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Evaluation of Water Quality at Triveni Sangam (Mahanadi, Pairi and Sondur Rivers) during Rajim Kumbh Fair

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Abstract: The main aim of the present study is to document the water quality of Triveni Sangam River at selected locations of Rajim, before and during Kumbh Fair. The samples were collected from six different sites at the River. This location is particularly noteworthy since it is home to the Triveni Sangam, a sacred confluence of the three rivers Mahanadi, Pairi, and Sondur. The water is contaminated by lead. Chromium content in water is within limits. The results from data analysis show that, the water is certainly unfit for drinking purposes without any form of treatment, but for various other surface water usage purposes it still could be considered quite acceptable. But as it is known, once a trend in pollution sets in, it generally accelerates to cause greater deterioration. So, few years from now, serious water quality deterioration could take place.

Index terms: heavy metals, permissible limit, physicochemical, Triveni Sangam, water quality

1. INTRODUCTION

Rivers in India regarded as sacred from times immemorial. A dip in a holy river is believed to wash all sins. Being obsessed by such faith, people take bath in these rivers, especially on auspicious occasions, such as Maghi Purnima, Deepawali, Somwati Amawashya, Sanichari Amawashya, Purnima etc. Mass bathing poses a great threat to river health with respect to water pollution in general (Chaurasia, 1994). Recently the study was conducted in Uttarakhand's River and found that five studied rivers (Alakhnanda, Bahgireathi, Ganga, Mandakini and Yamuna) were polluted (Kumar et al 2010).

Several studies have been directed on the impact of mass bathing on various water bodies in India (Sinha et al., 1991; 2001; Kulshreshtra and Sharma, 2006). Polluted rivers are important vectors for the spread of diseases. Due water-borne diseases in developing countries 1.8 million children die every year (WHO 2004). This Mass Bathing, an old age ritual practised in India is one of the main causes for increasing organic pollution of the river and also inorganic wastes are accumulated at the riverbeds creating huge garbage. High amount of organic matter is flooded into the river water in form of soaps, detergents and washing of cloths. Many a times such offerings are brought in polythene carry bags and in the absences of a proper disposable system, these polythene bags and other non-biodegradable materials are dumped at the site of river banks which remain either floating on the water surface or cover the river bed substratum, creating a noxious environment to aquatic life (Semwal and Akolkar, 2006). Mass bathing at Triveni during Kumbha and Mahakumbh mela has attracted numerous scientists to study the water quality of the river (Upadhyay et al., 1982; Singh et

al., 1988). It is a belief that a dip in "Holy River washes away you're sins". Thousands of pilgrims across the country took a holy dip in the Triveni sangam during the Rajim kumbh festival held in Rajim from 24th February to 8th March 2024. The primary aim of this study was to assess few impacts on River water quality of mass gathering and taking a holy dip at Triveni Sangam, Rajim (Chhattisgarh) during Kumbha mela 2024 and to make a comparison of few parameters in the pre-fair period and during the fair days.

2. SITE OF STUDY

The town of Rajim is formally in the Gariaband district of Chhattisgarh, India, however it is suggested to be in the Raipur district. Rajiv Lochan Mandir, the primary Hindu pilgrimage temple in Rajim devoted to Vishnu, is the source of the name Rajim. In the Triveni Sangam, there is also the ancient Kuleshwar Mahadev Mandir, which is devoted to Shiva. The Triveni Sangam of Mahanadi, Pairi (Physically) and Sondor (Virtually) is held in the town. Rajim, known for his numerous blessings, is often referred to as the Prayag of Chhattisgarh. Rajim, which is located at roughly latitude 21.4667° N and longitude 81.8833° E, is an important place because it meets the Mahanadi River.

3. MATERIAL AND METHODS

Chemicals and Glassware: All the standard solutions were prepared from analytical grade compounds of Merck Company. All the glassware used was of Borosil. Prior to all chemical analyses, the reagent bottles, beakers, and volumetric flasks were cleaned by soaking overnight in 2 N hydrochloric acid, rinsed with water and oven dried at 60ºC.

Instruments: Instruments used in the investigation are UV VIS Carry 100 of Varian used for the analysis of fluoride, iron, calcium & lead concentration and EUTECH pc510 pH and Conductivity meter was employed for all pH and EC measurements. Standard buffer solutions of pH 4 and 7 were used for calibration.

Sampling: River water samples were collected near the off-take point and were collected after clearing the suspended and floating matter. The samples with suspended matter were filtered on site. Filter paper was washed with sample first prior to filtration. Fresh/new filter paper was used for each filtration. The samples for physicochemical examination were collected in a clean, white 1000 ml capacity leak proof pet bottle, pre rinsed with detergent then thoroughly washed and rinsed with de-ionized water. For heavy metal analysis of water, 5 ml of concentrated nitric acid was added to 1000 ml sample; the cap was replaced and mixed well. Before the samples were collected, the container was washed with acid (0.1 N HCl), followed by distilled water. The 'field code number (sample ID)' was written on the container. The 'field code number' and the source details were separately recorded.

Table 1: Methods used for estimation of physicochemical and other parameters

S.N.	Parameters/Units	Method / Apparatus	Reference
1	pH & EC	pH Meter Orian 5-Star	APHA (2005)
2	Alkalinity mg/l	Titrimetric	APHA (2005)
3	Hardness mg/l		
4	Chloride mg/l		
5	TDS mg/l	Calculation	
6	F and Ca mg/l	UV VIS Spectrophotometer (Cary 100-Varian)	APHA (2005)
7	Fe, Pb, Cr mg/l	Atomic Absorption Spectrometer (AA240- Varian)	APHA (2005)

4. NEMEROWS POLLUTION INDEX -NPI

The Nemerow index (Nemerow and Leonard, 1971) evaluation method used to analysis the quality of water. The pollution causing parameters are evaluated through Nemerow's pollution index using the obtained values of various physicochemical parameters. NPI is evaluated for all the parameters for each sample analyzed, thus identifying the pollution causing parameters.

The equation used in evaluating the NPI is reproduced below:

NPI = Ci / Li

Where Ci = observed concentration of i parameter

Li =permissible limit of i parameter.

In above expressions unit of Ci and Li should be identical. Each value of NPI shows the relative pollution contributed by a single parameter. It has no units. Li values for different water quality parameters are indicated in Table 4. NPI value exceeding 1.0 indicate the presence of impurities in water. As per Nemerow's Pollution Index (NPI), the pollution parameters at each station are calculated.

5. RESULT

The observed values were compared with the recommended standards by BIS (1993) and WHO (2004). Table 2 and 3 reveals that there were considerable variations in the examined samples from different sources before and during indicates that the quality of water considerably varies from location to location. All the investigated data were compared with BIS standard values given for drinking and industrial & irrigation purpose (Table 4).

Table 2: Physicochemical parameters of Triveni Sangam analyzed before the onset of Fair

S.N.	Parameter (mg/l)	Sample Code					
		BFS1	BFS2	BFS3	BFS4	BFS5	BFS6
1.	**pH**	8.7	8.7	8.7	8.6	8.5	8.4
2.	**Conductivity(µS/cm)**	155.3	132.0	116.1	132.8	122.6	132.5
3.	**T.D.S**	93.18	79.2	69.66	79.68	73.56	79.5
4.	**Alkalinity**	50.5	47.5	55.3	50.5	53.0	40.2
5.	**Chloride**	15.42	11.69	10.63	11.69	12.23	12.23
6.	**Hardness**	51	50	50	55	50	50
7.	**Fluoride**	0.057	BDL	0.011	0.077	0.015	0.097
8.	**Iron**	0.004	0.033	0.013	0.029	0.012	0.040
9.	**Lead**	0.02	0.06	0.05	0.05	0.03	0.05
10.	**Chromium**	0.001	0.0004	BDL	BDL	BDL	BDL

BFS- Before Fair Samples

Table 3: Physicochemical parameters of Triveni Sangam analyzed during the Fair

S.N.	Parameter (mg/l)	Sample Code					
		DFS1	DFS2	DFS3	DFS4	DFS5	DFS6
1.	**Ph**	9.1	8.8	9.0	8.8	8.7	8.6
2.	**Conductivity(µS/cm)**	162.0	151.7	159.4	156.7	125.6	134.5
3.	**T.D.S**	97.2	91.02	95.64	94.02	75.36	80.7
4.	**Alkalinity**	274.0	100.1	75.4	56.3	70.3	130.0
5.	**Chloride**	19.85	20.20	20.73	26.76	24.10	32.08
6.	**Hardness**	100	55	53	56	50	50
7.	**Fluoride**	0.057	BDL	0.025	0.488	0.027	0.296

8.	**Iron**	0.101	0.044	0.042	0.047	0.034	0.112
9.	**Lead**	0.07	0.06	0.06	0.06	0.03	0.05
10.	**Chromium**	0.009	0.011	0.004	BDL	BDL	BDL

DFS- During Fair Samples

Table 4: Surface Water quality standards recommended by BIS

Class –A: Drinking water without conventional treatment but after disinfection Class –B: Water for outdoor bathing. Class -C: Drinking water with conventional treatment followed by disinfection. Class -D: Water for fish culture and wildlife propagation. Class -E: Water for irrigation, industrial cooling and controlled waste disposal. (Unobj = Unobjectionable).

S. No.	**Parameters (mg/l)**	**Surface water quality standards**				
		Class –A	**Class –B**	**Class –C**	**Class –D**	**Class –E**
1.	pH	6.5-8.5	8.5	8.5	8.5	8.5
2.	Conductivity µS/cm	300	-	-	1000	2250
3.	TDS	500	-	1500	-	2100
4.	Alkalinity	200				
5.	Chloride	250	-	600	-	600
6.	Hardness	300	-	-	-	-
7.	Fluoride	1.5	1.5	1.5	-	-
8.	Iron	0.3	-	50	-	
9.	Lead	0.01	-	0.1	-	-
10.	Chromium	0.05	0.05	0.05	-	-

Table 5: NPI values of different sampling sites

Parameters	Sample code					
	RWS1	RWS2	RWS3	RWS4	RWS5	RWS6
PH	1.070	1.035	1.058	1.035	1.023	1.011
Conductivity	0.54	0.505	0.531	0.522	0.418	0.448
T.D.S	0.194	0.182	0.191	0.188	0.150	0.161
Alkalinity	1.37	0.500	0.377	0.281	0.351	0.65
Chloride	0.079	0.080	0.082	0.107	0.096	0.128
Hardness	0.333	0.183	0.176	0.186	0.166	0.166
Iron	0.336	0.146	0.14	0.156	0.113	0.373
Fluoride	0.057	BDL	0.025	0.488	0.027	0.296
Lead	1.4	1.2	1.2	1.2	0.6	1
Chromium	0.18	0.22	0.08	BDL	BDL	BDL

5. DISCUSSION

Hydrogen ion concentration (pH): Determination of pH influences the other physicochemical parameters and the availability of metal ion in the water and wastewater. In addition, all the biochemical reactions are sensitive to the variation in pH and it is one of the most important operational water quality parameters (Mohammed and Nur, 2013). The recommended pH range necessary for drinking water is from 6.5 to 8.5. The pH value ranges from 8.4 to 8.7 in the samples analyzed before fair (BFS) while values of pH of the samples collected during the fair (DFS) are comparatively very high at all the six sites i.e. 8.6 to 9.1, it indicates the increased pH during the fair period. All the six samples showed high pH which is above the BIS recommended value and it was likely due to the use of detergents by the pilgrims during the holy bath. Similar ranges of pH were also obtained by other works on river Ganga (Sood et al., 2008; Sati et al., 2011; Kumar et al., 2018). The present observation finds support with the work of Gohar et al (2018), Reymond et al (2021) and Shukla and Gupta (2015).

Conductivity: Electrical conductance (EC) is a measure of the ability of an aqueous solution to carry an electric current that depends on the presence and total concentration of ions, their mobility and valance and on the temperature. It is a useful tool to assess the purity of water (Hsieh and Lantz, 2012). The BIS permissible limit for EC of water is 300 µS/cm and the values of EC in all the samples varied widely from 116.1 to 155.3µS/cm for the samples collected before fair. The conductivity analyzed during the fair showed slight increase (125.6- 162.0 µS/cm) in comparison to BFS that is due to mass bathing and other religious human activities that shows mixing of electrolytes. All the values (before and during fair) are below the recommended values by BIS. The present observation finds support with the work of Sosale et al (2020), Reymond et al (2021).

Total Dissolved Solids: Total dissolved solid (TDS) is a measure of the combined concentration of all inorganic and organic substances contained in water. TDS have great implications for the control of biological and physical wastewater treatment processes. The largest amount of total solids adds to the highest turbidity and EC value in the river water. The values of TDS in both the collected samples before and during the fair found within the permissible limit of BIS (500 mg/l). TDS in BFS was 69.66 to 93.18mg/l while a slight increase was found for DFS that ranged from 75.36 to 97.2mg/l. The present observation finds support with the work of Sosale et al (2020), Reymond et al (2021) and Gohar et al (2018).

Alkalinity: It is the quantitative capacity of water sample to neutralize a strong acid to a neutral pH. In the present investigation all the samples showed the alkalinity within the permissible limits of BIS (200 mg/l) but on the day of mass bathing, the alkalinity is more, ranged from 56.4 to 247mg/L in comparison to the BFS (40.2 - 55.3mg/l). The present observation finds support with the work of Reymond et al (2021). The high value of alkalinity (247mg.l) at site 1 i.e. Separate snan site during the fair indicates the presence of weak and strong base such as carbonates, bicarbonates and hydroxides in the water body (Abassi et al., 1999; Jain et al, 1997). The high values of alkalinity may also be due to increase in free carbon dioxide in the River which ultimately results in the increase in alkalinity.

Chloride: Chloride is one of the major anions found in water and are generally combined with calcium, magnesium or sodium. Chlorides are leached from various rocks into soil and groundwater by weathering. The chloride ion is highly mobile and is transported to closed basins. The main source of chloride in surface water and groundwater is due to atmospheric precipitation, animal feeds, septic tanks, use of inorganic fertilizers and landfill leachate. In this study, the chloride contents were ranged from 10.63 -15.42mg/l for BFS, and 20.20 - 32.08mg/l for DFS. The values are far below the permissible limit of BIS (250mg/l). The present observation finds support with the work of Sosale et al (2020).

Hardness: In general, hard water has no known effect on human health but is unsuitable for domestic uses. Hard water contains high levels of dissolved calcium, magnesium and other mineral salt such as

iron. In the present study, all the samples before fair showed similar amounts of hardness ranged from 50 to 51mg/l. But on the day of mass ritualistic bathing the hardness is high between 50 to 100mg/L. it was highest (100mg/l) at site 1/Separate snan site followed by site 4 (56mg/l), site 2 (55mg/l), and site 3(53mg/l), and there was no change observed at site 5 and site 6 (50mg/l). It is clear from the study that all the sites have value of hardness below the permissible limit of BIS (300mg/l) but increases after mass ritualistic bathing. The present observation finds support with the work of Gohar et al (2018), Reymond et al (2021).

Heavy metal analysis: Heavy metals are regarded as serious pollutants in the aquatic environment because of their environmental persistence and tendency to concentrate in aquatic organisms. The concentration of Fe was found to be slightly increased after the religious activity whereas concentration of Cd was recorded nil at all the sites. Concentration of Cr was recorded only at site1- 0.001 and site2- 0.0004 before kumbh fair and during kumbh fair Cr was recorded only at site1- 0.009, site2- 0.011 and site3- 0.004 respectively and Cr did not show any specific trend. Table 3 shows an increase in concentration of Fe and Pb almost at all the sites during the religious activity.

Metals in deposition are consequent from both natural and anthropogenic (point and non-point) sources (Baker et al., 1997). Bioaccumulation of the metals in many fish species and their organs has been described worldwide by Kumada et al., (1980); Osborne et al., (1981); Norris and Lake, (1984) and Evans, (1987). Lead is also reported by Yigit and Altindag (2006), but they reported Cd >Pb.

Iron is one of the most abundant metals found on the earth crust and is essential for aquatic life and human beings. The Fe concentration of water samples ranged from 0.004 to 0.040 mg/L in BFS and from 0.101 to 0.112 mg/L in DFS. Slight increase in the concentration of Fe was recorded after the religious activity (table 3) at sites1 i.e.0.101 and sites2 is 0.112 mg/L but these values were found below the prescribed limits of water quality standards (table 4). This increase of Fe concentration may be attributed to the addition of coins and other materials made of Fe during the religious activity. The Pb and Cr might have come through paints and colours of Diyas, and small idols immersed during the religious rituals as also reported by Gupta et al. (2011). Concentrations of copper and cadmium were not detected in most of the samples. The concentration of Cr was found as 0.001 to 0.0004 mg/L in BFS and 0.009 to 0.004 mg/Lin DFS respectively. The low value of Cr indicated that there was not any significant source of copper and chromium pollution in all the study sites. Similar results were also reported by Eitei and Kh (2013). According to the ICMR, BIS and WHO standards, the permissible limit of fluoride content is 1.0 mg/L and 1.5 mg/L. From the Table 2 & 3, it is clear that all the water samples contain fluoride content in the range 0.057 to 0.097 mg/L in BFS and 0.057 to 0.296 mg/L in DFS, which is lesser than the permissible limit (Monica et al, 2018).

NPI Values: Surface water is one of the earths widely distributed, renewable and most important resources. It is generally considered as Triveni Sangam River water is least polluted compared to other inland water resources, it is proved from this study. The NPI values indicate that surface water is not suitable for drinking purpose, but it is suitable for commercial and irrigation purposes. From the results of NPI, the parameters except pH, alkalinity and lead all the remained parameters are within the permissible limits. Treatment should be carried with respect to pH, which varies from 1.070 to 1.011 and alkalinity as high value in sample 1 which is 1.37 and lead which varies from 1.0 to 1.4. The remaining parameters like, Conductivity, Hardness, T.D.S, Fluorides, Chlorides, Iron, Chromium are not needed to treat. Very high NPI Value in dictated that unsuitable for drinking purpose.

Conclusion: The present study is directed to assess the water quality before and during Kumbh fair held in Rajim for 15 days in February 2024. It may be concluded that mass bathing causes an observable and major change in the physico-chemical quality of river water. The number of devotees visiting the river per day was directly proportional to the degree of contamination. The devotees carry out some religious activities such as taking Holi bath, immersing and non-degradable materials into the river water which

leads to the contamination of water. It also disturbs environmental conditions such as salinity, oxygen, temperature and nutrients which influence the composition, distribution and growth of its biota, and hence it is necessary to take proper care of river in order to ensure the healthy maintenance of the river and its surroundings. The day of mass ritualistic bathing i.e., on the days of Rajim Kumbha showed increased amount of almost all the tested parameters because of the addition of salts and chemical substances into the river. So, water in these areas is more prone for contamination and pollution.

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