.2711	ND-0.1775
VARANASI U/S	0.0214-0.1029	0.0045-0.1156	0.0126-0.1152	ND-0.1158	ND-0.4317
VARANASI D/S	0.0141	0.041-0.1029	ND-0.1517	ND-0.2075	ND-0.1767
TARIGHAT	0.0328-0.3243	0.0127-0.1143	0.0045-0.2751	ND-0.0838	ND-0.8301

NR= Not Recorded

Value of Fresh water aquatic life (USEPA, 1979) is 0.01 ug / L (ppb)

Maximum Permissible limit for Drinking Water Standard (WHO) = 0.056 mg/litre (ppm) or 0.00056 ug / litre (ppb) so is the violation above the limit on almost all stations. After 1988-89, the concentration range were found declining, but still on majority of stations the concentration was found above the permissible limits.

ENDOSULFAN:

Endosulfan another organochlorine pesticide is used as a broad spectrum insecticide and acaricide. It is generally used for the control of wood borers and other insects on fruits and ornamental trees and shrubs.

Endosulfan while applied to agricultural areas, its movement to aquatic environments is basically via spray drift, leaching from soils and indirect transport.

As compared to DDT and BHC, endosulfan levels were found to be less on various monitoring locations (Refer Table-4.16). During the first three years, the concentration range and frequency of detection on various monitoring station declined in subsequent years. Same as in the case of levels of concentration violating the permissible limit, also declined in consequent years.

TABLE- 4.16

ENDO SULFAN

(ug/l) (ppb)

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	ND-0.0113	ND-0.0153	ND-0.0048	ND-0.0643	ND-0.0026
HARIDWAR D/S	ND-0.0148	ND-0.0189	ND-0.0143	ND-0.0034	ND-0.0039
GARMUKTESHWAR	ND-0.0205	ND-0.0163	ND-0.0029	ND-0.0183	ND-ND
KANNAUJ U/S	ND-0.0111	ND-0.0297	ND-0.0122	ND-0.0216	ND-0.0027
KANNAUJ D/S	ND-0.0229	ND-0.2972	ND-0.0035	ND-0.0001	ND-ND
KANPUR U/S	ND-0.0223	ND-0.4471	ND-0.0037	ND-ND	N-R
KANPUR D/S	ND-0.0204	ND-0.1917	ND-0.010	ND-ND	ND-0.0245
ALLAHABAD U/S	ND-0.0175	ND-0.4594	ND-0.0306	ND-0.0016	ND-ND
ALLAHABAD D/S	ND-0.0252	ND-0.5671	ND-0.0022	ND-0.0376	ND-0.0014
VARANASI U/S	ND-0.0148	ND-0.1535	ND-0.0211	ND	ND-0.0052
VARANASI D/S	0.0252	ND-0.0591	ND-0.0105	ND	ND-0.0008
TARIGHAT	ND-0.0236	ND-0.0474	ND-0.0037	ND	ND-0.0032

NR = Not Recorded

USEPA (1979) Satandard value of fresh water aquatic life = 0.003 ug/l (ppb)

Overall the violation frequency showed a declining trend towards 1989-90, followed by slight increase in violation frequency 1990-91, which was in a way some how similar to the trend in case of DDT and BHC. The reason may be due to the pattern of use of these pesticides in the catchment area of the main stretch of River Ganga.

<u>Organophosphorus</u> <u>Pesticides</u>:

MALATHION :

Malathion, a broad-spectrum, non-systemic organophosphorus insecticide and acaricide of low mammalian toxity is widely used against aphids, scales and other insects on a wide range of fruits and vegetables in agriculture and horticulture for preharvest treatment. It is commonly used on crops like carrots, turnips, tomatoes, leafy vegetables and fruits. In post harvest treatments, malathion is used on a fairly wide range of product for storage.

Malathion, due to its high water solubility, a significant portion of the malathion applied to terrestrial environments may be expected to enter the aquatic environments may be expected to enter the aquatic environment through leaching and run-off processes. In a wider view point malathion enters in to aquatic environment through direct application and surface run-off from treated areas.

Among the four organophosphorus pesticide monitored for their concentration in Ganga at the monitoring stations, malathion has been second most common to be detected after dimethoate.

The malathion concentration was detected during all five years (Refer to Table-4.17). During first three years (1986-89) the frequency of detection and violation frequency has been observed more in comparison to the remaining two years (1989-91). The maximum violation frequency has been found in 1987-88 at majority of the monitoring stations.

METHYL PARATHION :

Methyl parathion a broad non-systemic organophosphorus insecticide and acaricide with some fumigant action find its use almost exclussively for agricultural purposes on field, forage and vegetable crops. This chemical has a wide spectrum of biological activity embracing both biting and sucking pests act a contact, stomach and respiratory poisons.

Methyl parathion, finds its almost exclusive use in agriculture, due to high aqueous solubility, it is probable that a significant amount will enter water bodies through spray drift, run-off and leaching.

TABLE- 4.17

ORGANO PHOSPHATES MALATHION (ppb)

(ug/ l)

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	ND-ND	ND-ND	ND-0.879	ND-0.009	ND-ND
HARIDWAR D/S	ND	ND-4.6109	ND-0.1349	ND-ND	ND-0.0078
GARMUKTESHWAR	ND	ND-ND	ND-0.0537	ND-ND	ND-ND
KANNAUJ U/S	ND	ND-1.2614	ND-0.0603	ND-0.0008	ND-ND
KANNAUJ D/S	ND-0.1600	ND-ND	ND-ND	ND-0.0012	ND-0.0516
KANPUR U/S	ND-0.1790	ND-0.0160	ND-ND	ND-0.010	N-R
KANPUR D/S	ND-0.4203	ND-0.7374	ND-ND	ND	ND
ALLAHABAD U/S	ND-ND	ND-ND	ND-0.1449	ND	ND-0.0329
ALLAHABAD D/S	ND	ND-ND	ND-ND	ND	ND-0.0167
VARANASI U/S	ND	ND-0.4890	ND-0.0058	ND	ND
VARANASI D/S	ND	ND-1.0867	ND-ND	ND-0.0370	ND-0.0417
TARIGHAT	ND	ND-0.0204	ND-0.0179	ND-ND	ND-ND

NR= Not Recorded

USEPA (1979) Standard value of fresh water aquatic life = 0.1 ug/l (ppb)
WHO standard for organophosphates compound as Drinking water limit
is 0.10 mg/ l i.e. .0001 ug/ l (ppb)

Both the concentration level and a frequency of detecting of the methyl Parathion in river Ganga as observed on the monitoring stations shows the decreasing trend (Refer to Table-4.18). Only in the 1988-89, the frequency of detection of concentration was extra ordinarily high as compared to other years.

DIMETHOATE :

Dimethoate a solid forming colorless crystals is a contact and systemic organ phosphorus insecticide and acaricide effective against a broad range of insects and mites. It finds its uses against aphids, mites, moths, grass hoppers. phim crirculio, pear, psylla, scale, leaf hoppers, thrips, loppers, drosophillia, lygus bugs, leaf minor flies, olive flies, white flies, lassids, houseflies, and many other insects. Important crops on which dimethoate is used are alfalfa, apples, beans, broccoli cabbage, cauliflower, citrus, peppers, potatoes, safflowers, soya beans, spinach, tobaccos, tomatoes, turnips, wheat, omamentals, bananas, mangoes, olivers, cocoa, coffee, tea, jute, sugarcane, sunflower, peanuts and other crops.

TABLE- 4.38
METHYL PARATHION

(ppb)
(ug/ ml)

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	ND	ND-0.1697	ND-0.0187	ND-0.0011	ND-0.0024
HARIDWAR D/S	ND	ND-ND	ND-0.0178	ND-0.0006	ND-ND
GARMUKTESHWAR	ND-0.2700	ND-ND	ND-0.0230	ND-ND	ND-ND
KANNAUJ U/S	ND-0.1850	ND-ND	ND-0.0320	ND-0.0111	ND-ND
KANNAUJ D/S	ND	ND-ND	ND-ND	ND-0.0014	ND-ND
KANPUR U/S	ND-0.0720	ND-ND	ND-ND	ND-ND	N-R
KANPUR D/S	ND	ND-ND	ND-0.0071	ND-ND	ND-0.0362
ALLAHABAD U/S	ND	ND-ND	ND-0.0427	ND-ND	ND-ND
ALLAHABAD D/S	ND	ND-ND	ND-ND	ND-ND	ND-ND
VARANASI U/S	ND-0.5460	ND-ND	ND-0.1651	ND-0.0001	ND-ND
VARANASI D/S	ND	ND-ND	ND-ND	ND-0.0043	ND-ND
TARIGHAT	ND-0.0600	ND-ND	ND-0.0084	ND-0.0108	ND-0.0052

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW

NR = Not Recorded

The main sources for Dimethoate entry to the aquatic environment is through the spray drift run-off and leaching processes from the agricultural fields etc. as this insecticide is highly solible in water.

Among all the organophosphorus pesticides, monitored on various stations, their concentration levels and frequency of detection during the five years (1986-91), Dimethoate has been found to be most prominent both from its concentration levels and frequency of detection point of view (Refer to Table-4.19).

Dimethoate was largely detected on almost and all the stations at significant concentration levels during first three years (1986-89). The concentration levels and detection frequency got reduced during 1989-90 and 1990-91. As there is no criteria value given by Environmental Protection Agency (EPA) is available for the standard for fresh water aquatic life, the degree of violation of the concentration levels cannot be calculated on the various stations.

ETHION :

Ethion, a colorless to amber color liquid, non-volatile organophosphate predominantly a contact active, acaricide, finds its use mainly in control of aphids, thrips etc. used on apples,

TABLE- 4.19
DIMETHOATE

(ppb)
(ug/ l)

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	ND-ND	ND-2.6794	ND-0.9977	ND-ND	ND-0.0251
HARIDWAR D/S	ND-0.6020	ND-2.2438	ND-1.9366	ND-0.0211	ND-ND
GARMUKTESHWAR	ND-ND	ND-5.9230	ND-0.2994	ND-0.346	ND-ND
KANNAUJ U/S	ND-0.4300	ND-0.3692	ND-1.1268	ND-0.0053	ND-0.0133
KANNAUJ D/S	ND-0.5430	ND-8.772	ND-0.6455	ND-ND	ND-0.0204
KANPUR U/S	ND-0.1710	ND-0.6863	ND-0.2930	ND-0.0021	N-R
KANPUR D/S	ND-ND	ND-5.2500	ND-1.3021	ND-0.0369	ND-0.0151
ALLAHABAD U/S	ND-0.4750	ND-4.6154	ND-0.8785	ND-0.0067	ND-0.0167
ALLAHABAD D/S	ND-1.5080	ND-7.7500	ND-0.763	ND-0.0047	ND-0.0484
VARANASI U/S	ND-1.1900	ND-3.4615	ND-0.8216	ND-0.0095	ND-0.0120
VARANASI D/S	ND-0.4540	ND-0.4118	ND-0.6162	ND-0.0108	ND-0.0408
TARIGHAT	ND-0.9280	ND-1.1053	ND-0.7923	ND-0.0347	ND-0.0375

NR = Not Recorded

No standard criteris value for fresh water aquatic life (EPA)

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW.

particularly with petroleum oils on dormant trees to kill eggs and scales. It is also used to control Boophilus spp, on cattle and mobile stages and eggs of spider, mites in fruit cultivation.

The main sources of entry of ethion to the aquatic environment is through the spray drift and run-off processes from the industrial, urban and agricultural fields, application sites etc.

Ethion concentration during 1986-87, 1988-89, 1989-90 and 1990-91 was not detected on any of the monitoring stations (Refer to Table-4.20). But it was present on the stations Haridwar downstream, Kannauj upstream, Kanpur upstream, kanpur Down stream, Varanasi upstream and downstream and Trighat.

As the criteria value for the fresh water aquatic life is not given, the degree of violation above the limit cannot be examined on the detected stations.

AN OVERVIEW

The Pollution of river Ganga can be traced to three distinct social processes occurring along its entire stretch. These are, industrialisation, urbanization and intensive agriculture. Although these processes are by and large

TABLE- 4.20
ETHION

(ppb)
(ug/ l)

YEAR / STATION	1986-87	1987-88	1988-89	1989-90	1990-91
RISHIKESH	ND	ND	ND	ND-ND	ND
HARIDWAR D/S	ND	ND-0.0635	ND	ND	ND
GARMUKTESHWAR	ND	ND	ND	ND	ND
KANNAUJ U/S	ND	ND-0.0201	ND	ND	ND
KANNAUJ D/S	ND	ND	ND	ND	ND
KANPUR U/S	ND	ND-0.0371	ND	ND	ND
KANPUR D/S	ND	ND-0.0578	ND	ND	ND
ALLAHABAD U/S	ND	ND	ND	ND	ND
ALLAHABAD D/S	ND	ND	ND	ND	ND
VARANASI U/S	ND	ND-0.0689	ND	ND	ND
VARANASI D/S	ND	ND-0.0228	ND	ND	ND
TARIGHAT	ND	ND-0.0391	ND	ND	ND

No standard criteria value for fresh water aquatic life (EPA)

SOURCE : INDUSTRIAL TOXICOLOGY RESEARCH CENTRE, LUCKNOW.

location specific, as a result of the continuum of the river system the pollution had affected the entire stretch of Ganga. However in the case of industrial pollution, the pollution load is observed at its maximum level in relation to the location of specific industries. The station-wise data that were available give an indication of this trend.

Within regard to urbanisation, it is important to recognise that the river passes through 29 class I cites, 23 class II cites and almost 48 towns. Such level of urbanization and the consequent discharge of sewage would be posing a serious threat to the river system, although to a lesser extent than the pollution from industries.

With regard to intensive agriculture, although location specific run-off data are not available, traces of pesticides are found above the maximum permissible limit in some cases.

The data presented above show the Governments intention to present the success story of GAP, not withstanding the contradiction in the data itself. For instance, while the PH levels are maintained, it has not been able to achieve the standard `B' for bathing with regard to dissolved Oxygen. The measured level of dissolved oxygen between Kanpur to Allahabad, means there is a reduced pollution in these two location. Our own personal observation show that the discharge of sewage and effluents continuously and going to the river in camouflaged manner, similarly data also show pollution reduction with regard to biological oxygen demand. However it is a fact that majority of the sewage treatment plants are not yet operational, and interception and diversion of sewage water do not result in such a degree of pollution reduction. Thus the reliability of some of these data are questionable.

Another important point to be recognised is the lack of assumption regarding increase in population and the consequent increase in the organic pollution load under the highly cost and capital intensive schemes. The total coliform and fecal coliform count which remain above the permissible limit, indicates that the above aspect needs to be considered.

While the emphasis of GAP is on domestic pollution reduction, the serious problem of industrial pollution is not taken up seriously. Neither the centre with its intensive powers under the Environment protection Act 1986 nor the states have shown any inclination to control it. It is alleged that the Ministry of Environment has been very lenient towards the pollutors.

For instance the Ministry has not been able to implement the Environment Protection Act 1986 and it was not further setting a deadline for the industries to construct effluent treatment plants and comply with pollution control standards. The 'Ganga pollution case' in Supreme Court is eye opener in this regard.

The data that we have presented show the seriousness of industrial pollution. The concentration of heavy metals in the river has been found to be above the maximum permissible limit. Combined with this, the levels of DDT and BHC mainly from agricultural practices also add to the problem of cleaning up operations.

- CHAPTER - V -

AN APPRAISAL OF GANGA WATER POLLUTION

The "Ganga Action Plan " was initiated in 1986, to immediately reduce the pollution load and to enlist public participation to purify the river Ganga. The need of the plan was felt in 1983 after the Central Pollution Control Board under took a comprehensive survey, which showed the magnanimous pollution in river Ganga. The findings indicated heavy waste water discharge to the river, and also the toxic effluents from the various industries. The survey also points out the non-point pollution discharges to the river from the agricultural sources and runoff of waste water discharged on land. The report thus highlighted the various sources viz. domestic pollution load industrial effluents and sub-surface runoff from agricultural fields which made the river water unsafe for drinking and bathing. An action plan was prepared in 1984 for preventing the pollution of the river. The central Ganga Authority was set up in 1985 in order to determine policies and programmes, allocate resources and mobilize public support for executing the action plan.

Ganga Action Plan, has given relatively more emphasis on domestic pollution load from cities and towns and as a result the 261 schemes are aimed at reducing the pollution from this source (supported by the self -sustaining sewage treatment plants) In order to control the highly toxic effluents discharged from the industries GAP has been trying to force these polluting industries (identified by the state(s) pollution control boards) to construct effluent treatment plant. This effort is basically under the Environment protection Act, 1986 and Water pollution ACt 1974, which defines pollution under section 2(e) where in pollution means "such contamination of water or such alteration of the physical, chemical or ecological properties of water or such discharge of any sewage water as may be, or is likely to create a nuisance or render such wastes harmful or injurious to public health or safety....". Notwithstanding the under definition of pollution , the criteria for identifying gross polluting industries is quite lenient and liberal and includes only those industries which discharge 1 mld. effluent per day with high BOD level. They have identified 68 gross polluting industries, neglecting all those small industries mostly tanneries, chemical units, dying or printing contributing largely in combined manner to the pollution load of Ganga. With this inherent weakness, it has become difficult for the Centre and State Government (through State Pollution Control Boards) under GAP to control the water pollution. Even with extensive powers under EPA, 1986 and water Pollution Act, 1974, neither the Centre nor the State have shown any inclination to control the effluent discharge by the industries.

Out of the huge expenditure on the grandiose schemes, the maximum goes for the interception and diversion of sewage water scheme and sewage treatment plants despite huge investments, the sewage water is still going to the river contrary to the claims of Ganga Project Officials. The Majority of the sewage treatment plants are still under construction, repair or are working below the capacity. Surprisingly places and towns in Uttar Pradesh where GAP officials claim effective implementation of these schemes, there are numerous instances of continuous unintercepted flow from Nallas, discharge of human excerta from the Sulabh `Shauchalyas', ghats being used for defecting unending repairs in sewage treatment plants etc. The Ganga Action Plan a Blue eyed baby of the Ministry of Environment has not been able to attain the objective largely due to the following reasons.

— Involvement of more than one implementing agency led to the shifting of the work load, red tapism and decision making without coordination.

— Sewage interception and diversion have been given extraordinary emphasis which do not reduce the pollution. Instead, by only diverting the polluted sewage water, this again finds its way to the river.

— Lack of proper or ineffective monitoring network in order to look into the performance of various

— Lack of peoples participation in real sense. The public has remained on the receiving side of the consequences of increasing pollution in river Ganga, while the programme has become more of a government show.

— Inefficiency on the part of the State Pollution Control Boards to implement the laws (Environment Protection Act, 1986 and Water Pollution Act, 1974), because of uncoordinated network of reporting the polluting industries and putting legal pressure on them to install the effluent treatment plant and other anti-pollution devices.

— The schemes and implementation of these schemes, especially that of domestic pollution has not resulted in any substantial reduction in pollution as the pollution load is increasing with the increase of population each year.

As crores of rupees have been spent on the Ganga Action Plant, the water quality has shown no significant improvement. Central Pollution Control Board Data shows water quality improvement in some parameters despite the inherent contradiction in water quality data, pollution load and schemes implemented.

While water quality data strongly reflect the rapid industrialization, a growing population, disproportionate development, excessive use of fertilizer and pesticides and other social factors in order of importance this is not reflected in the priorities of the Action Plan, as a programme of pollution reduction.

The effluents from the Hazardous industries are still going to the river uninterrupted and untreated. This will be continued as long as the lenience of the state to take strong action against the polluters continues. Polluters create unsurmountable social damage by spoiling the water quality. It is therefore necessary to estimate the social costs and evolve the fiscal measures to penalise these defaulters and simultaneously charge the penalties for discharging the untreated effluents to the water source. The coercive policies can only, some how reduce the effluent discharging practice, if there is a political will to levy fine and enforce legal action.

Developing improved methods of production and there by increasing the productive capacity and simultaneously minimising the pollutants discharged are alternatives which could be considered, although considering the high cost involved in the short run, the industry may not be prepared to implement these measures. Ganga Pollution reduction programme as evident from the water quality data, schemes implemented, etc., aim to project a success story even though the data themselves do not warrant such a conclusion. The concentration of toxic chemicals discharged by industries remain above the maximum permissible limit which might cause health hazards with serious social costs (social costs in the form of increasing morbidity, low productivity of labour, deteriorated level of living conditions, serious health problems, etc.).

As this is a sensitive area of research in the field of Environmental health, there is paucity of information in this regard. In order to assess the effectiveness of Ganga Action Plan and also to make the programme people-oriented, the social costs of pollution needs to be a major component of the action programme. It will become a people partnership project only if the sufferings of the people living along the banks and getting affected by polluted water are ameliorated.

For assessing the health status and quality life of the towns and cities on the banks of River Ganga, in which highly toxic substances are discharged from industries, the need is to maintain trends of data on diseases patterns, the effects of these pollutants on high risks group (aged, women and child). The process of Ganga cleaning by the Government has neglected the health dimensions especially the exposure to the pollutants. So far, no specific study has been carried out to measure the health effects, especially in U.P. stretch where the maximum pollution load is observed.

The Ganga Action Plan has been a failure in terms of a large number of its objectives. Even the limited success in industrial effluent discharge reduction is due to determined judicial action. The Ganga Project Directorate has not carried out any feasibility and viability study of any specific scheme or schemes in relation to the pollution reduction. Secondly, there is no data on the techno-economic aspects of the various schemes through which the relative efficiency of any specific schemes vis-a-vis its contribution in pollution reduction process could be estimated.

From an economic point of view, on e can only conjecture that there is a mismatch between highly capital intensive schemes and the consequent pollution reduction. Another aspect which needs to be considered for an economic analysis, which has been mentioned earlier, is that these scheme are being constructed keeping the present pollution load in mind; no futuristic projection regarding rise in population and the consequent rise in domestic pollution load have been made. The increasing operational-maintenance cost have to be kept in mind when we consider the sustainablity of these schemes. A part and parcel of such an analysis should be the assessment of health effects of population exposed to pollution. This will provide an understanding of the quality of life, quality of labour, etc., so as to finally estimate the social cost of pollution.

The present study has been an effort to collect all the available data on Ganga Water Pollution and regarding Ganga Action Plan from its inception. The data expose the severe pollution levels even after more than five years of the existance of GAP, contrary to the claims of authority. The data also highlight the need to explore the missing dimensions of wate pollution such as health effects and quality of life of the people. Only a multidisciplinary effort involving economics, epidemiology, toxicology and other bio-medical sciences would reveal the intricacies of the problem.

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- APPENDIX-I -

HEALTH HAZARDS IDENTIFIED DUE TO EXPOSURE TO SOME OF THE HEAVY METALS

I. CADMIUM :

Cadmium is not essential for human body. Cadmium is toxic to all system studied in man, exhibiting a variety of toxic effects which are closely related. Symptoms of acute toxity following oral ingestion of cd salts include excessive salivation, persistant vomiting, abdominal pains, diarrhoea, vertigo, and loss of consciousness. Severe ulcerative gastro enteritis, and congestion along with pulmonary infarects and subdural hemorrohages also may be noticed.

The total body burden of average man is about 30 mg, about a third in the kidney and a sixth in the liver. The quantity in liver increases shortly after exposure. The kidney burden increases with age.

Symptoms of chronic toxity of cd are growth retardation, produces proteinurio, impaired kidney functions, impaired reproductive function, hypertension, tumour formation and teratogenic effects. Effects on kidney functions are affects proximal tubules of the kidney, causing the formation of kidney stones. The main symptoms following inhalation are persistent choking, coughing leading to pulmonary emphysema, and bronchitis, damage of renal tissues and olfactory nerves subsequantly occurs.

A specific disease, observed in Toyama city in Japan, has been attributed to cadmium. The epidemic was related to exposure to cadmium released from a nearby mining complex, resulting in contamination of water and rice paddies. It is Known as "Itai-Itai byo" (ouch-ouch) disease because of the severe painful symptoms in bones from the multiple fractures arising from osteomalacia, a waddling gait, amino aciduria, and glycosuria. It appears largely confine to post-menopausal women (45-70 years of age) who have expereinced several deliveries. In the terminal stage, multiple fractures occur after very mild exertion, such as coughing.

Cadmium toxication causes derangement in cardohydrate and mineral metabolism, in renal, hepatic, testicular and prostate functions, and disturbs the integrity of the central nervous system.

A few studies reports that the cadmium may be carcinogenic (prostatic & pulmonery cancer) in nature. The observation that persons suffering from lung cancer display high cadmuim levels in the liver, kidneys and blood.

<u>Mutagenicity of Cadmuim</u> - A summary of various studies shows that the potential of cadmium to cause gene mutations or chromosome aberrations has been assayed in numerous test systems.

Teratogenicty of Cadmium - In case of animals cadmium in high doses is teratogenic. One of the various researches it was found that human placenta is also less transmissible than it is for most other heavy metals. So far no observations in Cadmium teratogenicity in man have been reported.

II CHROMIUM : Trivalent chromium is one of the least toxic of the trace metals. Humans can tolerate 500 mg Cr2O3 daily. Hexavalent chromium is topically corrasive and oral ingestion of Cr^{6+} is toxic despite the organism's ability to reduce Cr^{6+} to the less toxic Cr^{3+}. In the past, treatments of warts by local application of chromic acid caused Cr^{6+} poisoning in humans, leading to nephritis, anuria and extensive lesions in the kidneys. Accidental swallowing of dichromate causes gastrointestinal ulceration and symptoms affecting the central nervous system, but no other reports of the toxic effects of ingested Cr^{6+} were found. Chromate-contact dermatitis varies from a dry erythematous condition to eczema on the exposed limbs; the eczema is due to the direct necrotizing effect of chromate. A high incidence of this type of skin allergy occurs among workers in the cemant, sulfite pulp, tanning, and electroplating industries. The injury to nasal mucosa caused by inhalation of hexavalent chromium compounds includes inflammation and ulceration, and the larynx is also affected.

Carcinogenicity : Chromium compounds are not carcinogenic orally, but epidemiologic evidence involves fine particles of chromium salts in pulmonary cancer among workers in chromium refineries and related industries. Chromium is a primary carcinogen, but does not induce cancer in other areas of the human body.

Mutagenicity ; The mutagenicity of chromates was not modified by the genetic absence of pathways for repair of DNA. Chromates are among the mutagens which exert their effects by directly modifying DNA bases so that base-pair error arise at subsequent cell divisions.

Teratogenicity : No inorganic chronium passes the placenta, but significant amounts of chromium are, however present in fetal tissues. Indeed, chromium in organic forms appears readily to cross the placental barrier. In view of the limited chromium transfer under conditions of toxic exposrue, it appears unlikely that this metal can affect the embryo, and the embryotoxic effect and malformations reported may, in fact, have been due to an action on the mother or on the plcenta.

III COPPER : Copper, because of the high reactivity of its ions, might be expected to be extremely toxic. Humans with Wilson's disease (Wilson's disease represent a special case of copper toxicosis. This condition is an iform error of human metabolism in which the liver, kidney, brain and cornea accumulate large amounts of copper) are especially sensitive to copper.

Acute copper poisoning in humans occurs typically 10-90 minutes following ingestion of acidic beverages which have been stored in or drawn throgh copper containers. Abdominal cramps, vomiting and diarrhoea lost less than 24 houres, Copper is more toxic in drink then in food. Acute copper sulfate poisoning results death therefore it is frequently used to commit suicide. Occassionaly children are accidentaly poisoned with this salt. Under these conditions the symptoms included vomiting, diarrhoea, jaundice, impaired liver function, hemoglobinuria, hematuria, oliguria, hypotension, coma and death. All the symptoms were not observed in all patients as it depends on the dose and the promptness of treatment. Contact dermatitis and eczematous dermatitis caused by internal exposure to copper in the form of intrauterine devices have also been reported.

Carcinogenicity : A high incidence of cancer among coppersmith, and of stomach cancer is humans living in regions with a high zinc/copper ratio in the soil, are suggestive of a carcigenic capacity of copper. This epidemiolgic evidence is not supported by experimental studies with rats. However, malignant tumours that are induced by organic carcinogens contain appreciable levels of Cu, Fe and Zn (Copper, Iron, Zinc).

Teratogenicity : Copper sals are poorly absorbed from the intestinal tract, but pass the placental barrier when injected intraperitoneally to hamsters on day 8 of gestation, and can provoke malformation of the head as well as resorption of fetuses (Ferm & Hanlon, 1974, quoted in Michaline kirsch-volders's "Mutagenicity, carcinogenicity & Treatogenicity of Industrial Pollutants". Plenum Press 1984). Copper sulfate (10 mg/kg/day) added to the diet of pregnant ewes for a period of 45-146 days caused abortion in one of four animals.

IV IRON : Iron overload in mammals occurs when the regulatory homeostatic mechanism fails and alters the absorptive capacity of the degestive tract, or when repeated blood transfusions are given. In humans, the ingestion of ferrous sulfate in doses ranging from 40 to 1600 mg Fe/Kg body weight has resulted in death. The average human lethal dose of ferrous sulfate has been computed to be about 200 - 500 mg Fe/Kg; however, the minimum lethal dose is much lower, since fatalities have occured at the 100 mg Fe/Kg level.

Acute Iron poisoning causes a biphasic shock; initial but rapid increases in the respiration and pulse rates, with congestion of blood vessels, lead to hypotension, pallor, and drowsiness in 6-8 hours. This is followed by prostration, coma, and finally death from peripheral cardiac failure in 36 hours. Chronic Iron poisoning causes hemorrhagic necrosis of the gastrointestinal tract, hepatotoxicity, metabolic acidosis, a greatly prolonged blood - clotting time, and elevation of plasma levels of serotonim and histamine.

Dietary ingestion of Fe in toxic doses results in hepatic damage, which causes jaundice by elavating the bilirubin level and inhibiting hepatic cellular enzyme activity: a study in the enzyme histochemistry of the liver suggests that there is inhibition of glucose - 6 - phosphatase, succinic acid dehydrogenase, and other oxidative enzymes.

Carcinogenicity : Some Fe compounds are reported to be carcinogens. Long - term inhalation of iron oxide results in a mottling of the lungs called siderosis; iron oxide penetrates the bronchial and alveolar walls and enters into lung tissue without extensive damage to the ciliary or mucous barrier. Iron oxides enhance the carcinogenic action of organic carcinogens in high concentration to healthy cells. Hematitie (Iron oxide) has been suspected as causing lung cancers in miners in Cumberland and Sweden, but other factors such as smoking, and exposure to radon daughters cannot be clearly seperated in these surveys. Iron therapy seemed unrelated to development to sarcoma, although local sarcoma could be induced by injection of ion - complexes, and the significance of tumors provoked by iorn appears doubtful.

<u>Muatgenicity</u> : Iron enhances, however, the clastogenic properties of ascorbate in mammalian cells.

V LEAD : The toxicology of lead is well-known and well-documented. Lead toxicity is more related to the levels of diffusible lead and to the lead content of soft tissues, such as liver, kidneys and brain, than to the total body content. The partitioning of lead among target organs and the concentration of diffusible lead in the soft tissues are directly responsible for toxic symptoms. Sometimes lead toxicity symptoms are not immediately seen after oral intake of a toxic dose, making it difficult to assess the lethal dose. Lead poisoning is cumulative, and the experimentally toxic and lethal does are reached at low levels.

Acute toxicity symptoms are lassitude, vomiting, loss of appetite, uncoordinated body movements, convulsions and stupor, eventually producing coma and death. Acute lead intoxications are rare. Chronic lead toxicity symptoms relate mainly to the hemopoietic system, the nervous system, the kidneys, and the gastrointestinal tract and also broadly includes symptoms like loss of appetite and vomiting, and long - terms effects are renal malfunction, hyperactivity, mild anemia, liver cirrhosis, brain damage and general intellectual and psychological impairment. In the adult, lead affects mainly the peripheral nervous system. Children who eat lead point (pia) can suffer from lead encephalopathy with convulsions, coma, and eventually permanent brain damage. Children surviving acute encephalopathy suffer permanent damage to the central nervous system. There has also been increasing concern and dispute that small exposure to lead may cause mental retardation in children.

<u>Carcinogenicity</u> : There is no evidence that industrial lead poisoning is associated with increased incidence of cancers of any type. Also no significant excess of cancers has been found amoung workers professionally exposed to lead. Therefore, one

may conclude that proof is lacking that lead represents a carcinogenic risk in man.

<u>Mutagenicity</u> : The experimental data do not furnish an unequivocal proof that lead is mutagenic to mammals specially to man. Although lead affects the fidelity of DNA, synthesis, cell proliferation, and in vivo DNA synthesis, negative results were obtained in all test systems utilized to assess its capacity to induce gene mutations in prokaryotes and eukaryotes.

Alterations in sperm morphology were also reported in workers from a plant manufacturing storage batteries, most likely this effect reflect the general cytotoxic action of lead.

<u>Tertagenicity</u> : The effects of lead on the developing embryo have recently been reviewed. Lead crosses the placental barrier less readily than mercury but more readily than cadmium; and lead concentrations in cord blood are lower than in maternal blood.

It has been known since the last century that women working in the lead industry suffered from menstrual disorders, were often sterile and spontaneous abortions. Lead was sometimes used as abortifacient. Abnormalities such as retarded growth and neurological symptoms were reported after accidental lead intoxication during pregnancy. A higher rate of mental retardation was noted in children from women living in areas with a water supply from leaden pipes.

In conclusion, lead reduces fertility and presents a certain teratogenic risk at high exposure levels. Lead exposure during pregnancy should be especially restricted becuase of its possible neurotoxic action on the developing central nervous system.

VI MANGANESE : Manganese is the least toxic of the essential metals. At concentrations greater than 1000 ppm, Mn is toxic to varying degrees, depending upon the type of Manganese ion and its oxidation state. Grwoth retardation, nonspecific anemia, "metal fume fever", and psychic and neurological disorders associated with "manganism" are some of symptoms of Manganese intoxication. Inhalation of Manganese compounds in aerosols or fine dust produces "metal fume fever". Chromic inhalation of manganese oxides for a few months causes pulmonary pneumonitis in Mn industry workers. This pathologic condition is characterized by the onset of pneumonia, intense dyspnea high body temperature, acute radiologic signs of lobar pneumonia, and hemorrhage in the lung with little expectoration; manganic pneumonia has a high mortality rate.

Chromic Mn toxicity in humans following chronic exposure to Mn through inhalation, ingestion, or parenteral administration for period of from six months to two years results in "manganism", a disease of the central nervous system involving psychic and neurological disorders. A peculiar slapping gait, cramps or termors of the body and extremities, slurred speech, hallucinations, insomania, and mental confusion are some of the systems; these symptoms resemble those of parkinson's disease. Divalent and Trivalent Mn act as neurotoxins, inducing degenerative changes in the nervous sytem. Nephritis, cirrhosis of the liver, anorexia, muscular fatigue, sexual impotence, leukopenia, anemia and monocytosis are other symptoms of "Manganism". In spite of the severity of the symptoms, chronic Mn intoxication or "Manganism" is not a fatal disease, although it causes permanent disability.

<u>Mutagenicity</u> : Manganese salts [$Mncl_2$, $Mn(No_3)_2$, $MnSo_4$, $Mn(CH_3\ Coo)_2$] are apparently potent mutagens. Positive results were obtained in the Rec - assay with Bacillus subtilis, Bacteriophage, yeast and E. Coli.

VII MERCURY : Metallic mercury enters the body mainly via inhalation of vapors; it is virtually not absorbed upon ingestion. Inorganic mercury salts are poorly absorbed (about

5%) after oral administration. The organic mercurials which are liposoluble can be absorbed by all routes. The principal sites of mercury deposition are the kidneys and the central nervous system after exposure to mercury vapor, the kidneys after exposure to inorganic mercury salts and to aryl or alkoxy mercury derivatives, and the central nervous system after exposure to alkyl mercury compounds. Alkyl mecury salts are more toxic than are elemental Hg (liquid or vapor) and inorganic Hg^{2+} salts. Inhalation of mercury vapor by man causes acute Hg poisioning, resulting in permanent damage to the nervous sytem, and possibly death. Chronic mercury poisoning following inhalation called mercurialism; it affects the nervous system in an insidious way, so that the toxic effects may not be observed for months following exposure.

Acute inorganic Hg intoxication causes nausea, headache, abdominal pain and diarrhoea, a metallic taste in the mouth, and albuminuria. Later stomatitis and gingivitis develop, with the swelling of salivery glands and ulceration in the buccal cavity. Other characteristics are severe irritation in gastrointestinal tract followed by renal necrosis, delirium and hallucinations; death results from extreme exhaustion. Intoxication by Hg vapor inhalation initially causes acute tightness and pain in the chest with breathing difficulties; more serious symptioms occur later.

The central nervous system is the main site of action of alkyl mercury. In humans the neurotoxic symptoms of methyl mercury salts, the Hunter - Russel Syndrome, involve focal cerebral and cerebellar atrophy. The granular cell layer of the neocerebelium is affected followed by cortical atrophy of the area striata, which leads to blind. Minamata Disease is caused by the toxic effects of Methyl Mercury (due to the consumption of fish contaminated with CH_3Hg^+ Methyl Mercury), on the multiple organ systems including the Kidneys, reticuloendothelial system, gastrointestinal tract, and testes. Inhibition of the early phase of DNA synthesis is suggested as the cause of toxic effect of CH_3Hg^+ on spermatogensis. Reproductive capacity is not adversely affected in humans of either sex following Hg intoxication, as was observed in the Minamata patients.

<u>Neurotoxicity</u> : The outward neurotoxic symptoms of acute CH_3Hg^+ intoxication in humans depend upon the severity of the exposure. The symptoms extend from simple paresthesia or oncentric constriction of visual fields with abnormal blind spots to grotesque incoordinated movements, tremor paralysis, coma and death.

Mutagencity : Production of C-mitosis, which can result in aneuploidy and polyploidy, is the noticeable mutagenic effect of mercurry observed in eukaryotes, Such a specific and restricted action may explain the negative results obtained in experiments on prokaryotes. The induction of C-mitosis could result from the high affinity of mercurry for sulfhydryl groups in the spindle apparatus. The cytotoxicity of organomercurials is, however, probably not only due to an action on sulfhydryl enzymes. An increase in structural aberrations in peripheral blood lymphocytes of persons exposed to mercury.

Teratogenitity :Mercuric methyl chloride, phosphate, sulfide and phenyl acetate can provoke teratogenesis; some of the observed effects on mammals are fetal resorption and death, lowered body weight of offspring, incidence of cleft palate, abnormals tails, and changes in the nervous tissue. Malformation of the spinal card, retarded growth of the cerebellum and disapperance of cerebeller granular matter, and diminution and atrophy of cells in the cerebral white matter are some of the changes in Hg-poisoned nervous tissue observed in mammals tests.

Some of the above teratogenic effects were partially present in fetuse of women suffering from Miniamata disease. A cerebral- palsey - like disease was reported in the children born of these women; mild spasticity, ataxia, seizure, and severe mental retardation were some of the clinical symptoms observed in some cases, the mothers showed no symptoms of Hg intoxication, and the children were never exposed directly to mercury-contaminated diets, but were nursed by the mothers, therefore found suffering with minamata disease. This indicates the transfer of organic mercury salts in womb through placenta and after birth through maternal milk, with subsequent deposition in the nervous tissues central nervous system damage was noted in newborns of maother suffering from Minamata disease; even when the mother was asymptomatic. The developing nervous and hematopoietic systems in the fetus are especially suspceptible to $CH3\ Hg^{+}$ intoxication.

The Health Hazards identification is the first step of Health Risk assessment.

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