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Comprehensive Investigation of Biological and Physico-Chemical Parameters of the River Ganga: From Its Source to the Plains of Prayagraj (Allahabad), India

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Abstract: ***River Ganga is the major River of the country that passes across the north and north east India. Domestic water, solid wastes, industrial effluent from various areas is dumped into the river through different drains. Water samples from different sites of river were collected and analysed for Physico-chemical and biological parameters, to assess the quality of the river system. The study reveals that as per Physico-chemical and biological parameters which exceed the permissible limits render the water of the holy river to be unfit for drinking purpose and it is also unhealthy for the aquatic life.***
Keywords: River Ganga; Physico-chemical parameters; Biological parameters
Abbreviation: CPCB: Central Pollution Control Board, MLD: Million Liters per Day, Gap: Ganga Action Plan, DO: Dissolved Oxygen, BOD: Biological Oxygen Demand, CETP: Common Effluent Treatment Plants, STP: Sewage Treatment Plant, UPPCB: Uttar Pradesh Pollution Control Board.

I. INTRODUCTION

River Ganga is the best example of fresh water ecosystem originated from Gangotri (Uttaranchal) and after traversing a distance of 2525 km falls into Ganga Sagar (W.B.). Ganga along with its tributaries is the largest and very important river basin of the country. It has been a symbol of purity but today it is highly polluted and is in utter disregard to its serenity. Ganga is increasingly being polluted in highly urban areas of U.P.According to a World Bank Sponsored Study (State of Environment Report- U.P.), pollution levels in the Ganga are contributing 9-12% of total disease burden in Uttar Pradesh(U.P.). The coliform bacteria levels are in excess of 2 lakh MPN as against the national water quality standard of 5000. The report estimated total health damage on account of water pollution in UP is around 6.4 million dailies (Disability Adjusted Life Year).

According to the CPCB survey report, the total municipal sewage generated in the identified 25 towns in 1985 was of the order of 1340 million litres per day (mld). Apart from this sewage, 260 mld of industrial wastewater, runoff from 6 million tons of fertilizers and 9,000 tonnes of pesticides used in agriculture within the basin, large quantities of solid waste, including thousands of animal carcasses and human corpses were being released into the river every day.

According to report of Water Resources Planning Commission (May, 2009), the programme GAP and NRCP has been positive. Water quality monitoring done by reputed independent institutions indicates some improvement in the water quality over pre-GAP period. The water quality analysis of samples collected at 16 stations on River Ganga during 1986 and 2008 shows improvement in Dissolved Oxygen (DO) levels at 4 locations namely UP and down streams of Allahabad and Varanasi. All the 16 stations except Patna downstream and Rajmahal show reduction in Biological Oxygen Demand (BOD) values. The BOD level show marked reduction in Allahabad and Varanasi indicating improvement in the water quality over pre- GAP period. However, at 7 of these 16 sites, BOD level does not meet standard for bathing water.

The population in cities is increasing resulting in the increase in development in areas adjoining the river; this has put tremendous pressure on the limited fresh water resources. The increasing silt and nutrient load further deteriorate the water bodies. Hence it is thought worthwhile to assess the water quality of Ganga River with respect to physio-chemical and biological parameters. The present paper deals with determination of this parameter at various locations and analysis of the data in the light of various standards.

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The study stresses to establish sewage treatment plant in every urban settlement. Preferably the sanction to the urban settlement should be given only after the establishment of the sewage plant. In India there is lack of clean drinking water and sanitation. Level of ground water is reducing. There is need of an effective water policy. The first policy was adopted by National Water Resources Council in 1987. This was revised and updated in April 2002. Since then, not only have several major developments taken place in the water sector, but also a greater realization has come that water is a prime natural resource, a basic human need and a precious national asset. A new national water policy is in the drafting stage after almost ten years.

The present study stresses that the awareness about the causes and effects of the water pollution should be spread all over the country. Government, NGO"s and educated people should have done efforts to aware the people about the water pollution and its effects. The NGO Green Earth organized competitions Programme, poster making, slogan writing and an environment quiz for creating awareness about the environment, health and sanitation at Brahm Sarovar of Kurukshetra. Such type of activities should be done on war footing.

Tanneries at Jajmau area near Kanpur have been polluting the Ganga in a big way. This Court issued notices to them but in spite of notices many industrialists have not bothered either to respond to the notice or to take elementary steps for the treatment of industrial efluent before discharging the same into the river. We are therefore issuing the directions for the closure of those tanneries which have failed to take minimum steps required for the primary treatment of industrial effluent. We are conscious that closure of tanneries may bring unemployment, loss of revenue, but life, health and ecology have greater importance to the people.

The present study finds that the right to access clean water is not specifically guaranteed either by the constitution of India or by any other Acts. Duty is imposed on the state to provide clean water and prevent and control the water pollution. The present study reveals that Water pollution is a major issue in India. The power of the Supreme Court under Article 32 is not only injunctive in ambit that is preventing the infringement of fundamental rights, but it is also remedial in scope and provides relief against a breach of the fundamental rights already committed. This paper unravel that the waste water treatment plants in India are not adequate. Efforts are being made. To save aquatic life in the Ganga and to effectively treat waste water, two pilot projects have been initiated by WWF in the city.

We also suggest that the water which is supplied for drinking purposes should be tested regularly by chemical analysts to find out whether it is potable and does not contain any germs or harmful chemicals. Supreme Court has also developed the Precautionary Principle and the Polluter Pays Principle for providing remedy in case of water pollution.No law or authority can get success in removing water pollution unless the determination of the people not to pollute water. Every industry, urban and rural areas should dump the toxic waste and hazardous waste at waste collection centers. The study also stresses about the strong implementation and enforcement of water quality laws, water pollution laws and to stronger the penal provisions. The study stresses to establish the separate environmental courts in each state to reduce the burden of the judiciary and to implement the recommendations of the 186th Report of India's Law Commission (Figure 1).

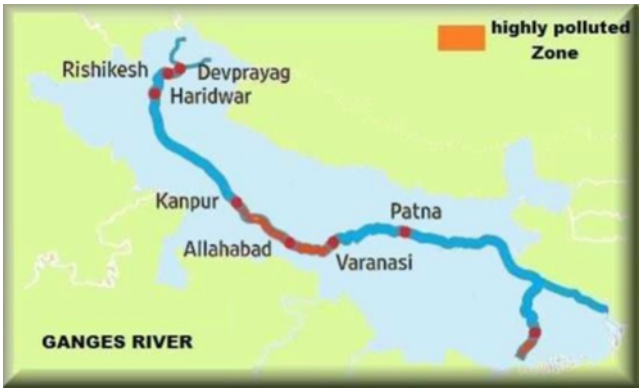


Figure1:MapofthesamplingsitespreferablywithGP.

II. MATERIALS AND METHODS

The sampling station points were chosen to cover the entire span of river Ganga including the city limits. After preliminary survey of the areas, five sampling stations along the river were chosen for the study to obtain a good distribution of the area of evaluate the overall quality. The sampling points are Gangotri, Haridwar, Meerut, Kanpur and Allahabad. Water samples were collected from these locations during pre and post monsoon seasons in the year 2016-2017.

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The pHs of the water samples were determined on the site and the rest of the sampled water was preserved for analysis and dispatched to laboratories. Water samples were analysed within few hours of collection. The physcio-chemical parameters like water temperature, pH, dissolved oxygen, alkalinity, BOD, COD, total hardness chloride, sulphate determined were by using standard methods. Plankton samples were collected by standard method by standard methods and preserved in 2-5% formalin and a few a drop of glycerine counting and identification were dived as per APHA and Adoni.

III. RESULT AND DISCUSSIONS

The results of the various Physico-chemical and biological analyses and presented in Tables 1 and 2. Temperature in one of the most important physical factors which regulated natural process within the ecosystem. Surface water temperature vary considerably during different seasons viz monsoon and post monsoon, maximum record of water temperature may also beattributed to low macrophytic production and highest load of suspended matter (Table 1).

Table 1. Physico–chemical characteristics of River Ganga water during pre-monsoon season (2016-2017).

Parameters/Ghat mg/L	Gangotri	Haridwar	Meerut	Kanpur	Allahabad
Temperature	33.8	34.2	36.5	32.2	36.5
pH	7.1	7.6	8.5	9.3	9.6
DO	6.5	4.3	5.2	50.5	4.1
BOD	2.2	3.4	4.6	7.5	13.5
COD	12.5	19.0	26.0	30.0	54.5
CI	14.0	15.0	16.0	23.0	18.0
SO4	25.0	29.0	28.0	28.0	32.0
Totalhardness	152.0	156.0	165.0	175.0	184.0

Suspended matter is known to absorb more heat from isolation. pH of river Ganga varied from 7.1 to 9.6. It was observed that the pH of water was found to be higher mostly during monsoon period. An acceptable pH for drinking water is specified as 6.5-8.5 (ISI 1991).

The dissolved oxygen (DO) varied from 4.1 to 6.5 mg in monsoon and 5.4 to 8.2 mg in post monsoon season. It appearsto be due to its greater solubility, reduced microbial decomposition of dead organic matter and low organism respiratory demand at low temperature and increased progressive growth of submerged macrophytes. The amount of DO determines whether the process undergoing in water are aerobic or anaerobic.

Table 2. Post monsoon season.

Parameters/Ghatmg/L	Gangotri	Haridwar	Meerut	Kanpur	Allahabad
Temperature	16.1	16.2	16.3	17.2	17.4
pH	7.2	8.3	8.4	7.6	8.9
DO	8.2	7.6	6.8	7.5	5.4
BOD	4.5	4.6	6.0	8.5	15.0
COD	25.0	24.2	30.0	36.0	65.0
CI	14.0	16.0	18.0	21.0	25.0
SO4	32.0	38.0	25.0	28.0	26.0
Totalhardness	114.0	118.0	130.0	141.0	140.0

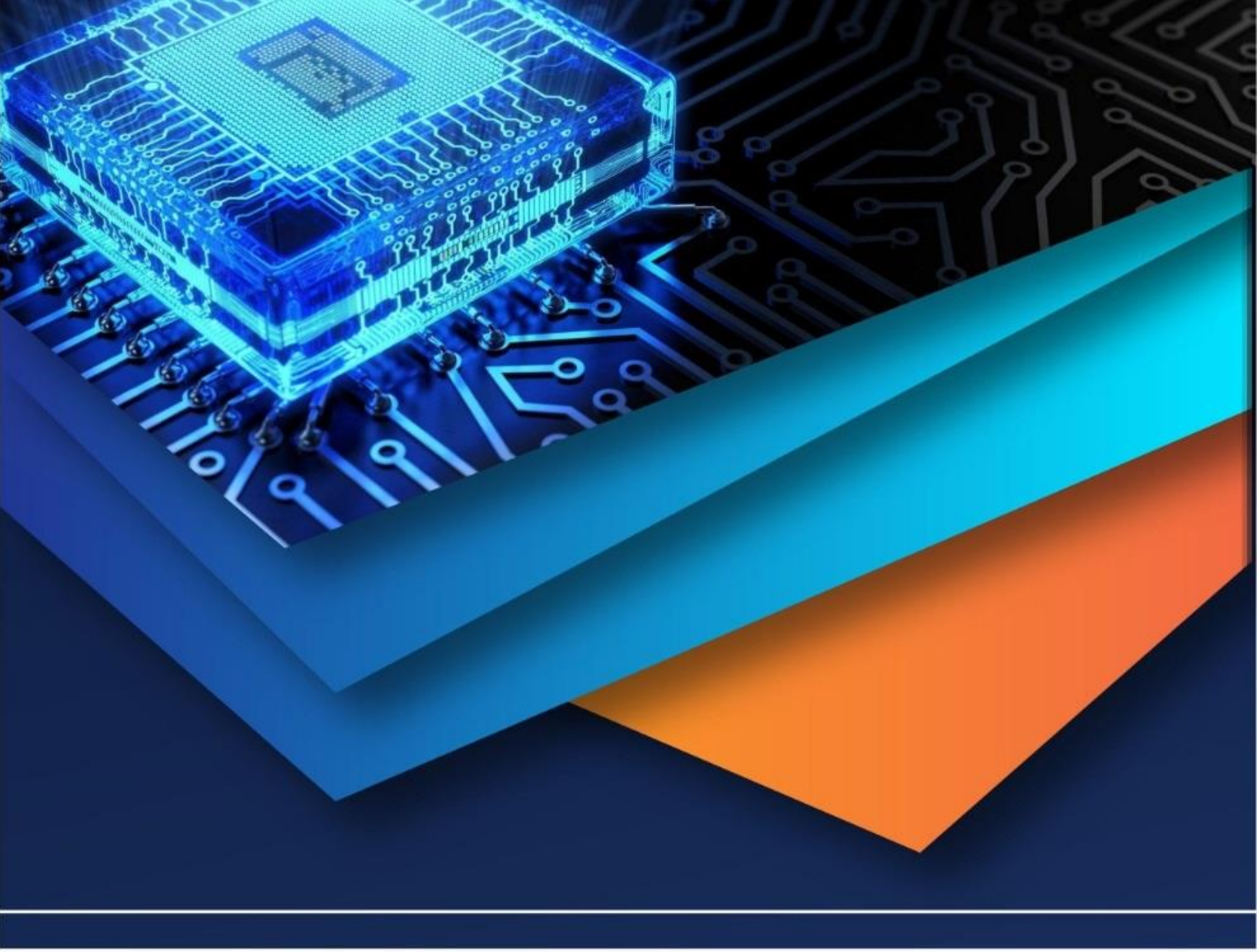
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The Biological oxygen demand (BOD) values varied from 2.2 to13.5 in pre-monsoon and 4.5 to 150 post-monsoon seasons. The BOD values clearly indicated pollution, which may be attributed to the maximum biological activity. Ray and David noticed that oxygen and high BOD went hand in hand at sight in the river Ganga where sewage pollution was taking place [17]. The Chemical Oxygen Demand (COD) varied from 12.5 to 5.45 in pre- monsoon and 24.0 to 65 in post monsoon season. Presence of high number of COD in water indicates the contamination though domestic sewage containing decaying organic matter and other efluent. The chloride concentration varies from 14 to 22 mg/l pre monsoon and 14 to 25 mg/l in post monsoon season. The tolerance limit being 200 mg/l as per the Indian and WHO standards. Similar observation have been made in River Pambr at Kozhencherry. Sulphate is an important component in protein metabolism and play important role in growth of pleats. The concentration of sulphate ranged from 25 to 32 mg/l in pre-monsoon and 25 to 38 mg/l in post-monsoon season. Excess sulphates in the river have laxative effect on human health [19,20]. High value may cause gastro intestinal troubles in human beings. The high values of COD, BOD, SO4 are indication of polluted water and thus, river in not fit for drinking purpose and industrial use.Total hardness due to carbonate and bio carbonate ranged from 152 to 184 in pre-monsoon and 114 to 140 mg/l in post- monsoon season. These observed values were slightly low then the prescribed limit of WHO and ISI (that is, 150 and 200 mg/l). Although alkalinity has little public health significance, highly alkaline waters are unpalatable and are not used for domesticwater supply.

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