International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

ASSESSMENT OF WATER QUALITY AND PHYSICOCHEMICAL CHARACTERISTICS IN THE GANGA RIVER

VISHAL BHARDWAJ
IIMT UNIVERSITY, MEERUT

ABSTRACT

Water physicochemical factors in the Ganga River are examined in this research, with an emphasis on how human activities, especially farming and household chores, affect water quality. Six locations along the river were chosen for water sampling, which took place over the course of four months (January–April 2021). We used disposable plastic bottles that had been washed before collecting water. We kept the bottles in an ice box at 4°C until analysis, at which point we followed conventional procedures. The statistical analysis that was conducted to determine the significance of the differences in water quality across the sample locations included one-way ANOVA. Findings show that temperature was consistent across all sites, although pH levels showed significant variations ($p < 0.05$). There were notable variances in the water composition affected by environmental and anthropogenic influences, as shown by the large variations ($p < 0.001$) in electrical conductivity, turbidity, total dissolved solids, total hardness, calcium, chlorides, and nitrites. But phosphate levels were stable ($p = 0.36$), suggesting that agricultural runoff was little.

Keywords: Ganga River, Water, Physicochemical Parameters, Pollution, Temperature

I. INTRODUCTION

From an ecological and cultural standpoint, the Ganga River—also known as the Ganges—is among the most significant and esteemed rivers in India. The Gangotri Glacier in the Himalayas is its source, and the river travels approximately 2,500 kilometers through several states before emptying into the Bay of Bengal. The Ganga is very holy to millions of Hindus, who perform a variety of rituals along its banks because of their belief in its sanctity. But fast urbanization, industry, and agricultural activities have posed serious pollution problems to the river over the years. Because of this, water quality has been declining, which is dangerous for people, fish, and the environment.

To what extent is water suitable for human consumption, recreational activities, agricultural irrigation, and the survival of aquatic life depends on its quality, which is defined by its chemical, physical, biological, and radiological properties. In order to determine the quality of the water in the Ganga River, a number of important physicochemical parameters are measured. These include temperature, pH, dissolved oxygen, total dissolved solids, heavy metals, nutrients like phosphates and nitrates, and biochemical and chemical oxygen demands. How well aquatic ecosystems are doing and whether or not water is safe to drink are both affected by each of these factors. High biochemical oxygen demand (BOD) values, for example, are indicative of organic pollution, which in turn may cause hypoxia, which is harmful to aquatic life. Eutrophication, which occurs when nutrient concentrations are too high, causes algal blooms, which further reduce oxygen levels in the water.

From the clean alpine streams of the Himalayas to heavily crowded metropolitan regions like Varanasi and Kanpur, the Ganga River passes through a wide range of landscapes, each with its own unique set of environmental challenges. The Indian government has taken note of these problems and is working to clean up the river and get its ecology back in balance via a number of programs. Key projects aimed at addressing water pollution and promoting sustainable management of the river's resources include the Namami Gange Programme and the National Ganga River Basin Authority (NGRBA). Both the water quality and the socioeconomic aspects of riverine communities are taken into account in integrated river basin management, which is emphasized in these initiatives.

Throughout its history, the Ganga has experienced several human-caused stresses, which have caused substantial changes to its original physicochemical characteristics. There have been many factors that have led to the decline in water quality, including runoff from cities and farms, industrial discharges, and the disposal of solid waste. As an example, the Kanpur section of the Ganga is well-known for its high concentrations of harmful pollutants due to the large number of tanneries and other companies that dump their untreated waste into the river. Similarly, religious acts produce organic and inorganic pollution, especially during festivals when thousands of worshippers gather near riverbanks, while they are culturally meaningful.

Due to the complex nature of Ganga water pollution, thorough studies are required to periodically check the river's water quality. Researchers may learn more about the river's current state by combining data from field observations with analysis conducted in a lab. In order to protect the Ganga River and the people who live along it from pollution, this information is crucial for formulating policies and programs. It is possible to better evaluate the efficacy of current conservation initiatives and locate possible pollution sources by learning about the river's physicochemical properties.

II. REVIEW OF LITERATURE

Akter, Beauty & Rahman, Syed. (2023) The Ganga River provides a means of subsistence for millions of people. However, the quality of the Ganga water has declined due to the boundless needs of humans and their activities. Heavy metals were the focus of this assessment of the physicochemical characteristics of Ganga River water. According to the results of the water quality evaluation, the majority of the river's length is unfit for human consumption. In the majority of the Ganga River research sites, the dissolved oxygen content is lower. Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) levels raise major red flags about potential dangers to human health and aquatic ecosystems. There are a number of pathways that allow various heavy metals, some of which are dangerous, to enter the river itself. Deterioration of water quality is caused by an increase in industrialization, urbanization, e-waste dumping, effluent discharge, and sewage. Since pollutants tend to pool near the river's base, this study focuses on the downstream region to assess the river's pollution state. Nonetheless, sufficient action must be taken immediately to restore the Ganga River's water quality.

Satya, Kumari & Narayan, Chandravir. (2018) Gangotri glacier is the headwater source for the Ganga River, which originates on the southern slopes of the central Himalayan area in India. With a total length of 475 km in the state of Bihar, the river drains a catchment area of 8,61,404 km2. Two sampling locations, Digha Ghat upstream and Gai Ghat downstream, were used in this investigation near Patna in the Ganga River. Observing the prominence of Ganga water in Patna was the aim of the study. While the river's pH is 7.75, DO is 7.42 mg/l, BOD is 2.48 mg/l, and COD is 15.12 mg/l when it reaches the area near Patna city (upstream at Digha Ghat), the concentration of all pollutants increases dramatically (pH 6.28, DO is 6.22 mg/l, BOD is 2 mg/l, and COD is 23 mg/l) when the river leaves the city after traveling 18 km (downstream at Gai Ghat). Total coliform bacterial concentrations were found to be between 5000 and 6000 MPN/100 ml, whereas faecal coliform concentrations were between 2200 and 3000 MPN/100 ml at both locations, above the maximum allowable limit. The increase might be attributed to the city's sewage and household runoff. In contrast to the city's sewage/township output of over 250 MLD, Patna's sewage treatment facility capacity is around 109 MLD. The treatment of sewage before release is necessary to ensure that the water of the river Ganga remains in perfect condition.

Abed, Suhad & Jazie, Ali. (2014) Anthropogenic activities have greatly degraded the quality of surface waterways, particularly river water, in the previous many decades. Indian researchers and policymakers have taken the increasing pollution levels and changes in the river's midstream water quality very seriously. The purpose of this study was to examine the Ganga River's water quality and document any changes, if any, in water quality over the course of three months of sampling in 2013. The water quality of the Ganga River in the city of Varanasi has been evaluated in a systematic research. The following physico-chemical characteristics were measured in 36 water samples taken from four different sampling stations: the By pass bridge upstream, Assi Ghat, Dashswamedh Ghat, and Raj Ghat bridge downstream. The samples were analyzed: temperature, pH, hardness, total dissolved solids, dissolved oxygen, B.O.D., and free CO 2.Some water samples from the study locations were found to have levels of total dissolved solids (TDS), pH, and hardness that were higher than the allowed limit, according to the analytical data of several physicochemical parameters (WHOS).

Singh, Namrata. (2010) The Ganga river basin, which had been mostly undeveloped until the 1940s, is now a landfill for sewage, industrial, and agricultural garbage due to India's independence in 1947. Water quality was negatively impacted by the discharge of waste products caused by the rapid population growth and development in the basin. In this study, we examine six separate ghats—Assi, Shiwala, Chauki, Harishchandra, Rajendraprasad, and Raj—to determine the effect of pollution on the Ganga water. In order to assess the physicochemical features of the Ganga River, including its temperature, pH, acidity, alkalinity, dissolved oxygen, biological oxygen demand, chloride, electrical conductance, nitrate, and phosphate, the study drew water samples from six separate locations. Based on the results of the analysis, Raj Ghat was significantly more polluted than Shiwala Ghat.

Joshi, D.M. et al., (2009) In order to determine the Ganga water quality index in the Haridwar District, a comprehensive investigation was conducted. The following physico-chemical parameters were measured in 90 water samples taken from 5 different sampling stations: temperature, velocity, pH, dissolved oxygen, free CO2, condensed organic carbonate, bicarbonate, total alkalinity, hardness, turbidity, calcium, magnesium, sodium, potassium, nitrate, phosphate, chloride, sulphate, electrical conductivity, total dissolved solids, and total suspended solids. Winter (November–February), Summer (March–June), and the Rainy Season (July–October) are the three main climatic phases experienced by the research region. Two years in a row, 2007 and 2008, saw sample collection and analysis. The desired limit of each parameter in river water, as set by various authorities, was compared with each parameter. Several physicochemical parameters, including pH, electrical conductivity, total dissolved solids, total suspended solids, turbidity, and sodium, were discovered to be higher than the allowed limits in water samples from the research regions, according to the analytical results. The water quality index (WQI) shows that due to excessive levels of dissolved solids and salt, water samples taken from certain monitoring sites are not suitable for human consumption. It was also noted that the water quality in 2007 was higher than in 2008. Some reasonable recommendations were made to raise the standard of the river's water.

III. RESEARCH METHODOLOGY

Study Area

The Ganga River served as the setting for the research. In order to analyze the water quality evaluation, six locations along the river were chosen and samples were taken. Locations were chosen based on the likelihood of human habitation and the presence of agricultural and household activities.

Field Sampling

From January to April of 2021, water samples were taken for four months. For the sake of uniformity, all locations' samples were taken on the same day.

Physicochemical Parameters and Water Quality

Water samples were collected in disposable polyethylene bottles for physicochemical investigation. After properly collecting the samples, these bottles were washed with the water samples. After being properly labeled and sealed, the bottles were carefully transported to the laboratory in an ice box and maintained at 4°C. Water temperature, pH, EC, TH, TDS, Calcium, nitrite, phosphate, chloride, biological oxygen demand, and chemical oxygen demand are some of the physicochemical characteristics that have been examined. We used industry-standard procedures to ascertain all of these criteria. At the moment of sampling, the temperature was monitored on-site. As soon as the samples arrived at the laboratory, their pH, EC, and TDS were determined.

Statistical Analysis

We found the most and least values for each of the parameters that were considered. The water quality of each site was compared using a one-way analysis of variance (p=0.05). Excel and the STATISTICA software suite for Windows (version 10.01) were used to conduct all of these experiments.

IV. RESULTS AND DISCUSSION

Table 1: Spatial Variation of Water Physicochemical Parameters across Sampling Locations

Parameters	df	F	P-value
Temperature (°C)	5	0.19	0.89
pH	5	3.37	0.041
Electrical Conductivity (µS/cm)	5	22.09	$<10^{-3}$
Turbidity (NTU)	5	4.11	0.023
Total Dissolved Solids (mg/l)	5	20.38	$<10^{-3}$
Total Hardness (mg/l)	5	3.22	0.047
Calcium (mg/l)	5	11.37	$<10^{-3}$
Chlorides (mg/l)	5	11.17	$<10^{-3}$
Nitrites (mg/l)	5	12.05	$<10^{-3}$
Phosphate (mg/l)	5	0.96	0.36
Chemical Oxygen Demand (mg/l)	5	26.58	$<10^{-3}$
Biochemical Oxygen Demand (mg/l)	5	6.21	$<10^{-2}$

Water physicochemical characteristics show geographic variance across multiple sample sites in Table 1. Each parameter's degrees of freedom (df), F-values, and p-values are detailed in the table. Since there is no statistically significant change in the temperature (°C) throughout the sample sites (p=0.89), we may infer that the temperature stays very consistent across the evaluated areas. The pH level, on the other

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

hand, differs significantly ($F=3.37$, $p=0.041$), suggesting that there is actual variation in pH levels between the locations, which may be due to environmental factors.

The electrical conductivity (µS/cm) shows a lot of variance, which is highlighted by a highly significant p-value of less than 0.001 and an F-value of 22.09. This suggests that the ionic composition of water differs at different places. In a similar vein, turbidity (NTU) shows a lot of fluctuation (F-value of 4.11, p-value of 0.023), which might mean that sedimentation or algae are to blame for the different water clarity.

The results demonstrate that there is a very significant variation in total dissolved solids (mg/l) among the locations (F-value = 20.38, p-value < 0.001), suggesting that the concentration of dissolved materials remains uneven. Differences in total hardness (mg/l) are also statistically significant ($p=0.047$), suggesting that the quantities of calcium and magnesium in the water may vary, which might impact its quality.

There are notable differences in the concentrations of calcium (mg/l) and chlorides (mg/l), which are most likely caused by geological or human-made factors (p-values < 0.001). There is a 12.05 F-value and a p-value less than 0.001 for nitrites (mg/l), suggesting that fertilizer runoff or pollution may be impacting various sample sites.

A p-value of 0.36 indicates that there is no significant variation in phosphate (mg/l), suggesting that levels are largely stable across locations and that pollution or agricultural runoff is not a major factor. There is a very significant difference in the chemical oxygen demand (mg/l) (F-value = 26.58, p-value < 0.001), suggesting that there are different amounts of organic matter, which might affect waters treatment and aquatic health. As a last point, the biochemical oxygen demand (mg/l) is getting close to being statistically significant ($p = 0.06$), suggesting a tendency toward fluctuation that may be attributable to variations in the amounts of biodegradable organic material.

V. CONCLUSION

The effects of human activities, especially farming and household chores, are shown by the large regional differences in the Ganga River's physicochemical properties, which are highlighted in this research. Water quality indicators such as pH, electrical conductivity, turbidity, total dissolved solids, hardness, and different ion concentrations showed significant variations in the study, indicating that the river's health was impaired in certain areas. A complicated interaction of environmental influences was indicated by the relatively consistent levels of certain indicators and the considerable changes of others, such as phosphate levels. Ongoing monitoring is necessary to determine the ecological health of the river, especially considering the large fluctuations in chemical and biochemical oxygen demand. These results are vital for guiding policies and water management plans that seek to reduce pollution, safeguard aquatic habitats, and make sure the Ganga River's resources are used sustainably. Protecting the river's water quality and preserving its important function in the local ecosystems depend on resolving these issues.

REFERENCES: -

1. Akter, Beauty & Rahman, Syed. (2023). A Review on the Physicochemical Properties of Ganga River Water from India and Bangladesh. Jahangirnagar University Environmental Bulletin. 8. 57-63.
2. Kesari, Vigya & Kumar, Sanjay & Yadav, Indrajeet & Chatterjee, Antra & Rai, Shweta & Pandey, Shraddha. (2021). Ganga River Water Quality Assessment using Combined Approaches: Physico-Chemical Parameters and Cyanobacterial Toxicity Detection with Special Reference to Microcystins and Molecular Characterization of Microcystin Synthetase (Mcy) Genes Carrying Cyanobacteria. 10.21203/rs.3.rs-518007/v1.
3. Kumar, Vinod & Kumar, Sanjay & Srivastava, S. & Singh, Jogendra & Kumar, Pankaj. (2018). Water Quality of River Ganga with Reference to Physico-Chemical and Microbiological Characteristics during Kanwar Mela 2017, at Haridwar, India: A Case Study. Archives of Agriculture and Environmental Science. 3. 58-63. 10.26832/24566632.2018.030108.
4. Satya, Kumari & Narayan, Chandravir. (2018). Study of Physico-chemical and Biological Characteristics of the Water of River Ganga at Patna, India. Current World Environment. 13. 374-379. 10.12944/CWE.13.3.10.
5. Haritash, A.K., Gaur, S. and Garg, S. (2016). Assessment of water quality and suitability analysis of river Ganga in Rishikesh, India. Applied Water Science, 6(4): 383-392
6. Seth, R., Mohan, M., Singh, P., Singh, R., Dobhal, R., Singh, K.P. and Gupta, S. (2016). Water quality evaluation of Himalayan Rivers of Kumaun Region, Uttarakhand, India. Applied Water Science, 6(2): 137-147, DOI: 10.1007/s13201-014- 0213-7
7. Abed, Suhad & Jazie, Ali. (2014). ASSESSMENT OF SOME PHYSICOCHEMICAL PROPERTIES FOR WATER IN GANGA RIVER AT VARANASI, INDIA . Al-Qadisiya Journal For Engineering Sciences. 7(2).
8. Singh, Jaspal. (2012). Assessment of physico-chemical properties of water: River Ramganga at Bareilly, U.P,. Journal of Chemical and Pharmaceutical Research. 4(9). 4231-4234.
9. Kamboj, N. (2012). Evaluation of some water quality parameters of river Ganga during Kanwer Mela-2011 at Haridwar, India. Journal of Sustainable Environmental Research, 1(2): 125-128.
10. Singh, Namrata. (2010). Physicochemical properties of polluted water of river Ganga at

Varanasi. International Journal of Energy and Environment. 1. 823-832.

11. Joshi, D.M. & Kumar, A. & Agrawal, N.. (2009). Studies on physicochemical parameters to assess the water quality of river ganga for drinking purpose in Haridwar district. Rasayan Journal of Chemistry. 2. 195-203.

12. Trivedi, Priyanka & Bajpai, Amita & Thareja, Sukarma. (2009). Evaluation of Water Quality: Physico - Chemical Characteristics of Ganga River at Kanpur by using Correlation Study. Nat Sci. 1.