Pollution of River Gomti at Lucknow City Area

Dr. Sudhir Kumar Srivastava
Central Ground Water Board, CHQ, Faridabad - 121001

Abstract—Water Quality of Gomti River is mainly affected by Sewage / Domestic Wastes and industrial wastes disposal in to the river. Apart from Mohan Mekin there are many Chiken cloth colouring units disposing colour dyes etc.in to the river Gomti. The washing of cloths near Gomti River increases detergents wastes. Also due to Religion, that is Temple's flowers, Idol submersion during Durga Puja, Ganesh Puja etc Cattle's bathing are also polluting the river water. Use of Plastics and their disposal in the river is creating havoc. A long duration study of water quality data of Gomti River in summer season average for the period 1997 to 2008.depicted that most of the chemical parameters are increasing. The chemical data of metal/ trace elements reveals that all the metal ions are within permissible limit of drinking water except the iron content, which is higher than its maximum permissible limit of 1.0 mg/l set by BIS.

Keywords: Pollution, Chemicals, River

I. Introduction

Water is essential for our existence. Good and adequate water is essential for the comfortable and happy living. As per the Indian Standards (IS-1172), the requirement of water per person per day is 135 ltrs. (about 9 buckets) for hygienic living. Of this total, the quantum needed for cooking and drinking purposes is only about 10 - 15 ltrs.; a substantial portion (about 40 - 45 ltrs.) goes for flushing the water closets. The rest goes for bathing (30 ltrs.), washing of clothes (15 - 20ltrs), vessels (10 - 15ltrs.), floors (5 liters), etc. The portion needed for cooking and drinking at least has to be absolutely free from any pollution.

Ever-increasing population and the consequent urbanization and industrialization have mounted serious environmental pressures on these ecosystems and have affected them to such an extent that their benefits have declined significantly. Lucknow is the capital city of Uttar Pradesh, located between latitude 26°30′N–27°10′N and longitude 80°32′E–81°12′E, and covers an area of about 2528 km2. The Gomti River basin, a major tributary of the Ganga River, flows through the center of the city, making it an important source of water for irrigation and domestic purposes.

II. Sources of Water Pollution

The human activities are the main cause of pollution of water bodies like rivers, lakes, marshes, ground water apart from the natural processes. Discharging various wastes in and near a water body causes pollution of that water body. Wastes from following operations cause pollution.

- Domestic waste
- Sewage
- Mining
- Agriculture: This sector uses 70% of total water use in India.
- Stock Breeding
- Fisheries
- Forestry
- Urban human activities
- Construction works
- Industries: This sector uses 8% to 50% of total water use.

Varied beneficial uses of water require different levels of minimum purity. Water is suitable for certain designated use if it complies certain criteria. Classes A to E is defined by Central Pollution Control Board (CPCB) in 1991.

Designated Best Uses	Class	Criteria
Drinking Water and Domestic supplies without treatment but with disinfection	A	pH 6.5-8.5 DO > 6 mg/l ; BOD < 2 mg/l Total Coli. < 50 MPN/100 ml
River bathing, swimming and water contact sports	B	pH 6.5 – 8.5 DO > 5 mg/l ; BOD < 3 mg/l Total Coli. < 500 MPN/100 ml
Source of raw water for municipal supplies consumed only after conventional water after treatment.	C	pH 6.0 – 9.0 DO > 4 mg/l ; BOD < 3 mg/l Total Coli. < 5000 MPN/100 ml
Propagation of wild life animal husbandry and fisheries	D	pH 6.5 – 8.5 DO > 4 mg/l Free Ammonia (as N) < 1.2 mg/l
Agriculture, Industrial cooling, washing hydro-power generation and controlled waste-disposal	E	pH 6.0 – 8.5 EC (at 25^0C). <2250 µmhos/cm SAR < 26 ; Boron < 2 mg/l

Table 1: Tolerance Limits for Inland Surface Water

III. Classification of Water Pollutants

A. *Depending on nature of polluting activity*

1) Natural surface water runoff.
2) Dissolved chemical that percolates through soil, causes ground water pollution - Leaching.
3) Human sources like agriculture, mining, construction, industry, homes and business - all cause water pollution - Anthropogenic.

B. *Depending upon the pattern of entry*

1) Point source, which is identifiable and hence comparatively easy to control. e.g. Sewage, storm-water, Industrial effluent, animal feed-lots.
2) Non-point source which is widely spread out, diffused and hence difficult to identify and to control. e.g. agricultural run-off, Sediment run offs from natural or human caused forest fire, construction, logging, drainage of acids, minerals, sediments from

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active/abandoned mines, oil-spills or spills of other hazardous material.

C. Depending upon the degradability or reactivity

1) *Biodegradable* degraded by microbes in reasonable time say up to 1 month. These pollutants become a problem when added to the environment faster than they can decompose. Biodegradable pollutants are of two types, rapidly degradable and slowly degradable. Rapidly degradable pollutants are 'natural', we put them somewhere until they degrade to non-toxic levels. Slowly degradable pollutants are materials that either do not decompose or decompose slowly in the natural environment. Once contamination occurs, it is difficult or impossible to remove these pollutants from the environment, e.g. synthetic compounds, which resemble nothing natural, such as dichloro diphenyl trichloro ethane (DDT), dioxins, polychlorinated biphenyls (PCBs), and radioactive materials. They can reach dangerous levels of accumulation as they are passed up the food chain into the bodies of progressively larger animals. These very slowly degradable pollutants are more problematic because they will not degrade to non-toxic levels in a reasonable period of time. Ultimately they seep back into the environment and create much havoc. Some special measures like advance oxidation systems are required to remove slowly degradable pollutants from wastewater. They are often difficult and expensive.
2) *Non degradable pollutants* are bacteria, virus, salts of metals, sediment fractions, heavy metals and the Plastics.
3) *Oxygen-demanding wastes:* They are degradable by bacterial activity or strong acids/chemicals. Hence, cause depletion of dissolved oxygen. Most of them, primarily organic materials hence, get oxidized to CO2 & H2O. If degraded in anaerobic condition, give out foul odour and decrease the usable & recreational value of water bodies. This process may cause fish kills & danger to other aquatic life, also affect colour, odour, and taste of water. Typically such pollutants come from sewage (domestic and animal), and industrial wastes. The amount of such substances is estimated in water by quantity called Biochemical Oxygen Demand (BOD).

Under aerobic conditions	Under anaerobic condition
$C \rightarrow CO_2$	$C \rightarrow CH_4$
$N \rightarrow NH_3 + HNO_3$	$N \rightarrow NH + Amines$
$S \rightarrow H_2SO_4$	$S \rightarrow H_2S$
$P \rightarrow H_3PO_4$	$P \rightarrow PH_3 + P\ compounds$

Table 2: Products of decomposition of organic matter

4) *Disease causing agents:* 75% - 80% infant deaths are caused by water borne diseases. Water has been a potential carrier of pathogens hence, causing epidemics of typhoid, para-typhoid, dysentery, cholera. Water also transmits diseases like polio and hepatitis. Modern disinfection and treatment plants have greatly reduced this danger in cities. Sewage and such discharge make the water body infected with such pathogens and that acts as source of this category of pollutants.
5) *Plant Nutrients:* For plant growth, nutrients are limiting factor. N & P enter freshwater and lead to plant growth. When in excess, they cause eutrophication. They tend to accumulate in ground water. Excess concentration also renders water unsuitable for certain uses as they cause high BOD and disagreeable odours. Nutrient enrichment is a natural process (e.g. peat and muck soils or coal and oil deposits). Human activities hasten this leading to aging of lakes in shorter time.

N-P-K fertilizers applied in agriculture get into run off. Run off coefficient is a function of solubility of fertilizer, rate of absorption by plant, rate of decomposition. In the process excess nutrients flow to water and cause eutrophication.

D. Organic chemicals

Detergents (surfactant), pesticides, various industrial products, decomposition products. Some of them are toxic to fish at very low concentration, such as 1 ppm (phenol). Many are not biodegradable or very slowly degradable. Agrochemicals are some special chemicals which may be toxic to biota, human, extremely stable like DDT or have tendency to accumulate in animal and human body.

In UP, big rivers like Ganga, Sarju, Betawa, Rapti, Gomti, Sai and its tributaries are the main sources of water supply. These rivers passes through almost all the big cities of UP. The sewage water, domestic and industrial wastes from the big cities are being disposed in these rivers. Investigation of the physico-chemical and biological parameters helps in assessing the status of water quality. The Jal Sansthan / related Department, supply the water after appropriate treatment of this water. The Dissolved Oxygen, Biochemical Oxygen Demand and Total Coliform bacteria are the main parameters for the surface water supply. Year wise average value of DO, BOD and Total Coliform bacteria in Gomti River in and around Lucknow city are depicted in figures1-3.

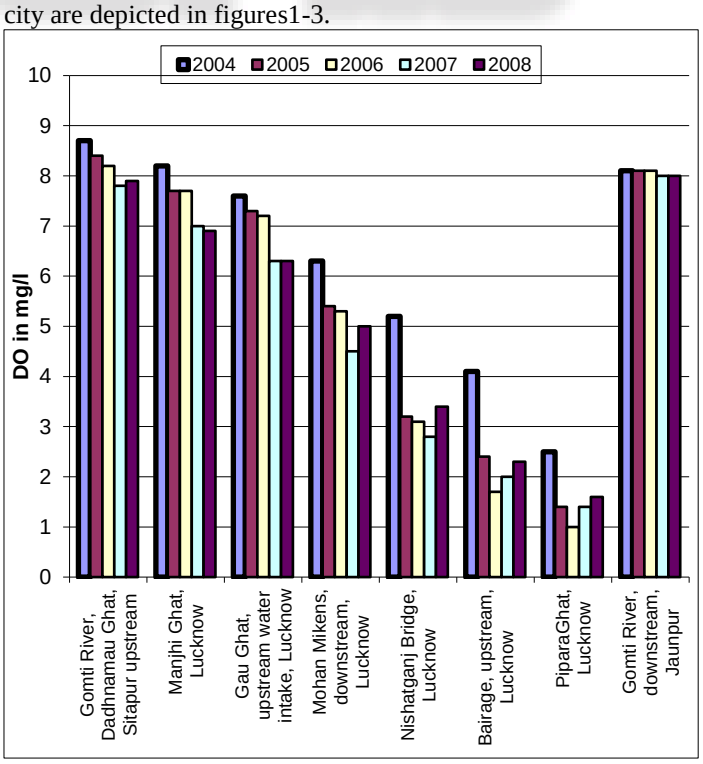

Fig. 1: Year wise Average Value of Dissolved Oxygen in Gomti River (Source: UPPCB)

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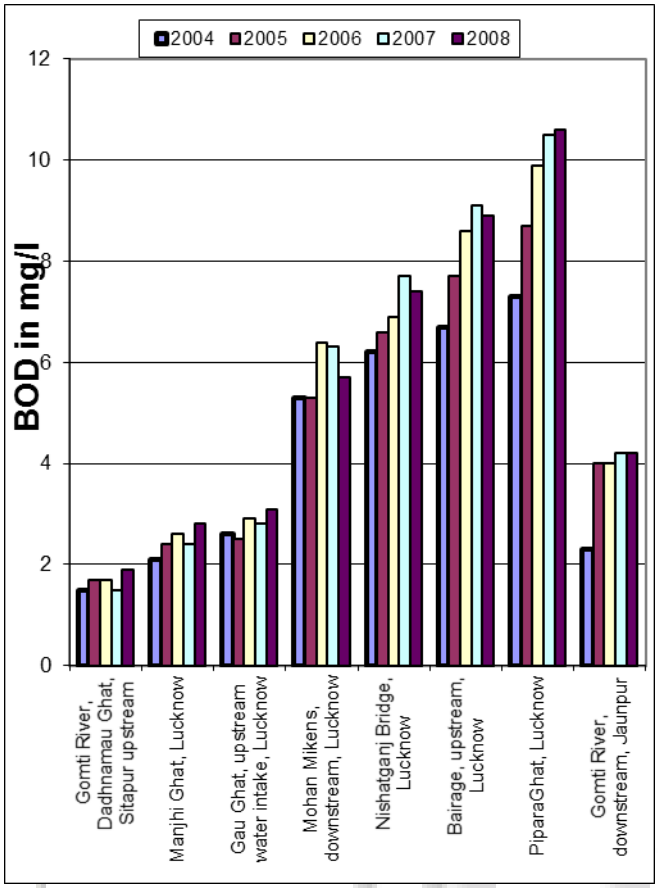

Fig. 2: Year wise Average Value of Biochemical Oxygen Demand in Gomti River (Source: UPPCB)

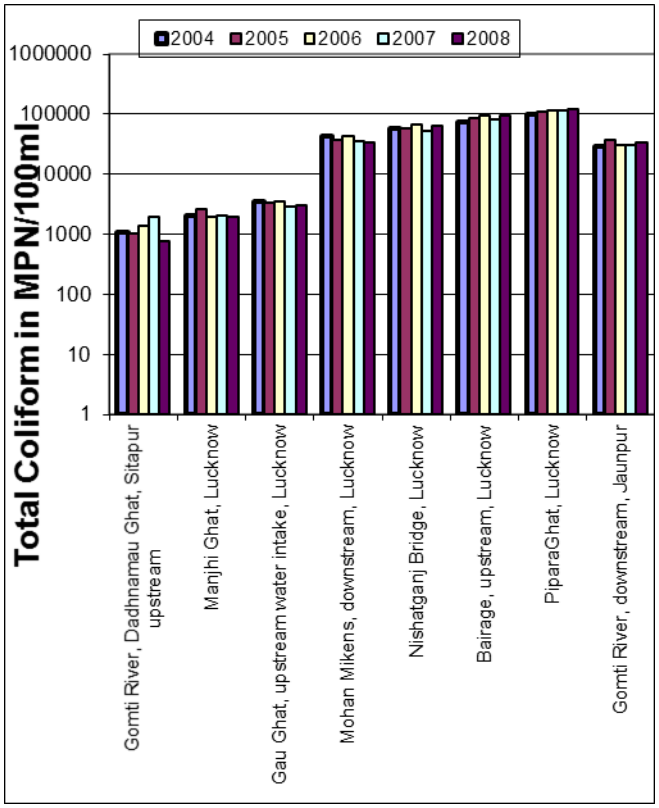

Fig. 3: Year wise Average Value of Total Coliform Bacteria in Gomti River (Source: UPPCB)

A long duration study of water quality data of Gomti River in summer season average has been depicted in the Table- 3 for the period 1997 to 2008. it has been observed that most of the chemical parameters are increasing since 1997. The year wise average values of Dissolved Oxygen in Gomti River have been found to reduce from upstream DO of around 8 to downstream DO less than 2 mg/L(Fig 1). The year wise average values of Biochemical Oxygen Demand (BOD) in Gomti River have been found to increase from upstream BOD of around 2 to downstream BOD more than 10 mg/L(Fig 2). Similarly, the year wise average values of total coliform bacteria (TCB) in Gomti River have been found to increase from upstream TCB of around 1000 to downstream TCB more than 100000 MPN / 100 ml(Fig 3). It has been observed that all the chemical constituents present in river water samples were within permissible limit before the river enters the Lucknow city and as it passes through the city, the quality of river water deteriorates due to the mixing of several drains especially near Daliganj disposal drains and Haider canal (Gomti Barrage). The chemical data of metal/ trace elements given in Table-4 reveals that all the metal ions are within permissible limit of drinking water except the iron content, which is higher than its maximum permissible limit of 1.0 mg/l set by Bureau of Indian Standard (IS 10500: 2007) There are few Dhobi ghats and clothes dying units at the bank of the river Gomti which are also polluting the river water. High concentration of Mn (0.223 mg/l), Cr (0.05mg/l), Zn (0.115 mg/l), Co (0.04 mg/l), Fe (2.60 mg/l), Cu (0.057mg/l) and Pb (0.023 mg/l) has been observed. The water quality improves slowly near Pipra Ghat. The occurrence of heavy metals in river water is mostly linked with industrial wastes, sludge & solid waste and other anthropogenic activities.

Parameter / Years	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Ca (mg/l)	40.85	40.85	42.6	37	40.75	42.95	39.15	49.3	50.7	34	49	57
Cl (mg/l)	29.96	40.94	35.45	25.62	27.03	30.04	28.01	39.44	28.01	12	29.9	29.9
CO3 (mg/l)	0	0	0	0	0	0	0	0	0	0	6.4	0
F (mg/l)	0.28	0.27	0.41	0.11	5.7	0.32	0.11	0.71	0.2	0.44	0.38	0.77
Fe (mg/l)	0.02	0	0	0	2.75	0.2	0	0.25	0.16	0	0.2	0.3
HCO3 (mg/l)	323.3	292.8	315.98	252.54	252.54	150.31	234.39	254.98	254.98	200	241	207
K (mg/l)	6.92	9.26	11.6	8.97	6.05	6.34	6.14	8.09	10.04	7.4	8.5	11.5
Mg (mg/l)	85.31	27.88	21.95	15.72	18.33	20.88	21.68	29.49	37.15	22.7	27.5	32.7
Na (mg/l)	23.35	15.87	12.31	9.72	10.35	9.6	11.5	17.37	18.17	24.1	26.8	26.6
NO_2+NO_3 (mg/l)										1.39	1.87	1.67

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NO2-N (mg/l)	0.2	0.3	0.33	0.02	0.16	0.1	0.17	0.06	0	0.08	0.1	0.1
NO3-N (mg/l)										1.31	1.77	1.56
o-PO4-P (mg/IP/I)	0.36	0.26	0.37	0.1	0.18	0.18	0	0.18	0.24	0.11	0.11	0.1
SiO2 (mg/l)	15.5	12.6	12.2	11.9	15.95	15.3	12.3	15.6	16.7	14.5	10.3	8.1
SO4 (mg/l)	0	0	2.64	10.68	0	0	9.72	0	8.04	28	27	26.7

Table 3: Average Water Quality Data of Gomti River in summer

Locations	Mn	Cr	Zn	Cd	Co	Fe	Cu	Pb
	←----------In microgram per liter----------→							
Gau Ghat	34	21	41	nd	3	1678	nd	16
Mohan Mekin	223	34	115	nd	4	2604	57	23
Shahid Smarak	56	33	52	2	3	1054	12	14
GomtiBairaz	86	50	40	1	3	1140	7	5
Pipara Ghat	76	49	40	2	2	1493	13	9

Table 4: Data of Metal Ions in Gomti River Water (nd- not detected)

IV. Conclusion

Water Quality of Gomti River is mainly affected by Sewage / Domestic Wastes and industrial wastes disposal in to the river. Apart from Mohan Mekin there are many Chiken cloth colouring units disposing colour dyes etc.in to the river Gomti. The washing of cloths near Gomti river increases detergents wastes. Also due to Religion, that is Temple's flowers, Idol submersion during Durga Puja, Ganesh Puja etc Cattle's bathing are also polluting the river water. Use of Plastics and their disposal in the river is creating havoc. occurrence of heavy metals in river water is mostly linked with industrial wastes, sludge & solid waste and other anthropogenic activities.

The Solid and Liquid Wastes of the City should be disposed only after proper treatment. Ban on the use of Polythene bags. Responsibility should be fixed on factory owners who are disposing wastes without proper treatment Awareness Programme should be initiated. Time to time cleaning of Trunk Sewer line of the city is required. Also, the students of School /Colleges should be taught and made aware of the water pollution.

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