Eco. Env. & Cons. 28 (3) : 2022; pp. (1636-1643)

ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i03.074

The Ganga River Water Pollution Status in India characterize with river Gomti

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(Received 29 August, 2021; Accepted 3 October, 2021)

ABSTRACT

This article puts forward to provide the state of pollution of the Ganga River in India along with its tributary river Gomti. A lot of research works for monitoring and assessment of Ganga river water have been done by many investigators in the past. With its pietism, Ganga River water is considered a great prominent river in India so that people use the water to perform last rites to their loved ones. It is deteriorated due to discharge of untreated wastes, chemicals, heavy metals and sewage from Industries and Cities. This paper reveals governmental efforts toward river water preservation, not executed properly because of the apathetic approach of people in our country. In India lack of sanitation in rural areas is also a major contributor of river water pollution. In the urban mega cities which are fast-growing- hotspots, pollution levels worsen along the Ganga River including its tributary rivers. Some studies by CPCB reveal high BOD levels at downstream, biochemical oxygen demand (BOD) levels were high towards downstream at Haridwar, Kannauj, Kanpur and on peak at Varanasi but alarming is that, almost at all the stretches of Ganga river and its tributaries, level of pollution is getting escalated. Alone Uttar Pradesh contributes 90% of Ganga pollution so that it is chosen for further research including Gomti River a significant tributary of Ganga. Although there are many contributions of researchers in cleaning Ganga but structured and stringent measures for the environment are to be taken.

***Key words**: River, Ganga, Gomti, Tributaries, Physico-chemical parameters, Biological_parameter*

Introduction

According to Hindu mythology, the Ganga River springs from the Gangotri glacier at Uttarkashi district Uttrakhand which lies in Garhwal Himalayas at about 3800 m altitude over mean sea level. So the Gangotri glacier 'a traditional source' having about 2550 km long main channel Vass *et al.,* (2010). In hydrology, Devprayag of the Alaknanda river in Uttrakhand is the source because of its largest channel (Rahman *et al.*, 2009). The Ganga enters the plains of Haridwar via Sivalik hills. By flowing through Uttar Pradesh it enters Bihar firstly in Rohtas district.

Then Ganga flows towards the south via West Bengal province. Ganga River is divided into two arms; the left arm reaches Bangladesh and the right towards West Bengal (south direction) known as Bhagirathi. Bhagirathi flows in directions west and southwest of Kolkata known as Hooghly. Finally, Ganga reaches Diamond Harbour and then a southward direction before emptying in the Bay of Bengal. Vass, (2010) states that the habitats of the delta are stretches of warm water, and also cool upland streams. The Source of water in the Himalayas is the melting of snow and monsoon rains.Ganga river basin is the third greatest stream on earth due to its heavy discharge. By traveling across 29 major cities, 23 small cities and 48 towns Ganga traverse the distance above 2500 km from Gangotri to Ganga Sagar. Major tributaries of Ganga includes Alaknanda, Damodar, Gomti, Ghaghara, Gandak, Kali, Koshi, Ramganga, Son River and Yamuna River.

Now Ganga has been declared as one of the world's fastest shrinking and most threatened rivers by the United Nations due to the industrial revolution and traditional rituals. As estimated major cities of India generated 38354 million l/day (MLD) sewage every day whereas the treatment capacity of sewage in India is only 11786 MLD. (CPCB, 2007) reported the major contributors of wastewater are Delhi, Maharashtra, Uttar Pradesh, West Bengal, and Gujarat. The Class-I (498) and Class-II (410) towns generated about 35,558 and 2,696 MLD respectively while the capacity of treating sewage is all about 11,553 and 233 MLD, respectively. Wastewater is emerging as a potential source for demand management after essential treatment because the current situation cannot be handled without enhancing water use efficiency and demand management.

River Ganga is divided into two segments in Uttar Pradesh, Sukratal-Anupshar and Kanpur-Varanasi region. According to Central Pollution Control Board, 2013, 45 drains were identified

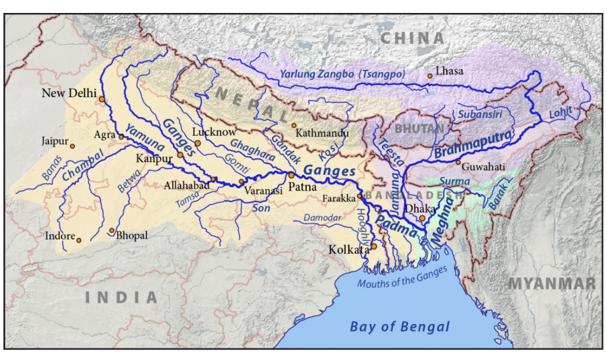

Fig. 1. Map of Ganga River and its tributary Rivers flowing along with its States

which discharge about 3289 MLD of wastewater from cities like Bijnor, Garh, Gajrola, Babrala, Kannauj, Kanpur, Allahabad, and Varanasi into the Ganga river.

Water Quality Standards

Different health agencies have prescribed their water quality standards and permissible limits for different categories of water (Lester, 1969). Prescribed water quality standards of prominent agencies such as U.S. Public Health Service Drinking Water Standards (USPHS) 1962, Bureau of Indian Standards (BIS), World Health Organization (1992), Indian Council of Medical Research (ICMR) 1962 are following in Table 1.

Water quality of rivers, streams and any other sources directly influences the wellness of humans and their environment so the measurement of water quality standards is crucial (Umar, 2000).

Status of Gomti River

Gomti river, a significant tributary of Ganga river receives huge load of untreated effluents through different point and non-point sources along their stretch (Singh Deepika *et al.*, 2022). According to a CAG report on both the rivers from 2011 to 2015, it is studied that Gomti River is excessively polluted than the Ganga River in Varanasi. Although Varanasi city has a high-density population, heavy tourism and in this regard Lucknow should perform better in aspects of state capital city. Gomti River, A major tributary of the national river 'Ganga'. It originates from FulharJheel near Madhotanda of Pilibhit, Uttar Pradesh. The river flows southwards from 200 m. to 62 m. above mean sea level towards the districts of Lakhimpur Kheri, Sitapur, Lucknow, Barabanki, Sultanpur, and Jaunpur and after a 950 km of run finally encounter with Ganga River at Kaithi, District- Ghazipur border of Varanasi.

The water quality of Gomti river in Lucknow gets affected by 26 major drains of the city which inundate from Cis side (14 drains) and Trans side (12 drains). The drains of the Trans side of Gomti are relatively at a higher level, than their cis counterpart (Singh *et al.*, 2016). From the downstream of Sitapur to upstream of Sultanpur the river is in purely exhausted condition due to getting industrial effluents from paper, plywood, and sugar processing industrial belts. Jaunpur having 10 municipal discharges and acid mixed effluents from ornament industries directly dump into the Gomti River. Gomti Action

Plan was drafted with extensive funding in 1993 but not a single sewage treatment plant is established over there till yet, report of 'Times of India'by Binay Singh. In India total no. of STPs including proposed is 1631 STPs among 35 states and Union territories having 36,668 MLD of total capacity. In which1,093 STPs are Operational and 102 are Non-operational, out of total no. of STPs 1,631 in India. Among these 274 STPs are under construction and 162 STPs are proposed. Uttar Pradesh has been recorded the highest level of sewage generation and then West Bengal is coming in the row of wastewater generation. Some data has been received till the year 2020-21 from PCCs and SPCBs for locations of Ganga River in India are following briefly;

Provocations

Pollution by Industries

Saxena *et al.,* (1966) ded a systematic survey of Physico-chemical parameters and pollution load on the Ganga River at Kanpur was analyzed. According to this study, the biochemical oxygen demand (BOD) varied from 5.3ppm which is minimum in winter, and maximum in summer, i.e. 16.0 ppm. Whereas the chloride is beyond the limit (9.2 ppm - 12.7 ppm) due to thisriver is found alkaline in nature except for the wet season. It was also found that sewage generated about 37.15 million gallons/ day and with 45 tanneries, 10 textile mills, and other industrial unitsapprox. 61630 kg/ day of BOD loaded along Ganga River. Finally concluded that due to discharge of huge effluents from tanneries contain organic wastes and heavy metals that increase the pollution load of the River Ganga.

One of the earliest studies of Kumar, (1989) had depicted that direct discharge of municipal wastes into Gomti River around Lucknow via drains are highly answerable for raised levels of heavy metals and PO4. To study the nature of sediments deposited on streams, Singh *et al.,* (2002) examined the six urban centers of Ganga plain and its tributary GomtiRiver in Lucknow. That paper reveals urban centers are responsible for metallic pollution that occur from Cadmium, Copper, Chromium, Nickel, Lead, Zinc, etc.

Pollution by Toxic Chemicals

Samanta *et al.,* (2013) reviewed the presence of metals, organic pollutants, and pesticides in river water contaminated. These contaminants showing a high level of risks due to residues present beyond the permissible limit for aquatic organisms by standards of US EPA. The uppermost stretch up to Haridwar is relatively free from contamination. The middle stretch is markedly polluted by receiving various kinds of effluents. A remarkable stretch of an estuarine zone with enormous industries receives effluents but is more optimized than a middle stretch of river Ganga due to tidal action which maintains the level of metals in water. This paper indicates that the major contaminations in water are HCH (Hexachloro Cyclohexane), DDT (Dichloro diphenyl

Table 1. Water Quality Standards for Inland Waters

Parameter	USPHS	BIS	WHO	ICMR
Temperature ^{0}C	-	40.0	-	-
EC	0.03	0.075	-	-
pH	6.0-8.5	6.5-8.5	7.0-8.5	6.5-9.2
DO mg/ l	>4.0	>5.0	-	-
BOD mg/ l	-	<3.0	-	-
COD mg/ l	-	<20.0	-	-
Chloride mg/ l	250	250	200	250
Alkalinity mg/l CaCo3	-	-	-	81-120
Nitrate mg/ l	10.0	50.0	45.0	20.0
Phosphate mg/ l	0.1	-	-	-
Sulphate mg/ l	250	150	200	200
Total hardness mg/l CaCo3	500	300	100	300
Total solids mg/l	500	-	500	-
Calcium mg/l	100	75	75	75
Magnesium mg/l	-	30	-	50
Potassium mg/l	-	-	-	20
Sodium mg/l	-	-	50	-

Trichloroethane), and Endosulfan whereas HCH, DDT, Aldrin, and Dieldrin stimulate the sediment phase.

Srinivasan *et al.*, (2010) state that Jajmau and Unnao, two cities of Kanpur (Uttar Pradesh) are a milestone in the tanning process for leather production. These industries were entrenched along the embankments of the river Ganga. Study shows heavy chemical pollution in soil due to unchecked wastes generating from industries. Frequent dumping of hazardous waste materials and continuous effluent release from various industries of fertilizer, Textile mills, and Leather industries causes the contamination in soil. A large number of arms factories also tenet the presence of high levels of toxic metals in the environment and groundwater which results in leaching. Total metal contamination in several samples was found over the international threshold limits for the detected values. Pollution of these hazardous metals generated from these industrial areas either from the release of effluents or by dumping of industrial waste to the ground that causes contamination in water bodies and streams of the study area. Cr and Zn were found in high concentrations in the research area.

Khare Richa *et al.,* (2011) studied different parameters like pH, Temperature, Turbidity, Total hardness, Suspended Solids, Oxygen consumption to measure high correlated and interrelated water quality parameters. The analysis was done during pre-monsoon, monsoon, and post-monsoon seasons where F-, Cl- and NO_3^- was lesser while turbidity value was higher according to WHO. The water samples were collected from the upper, middle, and lower streams of Ganga for Physico-chemical analysis appeared beyond permissible limits. The river Ganga passing along various Ghats and lakes entering via Bithoor in Kanpur and then exit at Jajmau after covering a distance of 22 km.

C. Pollution by Heavy Metals

Rai *et al.,* (2010) presented their research workon microbial pollution and heavy metal contents found in river water regarding water quality at Varanasi. While assessing the case of three sewage treatment plants along with the Ganga River DO, BOD, and heavy metals (Zn, Cu, Cd, Pb, Cr) were at outlets beyond the permissible limits at all the sites. An approach of phytoremediation of Macrophytes and process of wastewater ozonization to be applied for this type of research to restraint the heavy metals and microbial pollution in River water.

This impact assessment by Singh *et al.,* (2004) assessed the impacts of toxic sewage generation either treated/untreated from STPs of Jajmau (Kanpur) and Dinapur (Varanasi) regions having sewage treatment plants capacity of 5 MLD and 80 MLD respectively. The sampling was done from inlet and outlets of both the STPs during peak times of the day (morning and evening) and non-peak (noon) hours. They found the effluent was enriched by heavy metals and pesticides with some nutrients

Table 2. Status of industrial unit, water consumption and wastewater generation along Ganga river basins

State	Number of Industry	Water consumption (MLD)	Wastewater generation (MLD)
Uttarakhand	42	224	627
Uttar Pradesh	687	693	8263
Bihar	13	17	2276
Jharkhand	0	0	1510
West Bengal	22	116	5457
Total	764	1123	501

Table 3. Status of STPs installed under Ganga river catchment basins

States	No. of STPs	Installed Capacity	Actual Utilised Capacity	STPs Not In Operation
Uttar Pradesh	8	358	287	1
Uttarakhand	4	54	-	0
West Bengal	34	457	214	13
Bihar	5	140	100	1
Total	51	1009	602	15

like N, P, and K. STPs sludge contains Cd, Cr, and Ni found beyond its tolerance for land applications.

Rawat *et al.* (2009) monitored river water of Ganga at Panki and Jajmau, Kanpur for the values of Fe, Mn, Zn, Cu, Cd, Ni, Pb, and Cr, etc.Indian Municipal Solid Wastes (Management and Handling) Rules, 2000 recommended values for compost quality and limits of USEPA signifies the higher concentrations especially for Ni, Pb, and Cr among all heavy metals of sampled water. Heavy metals were found in the food chain via ground or surface water contaminated and create adverse impacts on the environment and human health.

Government Actions

Review of various Projects initiated by the Government of India in perspective of Cleaning the Ganga**.**

Ganga Mahasabha

Ganga Mahasabha, an organization of India founded by Madan Mohan Malaviya in 1905. In the history of India on 19 December 1916 an agreement was done by Hindu believers known as an Uninterrupted Ganga Flow Agreement Day also known as 'Aviral Ganga Samjhauta Divas' but after independence that legal sanctity and agreement was not preserved by the state and by the government of India. So that more water diverted for irrigation use, gradually river start converting into the polluted sewer. Now the existence of Ganga has come under question, due to pollution, encroachment, global warming, and commercialization resulted in present status became extremely worse in comparison to 1916. Therefore Ganga Mahasabha was restructured in 2005 to protect Mother Ganga.

Ganga Action Plan

On 14 January 1986, the Ganga Action Plan (GAP) was announced by Shri Rajeev Gandhi, to improve the water quality by the diversion of routes, interception of water, and by treatment of sewage. To identify and ban polluting units which flow toxic and industrial chemical wastes into the river. This plan comprises two phases of GAP I and GAP II and 261 schemes for 25 towns (Class I) of U.P., Bihar, and West Bengal. Since the GAP I was unable to cover up the heavy pollution load on Ganga in 1993 the second phase of the Ganga Action Plan was approved to apply. GAP II comprised Ganga and some other tributaries like Yamuna, Damodar, and Gomti also. Further launching of NRCP (National River Conservation Plan) in 1996 schemes of GAP II had been merged into it. At present NRCP is covering highly polluted stretches of 36 rivers of 20 states of our country (sourced by National River Conservation Directorate MoEF and F, 2009).

National River Ganga Basin Authority (NRGBA)

NRGBA was organized by the Government of India in 2009 under the Environment Protection Act, 1986 with the funds of $1 billion approved by the World Bank. The Ganga was declared as the "National River" of India by the National River Ganga Basin Authority of India.

Supreme Court of India

There are many bills, laws, and acts passed in India but because of substandard implementation of rules execution, they are not able to put a remarkable control on pollution. In that cases, the Supreme Court of India had to intervene and passed strict orders of closure or relocation to different factories and industries like 'Tulsi' in 2010. Gaumukh and Uttarkashi stretch of river published as an 'Eco-sensitive zone' by Government of India ('The Hindu', Chennai, 25 July 2011).

Namami Ganga Programme

Namami Ganga Yojana officially known as the "Integrated Ganga Conservation Mission Project" passed with a budget of Rs. 2037 crores. The mission of this project was to clean and beautiful Ganga so that 8 states, 47 towns, and 12 rivers included. The Prime focus of this project was to establish a Ganga Knowledge center for the development of skillful agricultural practices, irrigation methods, and beautification of ghats and River Fronts at Kedarnath, Haridwar, Kanpur, Varanasi, Allahabad, Patna, and Delhi. In this project government also ordered to shut down 48 industrial units along the Ganga river. Due to this unsatisfactory actions by state governments, some schemes issued by Central Government for maintenance and preservance of major hotspots of India. A special Ganga Eco Task Force had been made to enforce the laws studied by Kumari *et al.*, 2016. Namami Gange comprises motive of pollution abatement interventions in form of diversion, interception of the river, and treat sewage. It can be done by STPs/ETPs/*In-Situ* treatments/Bio-Remediation and also by applying some more technology which includes augmentation and rehabilitation of existing STPs. It measures to control pollution at the exit point of riverfronts which stops the sewage inflow. Significantly the project supports socio-economic benefits in terms of job creation, improved livelihoods and health benefits to the population lives along the Ganga River.

Assurance of industrial units

The Government identified 187 industrial units that discharge their effluents into the river Ganga. Among them, 112 having Effluent treatment plants, remain 31 not working and the rest of the 44 units were defaulters. 43 defaulting units present in U.P. out of 44. The effluents released from these industries, Tanneries, Sugar Distilleries, Textile factories, Paper and Pulp Industries having higher values of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Suspended Solids. So that factories have to ensure the government to not discharge their effluent into the Ganga River and find them within their permissible limits.

Ganga Manthan

Ganga Manthan, a national conference was organized by National Mission for Clean Ganga on 7 July of 2014 at VigyanBhawan in New Delhi. This conference proposed to discuss issues and needed solutions to clean the Ganga. Stakeholders provided their feedback and suggestions and aimed to prepare a road map to rejuvenate the Ganga.

Technological Advancement

The launching of 'Clean Ganga Portal' and 'Bhuvan Ganga Mobile Application' are the two major betterment under the BJP Government. These applications follow the same objectives to get the involvement of the public for the extensive mission of clean Ganga. The Water ministry of India and the Indian Space Research Organization (ISRO) got to unite together to understand the nature of rivers and about the changes that occur after a fixed time intervals.

Some More Previous Research Work

Kumar *et al.,* 2018 Rapid rise in population, urbanization and industrialization causing a major impact on water quality. The Gomti River is the source of drinking water for the inhabitants of Lucknow. Its deteriorating quality is due to discharge of effluents and sewage without or partially treated into the river due to lack of proper drainage facilities and use of substandard sewage treatment plants with low treatment capacity. Physico-chemical characterization of water studied in Mirzapur and Varanasi by Shukla *et al.,* (1989). Both the works concluded that the quality of Ganga water has continuously decreasing and still it is degrading. Bacteriological pollution was also assessed at river Ganga by Shukla *et al.,* (1992).

Trivedi *et al.,* (2010) reveal that the Ganga is a lifeline for the major Indian population but due to fast industrialization and urbanization water quality of the river is degrading. The paper showed that water monitoring values of different segments of river polluted between Kannauj and Allahabad distance of 350 km approximate. Prominent causes of polluted river water is the presence of organic pollutants and pathogens detected by BOD and coliform index respectively. Paper also reveals water quality of water proportional to the Flow or discharge which directly depends on the rainfall and abstractions produced in water. Urgently it is a need to balance water availability at the basins by conserving water and water quality both, collection of rainwater, and examination of environmental flows affected by abstractions of water.

Basant Rai, (2013) collected samples from 16 stations of river Ganga from 1986 to 2008 to assess the level of pollution and suggest the measures of conservation of river Ganga. Dissolved Oxygen (DO) levels showed better at locations of upstreams and down streams of Varanasi and Allahabad. Biological Oxygen Demand (BOD) marked reduction indicates improvement in water quality over the pre-GAP period. Whereas 7 out of 16 sites, BOD levels were not within the permissible limit. So the Ganga Action plan urgently pointed towards the interception and diversion of sewage water. This study is addressed to be successful with previous assumptions, analysis, and positive to clean the Ganga.

Conclusion

We have already discussed challenges to Ganga river water and the works which has been done earlier. Now it is clear that researchers did a lot of work in favor of Ganga river water quality. Finally, the need is to spread awareness to clean Ganga and the Environment. Establishment of STPs at each industry and to apply the laws and norms strictly to the industries otherwise they have not right to spoil the piousness of Ganga. It is applicable that all industries must treat their sewage and establish Sewage

Treatment Plants and septic tanks for untreated discharges (NGT Rules). In Uttar Pradesh the status of river water is almost grim. Especially the stretch of Kanpur- Varanasi is most polluted and need to control the pollution. As it is difficult to build conventional sewerage networks in urban areas at the required scale and pace. So, the conveyance of waste to STPs must be re-conceptualized and re-implemented while planning the STPs. Untreated waste should not be released into the river anyways. Criminations at the Ghats should be prohibited, controlled, and impose a strict ban on plastics, glass bottles, and eatables. The bottom line is that we all live downstream, we will be the biggest losers if we do not clean the Ganga.Awareness is not only needed for the branches that are of common people but also for those who are at the top of the tree. So let the Ganga clean.

Conflits of Interersts

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript.

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