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STUDY ON WQI OF DIFFERENT GHATS OF RIVER GANGA AT KANPUR (U.P.)

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ABSTRACT

In the present study WQI and physico-chemical parameters of river Ganga at Kanpur were studied. Study was conducted for one year. Six sampling stations were selected for sampling on the river Ganga. The collected samples were analyzed for different Physico-chemical parameters viz.; Temperature, pH, Turbidity, Electrical conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total Dissolved Solids (TDS), Chloride, Nitrate and Phosphate. The results were compared with the surface water quality standards. Water Quality Index (WQI) was also calculated to find out the overall water quality of the study area. The observed values of major parameters were slightly higher than the permissible limits.

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Keywords- Ganga, Kanpur, Physico-chemical, WQI

INTRODUCTION

Water is the basic necessity of our life. We cannot survive without water. Besides our need, water also plays a versatile role in the functioning of the biosphere (Ghose, 2002; Mishra, 2008). Our natural heritage like rivers, seas and oceans has been exploited, mistreated and contaminated. The water of rivers plays an important role in overall development programs of the country. They also serve as a source of water supply for domestic and industrial purposes and also for agriculture, fisheries and power generation. The same water resources are also utilized for the disposal of industrial waste and sewage, leading to water pollution. The pollution of rivers and streams by industrial waste and domestic sewage has increased tremendously and producing the most unsanitary condition in the environmental sources of water.

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The Ganga is one of the important rivers of North India. The river Ganga at Kanpur is the main focus of the study. Along every kilometer of the river Ganga at Kanpur in Utter Pradesh, people and factories are pouring their garbage, excreta and much into the river which is gradually turning control of water pollution says that none of the large cities on the banks of the Ganga has a sewage treatment plant although most of them have partial sewage into the river every day (Jaiswal and Tiwari, 2012). To this is added the burden of other human activities like bathing, washing of clothes and immersing of ashes of unburnt corpses (Ahmad and Chaurasia, 2019). Industries contribute chemical effluents to the Ganga pollution load. The Ganges river follows a 900 km (560 mi) arching course passing through the cities of Kannauj, Farukhabad, and Kanpur. Along the way it is joined by the Ramganga, which contributes an average annual flow of about 495 m3/s (17,500 cu ft/s) to the river (https://en.wikipedia.org › wiki › Ganges). Therefore, it is necessary to evaluate the water quality of Ganga river with special reference to its Physico-Chemical and biological properties.

The main sources of pollution of river Ganga at Kanpur are industrial effluents, tannery effluents, domestic sewage and cremation of dead bodies. The leather industry is major industrial contributor for Ganga pollution in Kanpur but the main source of pollution is human waste. Presently the Sewage Treatment Plant (STP) installed to treat sewage from Kanpur city is not working to its full capacity. Also river flows across the city of Kanpur without receiving fresh water from any tributary till it is joined by Kali and Ramganga at Kannauj. At Kanpur, a local river called Pandu meets Ganga. Several researchers have investigated water quality of river Ganges at Kanpur and other locations in the country.

WQI is a mechanism for presenting a cumulatively derived numerical expression defining a certain level of water quality (Bordalo et al. 2006). In other words, WQI summarizes large amounts of water quality data into simple terms (e.g., excellent, good, bad, etc.) for reporting to management and the public in a consistent manner (Table 3). The desired use of WQI is to assess water quality trends for management / decision making purpose even though it is not meant for an absolute measure of the degree of pollution or the actual water quality.

STUDY AREA

Kanpur is known as Manchester of the East, the largest industrial hub of Uttar Pradesh State. It is bounded by 26.28 degrees North latitude and 80.21degrees East longitude. Kanpur is situated on the western bank of the river Ganga. In Kanpur river Ganga takes entry at Bithoor and passing along several ghats, takes exit at Jajmau, covering a distance of 24 kms. This paper consists of water quality of river Ganga for surface water samples collected from different stations namely Bithoor, Rani, Permat, Sarsaiya, Nanarao and Siddhnath ghats (Fig. 1)

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Table 1: Sampling Stations detail at a glance

S.No.	Sampling Stations	Name of Sampling Stations	Lat/Long
1.	S1	Bithoor Ghat	26.61°N, 80.27°E
2.	S2	Rani Ghat	26°29'43"°N, 80°19'27" °E
3.	S3	Permat Ghat	26°29'14"°N, 80°20'37"°E
4.	S4	Sarsaiya Ghat	26°28'43"°N, 80°21'32"°E
5.	S5	Nanarao Ghat	26.46°N,80.33° E
6.	S6	Siddhnath Ghat	26.4600°N, 80.3500° E

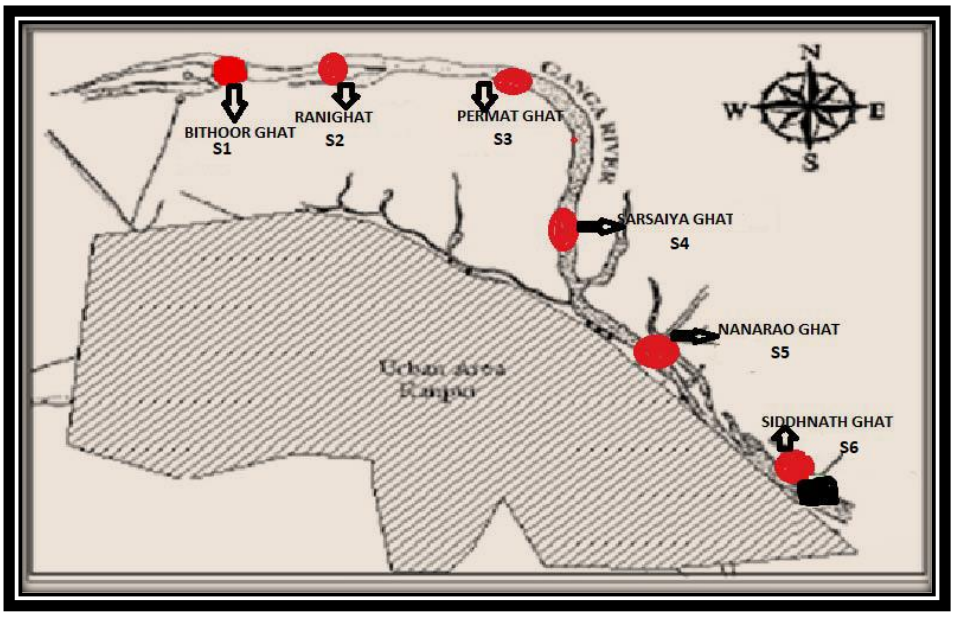

Fig 1: Map Showing Sampling Stations on River Ganga at Kanpur

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MATERIAL AND METHODS

The water samples were collected from six major Ghats (Stations) of river Ganga at Kanpur (Uttar Pradesh). Station 1 & Station 2 (Upstream from Bithoor), Station 3, Station 4 & Station 5 (Middle stream dense area of Kanpur city) Station 6 (downstream of river Ganga from tannery area near Jajmau to siddhnath Ghat).The detailed description of all these Stations and figure of the same are given in (Table 1,Fig 1). Water samples were collected for one year (2018) and analysed for various physico-chemical analysis. Separate samples were collected for the estimation of dissolved oxygen taking all the precautions and analyzed immediately at the sampling station. For bacteriological analysis, samples were collected in clean, sterilized and narrow mouthed glass bottles. The physico-chemical and biological parameters analysed were Temperature, pH, Turbidity, Electrical conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total Dissolved Solids (TDS), Chlorides, Nitrate and Phosphate were analyzed in the laboratory by using standard methods of analysis (APHA, AWWA and WPCF-2012).

CALCULATION OF WATER QUALITY INDEX

The calculation of WQI was made using weighed arithmetic index method (Cude 2001) in the following steps- using the equation:

$$\boldsymbol{WQi} = \frac{\sum_{i=1}^{n} \boldsymbol{WiQi}}{\sum_{i=1}^{n} \boldsymbol{Wi}}$$

Step1: Wi= Unit weightage of the ith parameter is an inversely proportional to the recommended standard (Si)

$$\boldsymbol{Wi} = \frac{\boldsymbol{K}}{\boldsymbol{Si}}$$

Where,

K= constant of proportionality

$$\boldsymbol{K} = \frac{\mathbf{1}}{\Sigma \mathbf{1}/\boldsymbol{Si}}$$

Si = Indian Standard in mg/l (IS 10500-2012)

Step 2: Qi = Sub index of the ith parameter

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$$Qi = \sum_{i=1}^{n} \frac{|Va - Ii|}{Si - Ii} \times 100$$

Where,

Va = observed value

Ii = All the ideal values (Ii) are taken as zero for drinking water, except for pH=7.0 and dissolved oxygen=14.6 mg/l. Rest for all the parameters will be zero

Si = Standard (IS 10500-2012)

RESULTS AND DISCUSSION

The present study briefly discusses the Physico-chemical and biological analysis of water samples collected from Bithoor to Siddhnath Ghats of river Ganga at Kanpur. Water quality index of the analyzed parameters for one year is also calculated. The Ganga river water samples were collected from six selected ghats covering the distance of about 24 kms. The distance between each sampling station was about 3.5-4 kms. Through experimental investigation a number of parameters were evaluated as follows:

Temperature

Temperature regulates all the chemical and biological reactions in water. The increase in temperature reduces solubility of gases changes improves taste and odour of water. The aquatic organisms exhibit specific sensitivities towards temperature (Yadav et. al., 2011). Minimum average concentration of Temperature was observed (24.8℃) at station S3 and maximum was found (25.5 ℃) at station S1 (Table 2). Water temperature was recorded more or less similar at all the stations (ghats) during the investigation.

pH

The pH of a water body is very important in determination of water quality since it affects other chemical reactions such as solubility and metal toxicity. During the course of study it was recorded that pH was always alkaline at all the stations. The alkaline nature of river water may be due to high temperature which causes reduction insolubility of CO2. Minimum average concentration of pH was observed at S2 station (8.41 ± 0.11) and maximum was found at S6 station (8.62 ± 0.14) (Table 2). At station S5 and S6 pH was found higher than the permissible limit of WHO (Table 2) and it may be due to joining of waste water in the river (Patil et al., 2012). The trend noticed in the present study is in accordance with the findings by other workers (Dalal and Arora , 2008).

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Turbidity

Turbidity or cloudiness is an optical property of water, which can be described by the observation that when a beam of light passes through muddy water the intensity of the light is reduced. This reduction caused by the suspended material in water, is a measure of water's turbidity (Ahmad and Mishra, 2014). Average turbidity was ranged from 122.75 to 405.75 NTU from Stations S1 to S6 (Table 2). Turbidity was much higher than the prescribed WHO standard limit (Table 2)However, it was found highest at S6 station (405.75).

Electrical Conductivity (EC)

The EC of water is a measure of capacity of a solution to conduct electrical current through it and depends on the concentration of ions and load of nutrients. As most of the salts in water are present in ionic forms, they make water capable for conducting current. The conductivity, thus serves as a good and rapid measure of the total dissolved solids in water (Arora. 2012). The conductivity values of different rivers vary greatly. In our observations minimum EC was recorded 247.58 ± 22.20 µs/cm at Station S1 and maximum EC was recorded 403.68 ±34.77 at station S6 (Table 2). Similar findings have also been reported by (Singh and Gupta. 2010).

Total Alkalinity (TA)

The cause of total alkalinity in water is the presence of various ions; the acid neutralizing capacity of water is called alkalinity. The alkalinity in water is caused by carbonates, bicarbonates, phosphates, borates, silicates along with hydroxyl ions in Free State (Gawas et al., 2006). The value of TA provides idea of natural salts present in water (Singh et al., 2010). Maximum TA was recorded at station S6 (267.25±8.45 mg/l) and minimum TA was recorded at station S1 (221.16±3.24 mg/l) (Table 2). These values are within the permissible limits prescribed by WHO (Table 2). The TA fluctuated in accordance with the fluctuation in the pollution load.

Total Hardness (TH)

Hardness mainly depends on the dissolved salts present in water. The water moves through soil and rocks, it dissolves very small amount of minerals and hold them in solution. Calcium and magnesium dissolved in water are two most common minerals that make water hard (Rao et al., 2010). Minimum average TH (177.67±10.51 mg/l) was observed at station S1 and maximum average TH (258.83±21.46 mg/l) was noted at S6 station (Table 2). TH was found higher at station S5 and S6 than the permissible limit prescribed by WHO.

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Dissolved Oxygen (DO)

DO is an important limnological parameter indicating level of water quality and organic pollution in the water body. The value of DO is remarkably significant in determining the water quality criteria of an aquatic system. In the system where the rates of respiration and organic decomposition are high, the DO values usually remain lower than those of the system, where the rate of photosynthesis is high (Mishra et al., 2009). In this study, Mean DO was observed 7.42, 7.33, 7.12, 7.32, 7.12 and 5.53 mg/l at stations S1, S2, S3, S4, S5 and S6 respectively (Table 2). Maximum average DO (7.42±0.49 mg/l) was found at station S1 and minimum average DO (5.53±0.96 mg/l) was found at station S6. Obtained results are showing that DO was gradually decreasing from S1 to S6 stations. At S6 station DO was found (5.53 mg/l) less than the permissible limit prescribed by WHO. The present study reveals a gradual decrease in DO from upstream to downstream stations. DO levels is important in the natural self-purification capacity of the river (Zeb et al., 2011).

Biological Oxygen Demand (BOD)

The biodegradation of organic materials exerts oxygen tension in the water and increases the biochemical oxygen demand (Abida et al., 2008). In our observation maximum average BOD was recorded 34.02±3.81mg/l at station S6 (Siddhanath ghat) and minimum BOD was recorded 8.77±2.54 mg/l at station S1 (Bithoor ghat) (Table 2) and was beyond the permissible limit given by WHO.

Total Dissolved Solids (TDS)

TDS is one of the important factors that determine the suitability of water for various uses. Total dissolved solids are simply dissolved solids of various salts (chloride, carbonates, and nitrates, Sulphates) of calcium, Magnesium, sodium; Iron etc. Due to presence of these salts water has a specific taste. TDS values were found maximum at station S6 and minimum at station S1. TDS also shows gradual increase towards downstream stations. Minimum average value of TDS during investigation found at Station S1 (168.42±20.94 mg/l) and maximum (282.33±18.91 mg/l) at Station S6 (Table 2), which was under maximum allowable limit prescribed by WHO standard.

Chloride

It is apparent that chloride can be taken as one of the indices of water pollution from sewage and drains in the vicinity of the towns within the drainage basin. Chloride concentration in water indicates presence of organic waste particularly of animal origin. Chlorides usually occur as NaCl, CaCl2, and MgCl2 and in widely varying concentration in all natural water (Singh et al., 2012). The average value of Chloride varied between 27.15±2.98 mg/l at station S6

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(Siddhnath ghat) to 16.32±0.78 mg/l at station S1 (Bithoor ghat). Chloride was found well within the permissible limit at all the sampling stations (Table 2).

Nitrate

The Nitrate concentration depends upon the activity of nitrifying bacteria. The main source of nitrogen in surface water is human and animal excreta and agricultural activities (Chaurasia and Karan, 2014). The average value of nitrate ranged between 4.38±0.33 mg/l at station S6 to 2.29±0.25 mg/l at station S2 (Table 2). The values were within the permissible limit given by WHO standard.

Phosphate

Phosphorus is a nutrient essential for all organisms for the basic processes of life and natural element found in rocks, soils and organic material. Phosphorus clings tightly to soil particles and is used by plants, so its concentrations in clean waters are generally very low (Chaurasia et al., 2017). The average values of phosphate vary between 0.16±0.03 mg/l to 0.86±0.06mg/l from S1 to S6 stations (Table 2).

WQI

Water quality Index (WQI) was also calculated in this study which is shown in (Table 4 & Fig .2).WQI of Ganga river was found in decreasing trend which laid down on above the scale of 100 which means that water quality of Ganga river at Kanpur was unsuitable for drinking purpose at all the sampling stations. WQI of S1, S2, S3, S4, S5 and S6 stations was found 67, 54, 49, 48, 46 and 37 respectively. Fig.2 shows WQI of Ganga river at Kanpur in decreasing trend which means that the water quality of river Ganga is fast losing its quality from station 1 (Bithoor ghat) to station 6 (Siddhnath ghat). WQI indicates that water quality at S1 and S2 stations was in medium range while remaining all the other stations was found in bad quality range. Similar results were also observed by Jindal & Sharma, 2011 in Sutlej river (Ludhiyana), Dutta and Sharma, 2018 in Kolong river (Nagaon, Assam), Gangwar et al., 2012 in Ramganga river (Bareily).

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Table 2: Average concentration of various parameters with their standard deviation at different sampling stations.

S. No.	Parameter	Stations						WHO Standards
		S1	S2	S3	S4	S5	S6	
1.	Temperature (°C)	25.52±3.46	25.34±3.78	24.82±3.43	25.18±3.72	25±4.06	24.92±3.17	NA
2.	pH	8.45±0.15	8.41±0.11	8.45±0.09	8.48±0.11	8.61±0.12	8.62±0.14	6.5 – 8.5
3.	Turbidity (NTU)	122.75±111.71	140.66±108.80	179.75±90.48	302.58±48.48	388.33±73.74	405.75±69.46	1.0
4.	EC (µmhos/cm)	247.58±22.20	248.35±25.42	252.62±31.54	289.62±35.95	313.36±46.07	403.68±34.77	NA
5.	TA (mg/l)	221.16±3.24	227.17±4.04	231.17±5.08	245.33±4.77	252.42±5.19	267.25±8.45	200 - 600
6.	TH (mg/l)	177.67±10.51	184.50±13.32	185.17±7.05	197.83±9.20	217±14.71	258.83±21.46	200
7.	DO (mg/l)	7.42±0.49	7.33±0.39	7.12±0.51	7.32±0.42	7.12±0.50	5.53±0.96	2 - 6
8.	BOD (mg/l)	8.77±2.54	11.99±1.29	20.4±2.60	27.4±3.75	24.97±3.41	34.02±3.81	3
9.	TDS (mg/l)	168.42±20.94	171.92±16.80	177.33±20.90	194±18.70	265.17±23.38	282.33±18.91	250 - 600
10.	Chloride (mg/l)	16.32±0.78	17.82±0.72	18.91±0.99	21.57±1.88	21.41±2.50	27.15±2.98	250 - 1000
11.	Nitrate (mg/l)	2.59±0.44	2.29±0.25	2.95±0.28	2.89±0.26	3.07±0.27	4.38±0.33	50
12.	Phosphate (mg/l)	0.16±0.03	0.21±0.01	0.30±0.04	0.31±0.05	0.36±0.05	0.86±0.06	0.5

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Table 3: Water Quality Index (WQI) range and status

WQI	Index Legend	Possible usage
91 - 100	Excellent	Drinking
71 - 90	Good	Drinking, irrigation and industrial
51 - 70	Medium	Irrigation and industrial
26 – 50	Bad	Irrigation
0 – 25	Very poor	Proper Treatment required before use

Source: Brown et al., 1972

Table 4: Annual water quality index for various sampling stations

S.No.	Stations	WQI	Status of water quality
1.	S1	67	Medium
2.	S2	54	Medium
3.	S3	49	Bad
4.	S4	48	Bad
5.	S5	46	Bad
6.	S6	37	Bad

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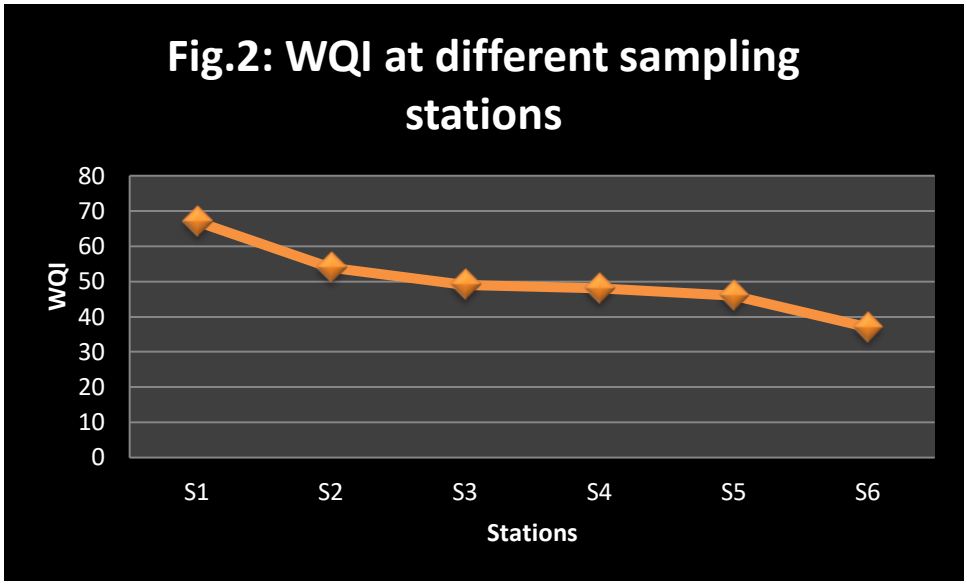

CONCLUSION

Physico-chemical property of Ganga river shows that at the upstream of the Ganga river in Kanpur at station S1 (Bithoor ghat), the water sample is good, but after entering the industrial belt it gets polluted mainly from industrial effluent. As a result it becomes grossly polluted, when it leaves the industrial belt. Continuous immersion of idols of God, Goddess and Tazias are among other remarkable factors. Stretch of the river from station S4 (Sarsaiya ghat) to S6 (Siddhnath ghat) is highly polluted and is not suitable for most of the beneficial uses of water except for irrigation, fish culture and industrial cooling. From this study of the surface water quality of the river, it is observed that the water of Ganga is fast losing its quality from station S1 to station S6. The river is highly polluted because of high total dissolved solids containing domestic waste and tannery effluent discharged into the river as compared to other ghats indicated by lower levels of DO. Thus, it can be concluded that the water of the river Ganga at station S6 (Siddhnath ghat) represents serious threat to the ecosystem due to anthropogenic pollution. Since river Ganga is lifeline for people of Kanpur who use its water for bathing and other purposes are at risk. The pollution level of the river is on the rise and can cause serious problems in near future.

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