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Assessment of Water Quality at Different Mass Bathing Ghats on River Godavari during Mahapushkar –2015 in East Godavari District, AP, India

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ABSTRACT

One of the sacred Indian religious festivals, "Pushkaram" which occurs once in 12 years was celebrated on the banks of river Godavari in the month of July 2015. This spiritual gathering drew people from all over India and world. During the 12 day mega event, crores of people not only took holy dip in the river but also performed various religious activities along Godavari River. The present study focuses on the impact of mass bathing and human activity on river water quality during the 'Mahapushkar' period i.e., from 14.07.2015 to 26.07.2015. River water Samples were collected from 20 selected ghats in three phases i.e. pre Pushkar, Pushkar and post Pushkar events. Analysis of water quality in terms of physico-chemical parameters indicated that all the parameters were within drinking water limits except pH and turbidity. A detailed assessment of biological parameters i.e. DO, BOD and COD and also microbial parameters like MPN, TBC, TFC and E. coli was carried out for all river water samples collected during the study period. It was found that all these parameters were above the permissible limits for mass bathing. One of the important microbial parameters, E. coli's range was found to be 13×10^2 to 64×10^7 per ml of water during study period, indicating extremely high fecal contamination in the river water. A natural pre-treatment technology, which enables the safe utilization of water from lakes or rivers known as River Bank Filtration - (RBF) technique is suggested for pumping river water for mass bathing especially for children and elder people through showers.

KEY WORDS: Mahapushkar, Mass Bathing, River Godavari, Water Quality, *E. coli*.

1. INTRODUCTION

Increasing industrialization, unchecked urbanization, devastating deforestation, excessive use of fertilizers in farming are naturally considered as factors responsible for pollution of world's water bodies. Along with these, another important factor i.e., human interaction plays a vital role in circumstances leading to contamination of water bodies. This intervention may be direct or indirect depending on the customs and traditions of the geographical area under consideration. Particularly in countries like India where Idol immersion, mass bathing and other religious rituals in ponds /rivers/ lakes are observed regularly at different times of a year and are considered to be most sacred, their adverse effects on the water bodies takes a back seat.

Immersion of Idols during festivals in Yamuna river was studied by many researchers (Kaur, 2013; Ujjain and Azhar, 2011). Thousands of Ganesh and Durga idols of various sizes reaching heights up to 20/40 feet are immersed every year in different water bodies (Reddy and Kumar, 2001). The effect of idol immersion on water quality in Futala, Gandhisagar and Ambazari lakes of Nagpur has been highlighted (Manisha, 2014). All these studies reveal that Idol immersion activity is one of the sources of heavy metal pollution which leads to significant alteration in the water quality.

On the same lines a survey of literature on number of people who participated in mass bathing on various religious occasions shows interesting results. The 'Kanwar Mela' is one of the most famous sacred events in Haridwar, which receives around 3.0 to 5.0 million pilgrims during a course of 15 days (Gangwar and Joshi, 2008). More than 8 million pilgrims took dip in river Ganga at Haridwar during Purna Kumbh (Vijay Sharma, 2010). Similar is in the case of Mahamaham festival observed at Mahamaham Pond at Kumbhakonam-Tamilnadu, Sagarmela at Sagar Island Beach near Bay of Bengal and Mahakumbh on the banks of Kshipra river in Ujjain-Madhya Pradesh, lakhs of people were reported to take mass bath. During such religious ceremonies people not only take holy bath but drink the water as holy water unaware of the water quality (Semwal and Akolkar, 2006). Although the pious events last for a few weeks during an year, managing huge gathering and making arrangements in terms of traffic control, sanitation, accommodation and providing food for the pilgrims coming from far off places becomes a herculean task for the government, NGO's and other charitable organizations. During such congregations river water quality is one of the important yet neglected aspects which has to be primarily taken care of. Many researchers have investigated on physico-chemical, biological and microbial parameters of the water bodies during various occasions of mass bathing and found that water quality is degraded and brings drastic changes water quality (Tiwari and Mishra,1986; Parashar, 2003; Verma and Saksena, 2010). It was observed that

microbial contamination in river water increases alarmingly and tends to disturb river ecology during mass bathing. This microbial contamination affects human health immediately (Saini, 2008; Pandey, 2005; Kumarasamy, 2009; Arora and Tewari, 2012). Hence, keeping in view the importance of the water quality during mass bathing, an attempt has been made to assess physico-chemical, biological and microbial characteristics of Godavari river water in East Godavari district of Andhra Pradesh, India, during 'The Mahapushkar period. The study was done at the time of Mahapushkar 2015.

Significance of 'Mahapushkaram-2015': Pushkaram is a holy festival of rivers. It pertains to 12 major rivers in India and occurs once in 12 years for each river as per its zodiac sign and is observed for 12 days. Jupiter's entry into a particular zodiac sign of a river in a particular year marks "Pushkarm" for that river. In this year i.e., 2015, Jupiter entered into the constellation of Leo and the sacred religious event was celebrated on the banks of river Godavari. Another significance of 2015 Pushkaram is that it is 12th in series, occurs once in 144 years and for this reason, is also called as "Maha Pushkaram".

The Mahapushkar period started from 14th July and ended on 25th July 2015. The city of Rajahmundry of East Godavari district of Andhra Pradesh is popularly known as "Dakshina Kasi" and hence is the focal city of Godavari pushkaram. The importance of Mahapushkaram and the city of Rajahmundry is clearly seen in terms of number of people who took dip at some of the important ghats during this unique religious ritual. Out of 20 ghats selected for study, 4 major ghats, The Kotilingala Ghat, The Pushkara Ghat, The Sarawathi Ghat and The Gowthami Ghat lie in Rajahmundry. Nearly two crores (20 million) of people took holy dip during these 12 days in these 4 ghats alone. Details about ghats, their latitude/longitude and the total number of people who took holy dip in each ghat during Pushkar period are given in Table.1.

Table.1. Pushkar ghat code, name, location and total population who took mass bath at each ghat

Ghat Code	Name of the Ghat	GPS (Degree Decimal)		Total population Who took mass bath during pushkar period* (14-25th July 2015)
		Longitude East	Latitude North	
G1	Kotilingala	81.761	17.022	9973573
G2	Pushkara	81.766	17.006	5278900
G3	Saraswathi	81.764	16.993	1390190
G4	Gowthami	81.768	16.989	1469346
G5	Dowleswaram	81.774	16.938	439980
G6	Rajavaram	81.740	16.906	61428
G7	Peravaram	81.760	16.908	61931
G8	Vaddiparru	81.762	16.893	63321
G9	Velicheru	81.762	16.873	85832
G10	Athreyapuram	81.795	16.832	76347
G11	Kattunga	81.763	16.818	81430
G12	Vadapalli	81.816	16.815	167911
G13	Jonnada	81.862	16.786	195089
G14	Ankampalem	81.770	16.774	63838
G15	Ravulapalem	81.860	16.769	95781
G16	Komaraja lanka	81.853	16.765	67419
G17	Narkedmilli	81.760	16.759	69486
G18	Mandapalli	81.872	16.750	52150
G19	Podagatlapalli	81.800	16.735	50535
G20	Gopalapuram	81.802	16.706	144108

*Source: Endowment Department, East Godavari District, Andhra Pradesh

Study Area:

Location: River Godavari originates near Nasik in Maharastra State and joins the Bay of Bengal at Antarvedi in Andhra Pradesh State, India. The total length of the Godavari river is 1,465 km. The river is popularly known as Akhanda Godavari, keeping in view its size of catchment and discharge. After crossing Rajahmundry, the Godavari splits into two branches which are called Vriddha Gautami (Gautami Godavari) and Vasishta Godavari. The Gautami branch splits into two branches namely Gautami and Nilarevu and similarly the Vasishta branch splits into two branches namely Vasishta and Vainateya. These four branches join the Bay of Bengal at different places, along the coast of length 170 km. The location of water samples collected at various ghats is between 81 40' 00'' to 82 00' 00'' E longitude and 16 40'00'' to 17 10' 00'' N latitude and the same is shown in Figure.1.

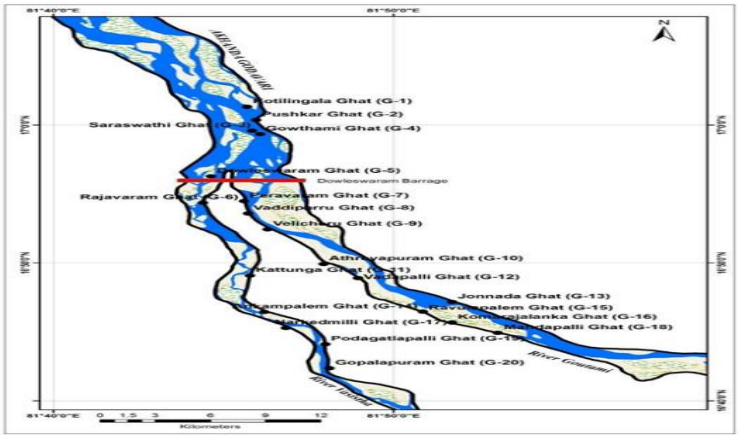

Figure.1. Location of ghats on River Godavari and its branches

Climate: Local climatic parameters ie., rainfall, maximum temperature and humidity play an important role for making various arrangements for people who gather in a particular place for religious festivals and during mass bathing. The measured daily rainfall, maximum temperature and humidity of Rajahmundry city during Pushkar period are given in Table 2. The total rainfall, highest maximum temperature and average relative humidity during Pushkar period are 79.2 mm, 38.2°C, and 90.83% respectively. Of these the rainfall pattern is one of the important climatic parameters which influences the hydrochemistry of water body.

Table.2. Details of climate parameters during pushkar period (14th July to 25th July 2015)

Parameter	Daily climate parameters during pushkar period at Rajahmundry city											
	14th	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th
Rainfall (mm)	0.0	0.0	0.0	11.6	0.0	0.0	8.5	11.5	29.6	5.0	13.0	0.0
Maximum Temperature°C	38.2	37.0	36.5	36.5	35.2	34.0	34.5	34.5	27.5	31.0	33.2	34.5
Relative Humidity (%)	86	89	91	89	91	90	97	92	95	95	89	86

*Source: CTRI, Rajahmundry

2. METHODOLOGY

River water samples have been collected separately in clean polyethylene bottles for physico- chemical analysis and in BOD bottles for biological analysis. Physical parameters (pH, temperature, electrical conductivity, turbidity) were measured at the site and chemical analysis was performed at Water Quality Laboratory of the Deltaic Regional Centre of the National Institute of Hydrology, Kakinada, Andhra Pradesh following Standard procedures (APHA, 1995). Physical parameters were measured with portable electrodes. Ca, Mg, Cl and HCO_3 analyses was carried out by volumetric analysis. Na and K were determined using Flame photometer and UV-Spectrophotometer was used to determine NO_3. Total hardness was calculated. Dissolved Oxygen was fixed by adding fixator $Mn(OH)_2$ in BOD bottles.

Biological analysis (DO, BOD, COD, MPN, TFC, TBC, E. coli) was carried out at WET (Research) Centre, SRKR Engg., College, Bhimavaram, Andhra Pradesh. MPN and TFC is a presumptive test specific for detecting Coliform bacteria. TBC and E. coli were estimated by serial dilution/Pour-plate technique.

3. RESULTS AND DISCUSSIONS

The study was conducted in three phases. River water samples were collected from 20 important ghats in East Godavari district in each phase i.e during pre Pushkar, Pushkar and post Pushkar periods. The average values of the physico-chemical analyses of the samples collected during these three phases are given in Tables 3, 4 and 5 respectively. In general, river water quality in terms major anions and cations was found to be within Bureau of Indian Standards desirable drinking water limits (BIS, 2012) except pH and turbidity.

Table.3. Physico-Chemical analysis of water samples during pre pushkar period

Ghat Code	Temp °C	Turbidity (NTU)	pH	EC (µS/cm)	TDS	HCO_3	Cl	NO_3	TH	Na	K
G1	32.2	31	8.3	220	150	90	25	16	100	15	2
G2	28.4	75	7.1	230	160	100	30	14	100	16	2
G3	32.0	43	8.3	200	140	100	29	11	110	14	2
G4	32.4	53	8.2	190	130	100	30	15	90	15	2
G5	31.3	41	8.2	220	150	70	27	11	80	15	2

G6	31.8	46	8.3	210	150	120	28	16	80	12	3
G7	33.8	44	8.2	250	170	130	30	8	90	12	2
G8	35.3	29	8.4	210	140	90	27	18	110	13	2
G9	35.3	51	8.2	200	140	110	23	14	90	14	2
G10	32.5	43	8.3	220	150	120	29	9	80	15	2
G11	32.7	47	8.0	210	130	110	23	13	80	14	3
G12	32.5	41	8.8	270	180	150	27	9	110	20	2
G13	29.8	55	8.8	270	180	80	25	14	110	17	2
G14	32.6	32	8.4	210	140	120	23	12	80	16	2
G15	31.4	8.5	8.3	220	150	150	25	12	180	19	3
G16	32.5	9.3	8.0	240	160	150	24	15	110	13	2
G17	32.7	45	8.5	220	150	90	28	15	110	13	2
G18	32.7	25	8.6	210	140	110	28	14	80	14	2
G19	31.4	9.0	8.2	230	160	180	25	8	90	23	2
G20	34.4	13	8.7	250	170	120	27	11	110	13	3

All units are in mg/l. TH: Total Hardness as $CaCO_3$. TDS: Total Dissolved Solids, EC: Electrical Conductivity

Table.4. Physico-Chemical analysis of water samples during pushkar period

Ghat Code	Temp ºC	Turbidity (NTU)	pH	EC (µS/cm)	TDS	HCO_3	Cl	NO_3	TH	Na	K
G1	31.3	33	7.6	170	150	90	26	16	90	16	2
G2	31.1	41	7.5	180	130	50	28	17	70	16	2
G3	31.3	40	8.0	160	110	60	29	15	70	14	2
G4	30.9	38	7.7	170	120	80	21	16	90	16	2
G5	30.9	27	8.2	180	130	80	28	15	80	15	2
G6	30.9	22	8.8	160	110	80	21	18	60	13	2
G7	30.9	18	8.9	140	100	80	21	14	80	13	2
G8	30.7	17	8.8	160	110	110	22	19	70	13	2
G9	30.8	16	8.9	160	110	80	21	14	80	13	2
G10	30.8	9	8.8	170	120	70	28	12	90	16	2
G11	30.8	15	8.7	140	100	80	21	14	80	13	3
G12	30.9	13	8.9	210	150	150	21	13	90	20	2
G13	30.8	10	8.5	200	140	120	28	16	100	18	2
G14	30.7	18	9.2	350	240	90	28	18	80	17	2
G15	30.1	10	8.7	343	230	130	35	13	150	20	3
G16	30.8	19	8.6	210	150	70	28	15	100	17	3
G17	31.0	18	8.8	140	100	80	21	16	90	13	3
G18	30.8	10	9.0	170	120	110	21	15	90	14	2
G19	30.8	19	9.0	170	120	100	28	13	70	17	2
G20	30.8	20	8.3	160	110	80	21	14	90	13	2

All units are in mg/l. TH: Total Hardness as $CaCO_3$. TDS: Total Dissolved Solids, EC: Electrical Conductivity

Temperature: The average temperature (°C) of river water during pre Pushkar, Pushkar and post Pushkar period was found to be 35.2, 30.9 and 31.8 respectively.

Turbidity: The average turbidity (NTU) of water during pre Pushkar, Pushkar and post Pushkar period is found to be 37.1, 20.7 and 74.5 respectively. The maximum permissible turbidity of water for bathing purpose is less than 5 NTU. Comparison of these values indicates the highly turbid nature of water during the total sampling period. The variation in turbidity may be attributed to various anthropogenic activities at ghats and to no significant river flow at these ghats. The average turbidity of river water decreased during Pushkar period which may be mainly due to the rainfall pattern and subsequent dilution.

pH: The pH is a measure of the acidity/alkalinity of water. The general pH limit (BIS, 2012) for potable water is 6.5 to 8.5. The pH value was found to vary between 7.1- 9.2 during the study period. The average pH of river water during pre Pushkar, Pushkar and post Pushkar period is 8.29, 8.59 and 8.4 respectively. The pH of all water samples was found to be more than 7 thus indicating that water was well buffered and alkaline in nature.

Electrical Conductivity (EC) and Total Dissolved Solids (TDS): The average EC of samples during pre Pushkar, Pushkar and post Pushkar period is 224, 187 and 202 µs/cm at 25°C respectively. Similarly the average TDS in mg/l during the corresponding three phases are 152, 132 and 137 respectively. The range of TDS value in mg/l in these three phases is 100 to 240. The highest TDS (240 mg/l) was observed at Ankampalem ghat (G13). The general acceptable limit of TDS for potable water is 500 mg/L (BIS, 2012).

Major anions and cations: The major anions (HCO_3, Cl and NO_3) and cations $CaCO_3$, Na and K concentration during pre Pushkar, Pushkar and post Pushkar period is within permissible limits of drinking water (BIS, 2012). It is also observed from Tables 3, 4 and 5 that there is no significant variation of concentration of major anions and cations in the water samples collected at different bathing ghats during the study period.

Table.5. Physico-Chemical analysis of water samples during post pushkar period

Ghat Code	Temp °C	Turbidity (NTU)	pH	EC (µS/cm)	TDS	HCO_3	Cl	NO_3	TH	Na	K
G1	31.0	69	7.6	230	160	90	30	10	90	19	3
G2	31.9	68	8.2	210	140	90	29	10	80	19	3
G3	31.8	65	8.1	190	130	80	28	11	80	20	3
G4	32.2	64	7.9	210	140	100	24	10	90	19	3
G5	32.2	72	8.2	210	140	100	28	11	80	20	3
G6	31.5	69	8.6	190	130	90	28	9	90	22	3
G7	31.6	74	8.6	210	140	100	28	10	80	22	3
G8	31.8	78	8.5	190	130	80	28	10	80	21	3
G9	31.8	78	8.6	190	130	80	28	10	90	22	3
G10	31.4	75	8.5	210	140	100	28	10	90	22	3
G11	31.2	89	8.1	190	130	90	24	9	90	23	4
G12	32.1	81	8.5	210	140	80	28	10	80	20	3
G13	31.4	66	8.5	210	140	90	28	11	80	21	3
G14	31.8	77	8.8	210	140	100	28	9	80	22	3
G15	31.3	33	8.4	230	160	110	28	9	110	22	3
G16	31.3	72	8.7	190	130	90	28	9	100	25	4
G17	31.2	88	8.6	190	130	90	28	9	80	25	4
G18	31.2	85	8.6	180	120	90	28	8	80	23	3
G19	31.3	92	8.6	190	130	90	24	10	80	23	3
G20	31.1	96	8.6	210	140	100	28	9	90	25	4

All units are in mg/l. TH: Total Hardness as $CaCO_3$. TDS: Total Dissolved Solids, EC: Electrical Conductivity

Biological parameters: Major biological parameters analyzed are dissolved oxygen (DO), biochemical oxygen demand (BOD) and chemical oxygen demand (COD). The primary factor that governs whether biological changes are brought about by aerobic or anaerobic organisms is DO. The Biochemical Oxygen Demand (BOD) is a measure of the amount of food for bacteria that is found in water. It determines the strength in terms of oxygen required to stabilize domestic and industrial wastes (Kavita and Vineeta, 2010). COD is the amount of oxygen required to chemically oxidize organic compounds in water.

The concentration of these parameters in the water samples collected at mass bathing ghats is given in Table.6. The range of DO (mg/l) during pre pushkar, pushkar and post pushkar phases is 5.3 to 6.3, 4.6 to 5.8 and 5.7 to 6.5 respectively. The range of BOD (mg/l) is 5.4 to 6.8, 7.2 to 9.5 and 6.8 to 8.0 respectively. The average concentration of DO during pre Pushkar, Pushkar and post Pushkar periods is 5.9, 5.2 and 6.1 (mg/l) respectively. Similarly the average BOD concentration during these three phases is 6.3, 8.2 and 7.5(mg/l) respectively. The range of COD (mg/l) of river water during pre Pushkar, Pushkar and post Pushkar periods is 16.4 to 32.8, 19.6 to 34.0 and 18.6 to 32.6 respectively. The average COD (mg/l) concentration during three phases is 25.3, 28.9 and 27.2. A consistent decrease in DO and increase in BOD and COD has been observed in all Ghats from during Pushkar period relative to pre Pushkar period. The variations of DO, BOD and COD in each ghat are shown in Figures 2, 3 and 4 respectively. The activities of pilgrims like adding soaps, detergents may be the possible reasons for the decrease in DO levels. The results are also in tune with the earlier findings (Bhatnagar and Sangawan, 2009). It was observed that a decrease in DO during and after mass bathing may also be due to entry of organic, domestic and biodegradable wastes by pilgrims (Shivi Bhasin, 2015). It was also pointed out that high values of BOD indicated contamination of water resources by biological, organic and inorganic pollutants and also high values of COD might be due to the presence of huge amount of accumulated organic matter and its incomplete oxidation (Kulshrestha and Sharma, 2006).

Table.6. Biochemical analysis of water samples at each ghat

Ghat Code	DO (mg/l)			BOD (mg/l)			COD (mg/l)		
	Pre	During	Post	Pre	During	Post	Pre	During	Post
G1	5.9	5.8	5.8	6.0	8.4	7.2	19.6	25.6	25.6
G2	5.9	5.8	5.8	6.0	7.2	7.2	25.6	25.6	25.6
G3	5.9	5.0	6.0	6.6	7.2	6.8	25.6	25.6	26.4
G4	6.0	5.8	6.0	6.0	8.0	7.0	32.8	32.8	29.3
G5	6.3	5.2	6.4	5.4	6.5	6.8	25.6	30.8	26.4
G6	5.8	4.6	6.0	6.6	9.0	8.0	25.6	32.0	32.6
G7	6.0	4.8	6.2	6.6	9.0	8.0	32.8	34.0	30.8
G8	6.2	4.6	6.4	5.4	9.5	8.0	30.8	31.8	30.8
G9	5.7	5.6	5.7	6.8	8.6	6.8	30.8	32.0	29.3
G10	6.1	5.8	6.3	6.6	7.2	6.8	25.6	30.8	29.3
G11	6.2	5.4	6.4	6.6	8.6	8.0	25.6	28.0	20.6
G12	5.8	5.6	6.0	6.8	8.8	8.0	19.6	20.6	20.6
G13	6.0	5.8	5.8	6.0	7.2	6.8	30.2	30.8	30.8
G14	6.2	4.6	6.5	6.6	9.2	7.8	30.8	32.2	30.8
G15	6.0	5.0	5.9	6.0	7.2	7.0	16.4	19.6	18.6
G16	5.8	5.2	6.0	6.4	8.8	8.0	19.6	25.6	24.4
G17	6.0	5.4	6.3	6.6	8.4	8.0	30.8	31.6	23.4
G18	5.8	4.8	6.4	6.6	9.0	8.0	16.4	25.6	25.6
G19	5.8	5.8	6.5	6.4	8.4	7.8	19.6	32.0	32.6
G20	5.3	4.8	6.1	6.4	9.0	8.0	22.8	30.8	30.8

Microbial parameters: Major microbial parameters analyzed are Most Probable Number (MPN), Total Bacterial Count (TBC), Total Fecal Count (TFC) and E. coli. The basic indicator of microbial contamination is MPN. The Most Probable Number (MPN) gives coliform or fecal coliform bacteria per unit volume of a sample. The general limit for total coliform for bating purpose is less than 500 in 100 ml of water and nil in drinking water (BIS, 1982). A glance at the results of MPN shown in Table.7, clearly indicates a large positive count of MPN even before Pushkar period, reflecting high degree of microbial contamination in the river course. During Pushkar period the count went up alarmingly. It is also noted that 50% of the samples consistently indicated MPN number above 2400 during study period. A similar trend was also observed in TBC. The range of TBC (Table 7) was found to be between 43 x 10^2/ml -214 x 10^3/ml during pre Pushkar period. During Pushkar TBC was found to increase drastically ranging between 59 x 10^3/ml - 257 x 10^7/ml. During post Pushkar it was found to be in between 256 x 10^2/ml - 209 x 10^5/ml. TBC count was exceptionally high at Kotilingala ghat (G1) during Pushkar period. These extreme results can undoubtedly be attributed to mass bathing. Moreover this ghat is the lengthiest ghat (1.2 km) among all ghats and highest number of people (9973573) took dip at this ghat during the Pushkar period. Also in this ghat, lakhs of people performed a ritual in memory of the departed souls, called "Pindapradanam", in which a lot of food material is immersed into the water. The present study is in conformation to statement that the most polluted ghats are the ones in which number of piligrims take holy dip and perform various religious rituals (Nirmaladevi, 2014; Saurabh and Smriti, 2015). The study of water quality of river Mandakini during Deepawali fair at Chitrakoot during mass bathing, assessed that water was highly polluted due to various offerings like flower, milk, rice, ghee, oil, etc. made during rituals by a large number of pilgrims and devotees (Gupta, 2014).

TFC is an indicator for total fecal coliform which mainly comes from animal and human activity. A detailed analysis of TFC and E. coli in samples collected at each bathing ghat during study period is given in Table 8. TFC was found in the range 23 to >2400, 90 to >2400, 43 to > 2400 in 100 ml of water in pre Pushkar, Pushkar and post Pushkar periods respectively. E. coli is an indicator for fecal contamination which comes from human and animal excreta. The range of E. coli during pre Pushkar, Pushkar and after Pushkar periods is 13 x 10^2 to 78 x 10^3/ml, 8 x 10^3 to 64 x 10^7/ml and 8 x 10^3 to 112 x 10^4/ml respectively (Table 8). E. coli count was found to be exceptionally high during Pushkar period especially at Pushkar ghat. The high count of TFC observed during study period is objectionable even for bating purpose or for general usage. The predicted high count of fecal coliforms in water clearly indicates the presence of pathogenic microorganisms, leading to water born diseases. A similar study

conducted during Kanwar mela, Haridwar, reported that there was a rise of 81.41%, 53.27% and 52.05% in the registered number of patients at three different hospitals due to cases of sudden development of diarrhea, eye infections, hypertension, indigestion, typhoid, jaundice, liver disorders, and stomach troubles (Vijay, 2013). An interview conducted with households in Ujjain and Dewas cities during mass bath showed that in most of the households, inhabitants residing nearby river constantly suffered from skin diseases and urinary tract infections (Shivi Bhasin, 2015).

Table.7. Microbial analysis (MPN and TBC) of water samples at each ghat

Ghat Code	MPN in 100ml			TBC in ml		
	Pre	During	Post	Pre	During	Post
G1	≥2400	≥2400	≥2400	$100x10^2$	$257x10^7$	$21x10^4$
G2	≥2400	≥2400	≥2400	$214x10^3$	$132x10^7$	$116x10^4$
G3	≥2400	≥2400	≥2400	$48x10^3$	$212x10^4$	$212x10^4$
G4	≥2400	≥2400	≥2400	$15x10^3$	$73x10^3$	$26x10^3$
G5	≥2400	≥2400	≥2400	$86x10^3$	$165x10^7$	$209x10^5$
G6	150	240	160	$192x10^3$	$214x10^3$	$205x10^3$
G7	≥2400	≥2400	≥2400	$160x10^2$	$59x10^3$	$23x10^3$
G8	≥2400	≥2400	≥2400	$600x10^2$	$112x10^3$	$107x10^3$
G9	≥2400	≥2400	≥2400	$500x10^2$	$68x10^3$	$60x10^3$
G10	230	460	260	$124x10^2$	$156x10^3$	$106x10^3$
G11	150	1500	1100	$56x10^2$	$182x10^3$	$134x10^3$
G12	240	460	240	$47x10^2$	$237x10^3$	$217x10^3$
G13	150	≥2400	≥2400	$28x10^2$	$56x10^3$	$14x10^3$
G14	240	430	260	$68x10^2$	$115x10^3$	$84x10^3$
G15	≥2400	≥2400	≥2400	$73x10^2$	$186x10^3$	$120x10^3$
G16	≥2400	≥2400	≥2400	$120x10^3$	$244x10^3$	$152x10^3$
G17	≥2400	≥2400	≥2400	$960x10^2$	$157x10^3$	$142x10^3$
G18	93	1100	260	$48x10^2$	$192x10^3$	$150x10^3$
G19	75	240	160	$43x10^2$	$167x10^3$	$256x10^2$
G20	93	≥2400	460	$112x10^3$	$255x10^5$	$236x10^4$

Table.8. Microbial analysis (TFC and E. coli) of water samples at each ghat

Ghat Code	TFC in 100ml			E. coli CFU in ml		
	Pre	During	Post	Pre	During	Post
G1	93	≥2400	93	$50x10^2$	$35x10^4$	$18x10^4$
G2	1100	≥2400	1600	$26x10^3$	$64x10^7$	$43x10^4$
G3	≥2400	≥2400	≥2400	$14x10^3$	$74x10^4$	$18x10^3$
G4	1100	≥2400	1600	$5x10^3$	$32x10^3$	$16x10^3$
G5	≥2400	≥2400	≥2400	$10x10^3$	$52x10^7$	$112x10^4$
G6	43	930	240	$78x10^3$	$82x10^3$	$80x10^3$
G7	1100	≥2400	≥2400	$50x10^2$	$12x10^3$	$9x10^3$
G8	1100	≥2400	1600	$30x10^3$	$32x10^3$	$31x10^3$
G9	≥2400	≥2400	≥2400	$60x10^2$	$8x10^3$	$77x10^2$
G10	23	240	140	$71x10^2$	$12x10^3$	$11x10^3$
G11	150	1600	1000	$23x10^2$	$8x10^3$	$74x10^3$
G12	93	97	460	$33x10^2$	$110x10^2$	$104x10^2$
G13	150	≥2400	240	$18x10^2$	$200x10^2$	$62x10^3$
G14	23	1600	1400	$52x10^2$	$100x10^2$	$74x10^2$
G15	93	1100	640	$32x10^2$	$142x10^3$	$28x10^3$
G16	1100	1600	1100	$50x10^3$	$70x10^3$	$65x10^3$
G17	1100	1300	1200	$21x10^3$	$90x10^3$	$76x10^3$
G18	43	90	43	$2x10^3$	$15x10^3$	$8x10^3$
G19	23	1600	1100	$13x10^2$	$12x10^3$	$63x10^2$
G20	23	460	240	$76x10^2$	$175x10^4$	$126x10^3$

In view of the above facts, many authors have proposed different measures to reduce the degradation of water quality on the account of various anthropogenic activities and human interferences during mass bathing (Praveen, 2007; Sayan, 2014; Shivi Bhasin, 2015). Along with these remedial measures, a natural pre-treatment

technology, which enables the safe utilization of surface water from lakes or rivers, known as River Bank Filtration - RBF has been proposed (Sandhu and Grischek, 2012). Biological and microbial contamination in the bathing water can be reduced to a great extent by using this Bank Filtration. In this technique the water passes through the natural porous sub-surface (aquifer) to the production well. The porous media serves as a natural filter and reduces the amount of suspended solids and pathogens to a great extent. Bank filtrate from the production wells shows a significantly higher quality compared to water directly extracted from surface water or groundwater sources. RBF during the monsoon season, helps in reducing turbidity and removes pathogens, decolourises water, reduces Dissolved Organic Carbon (DOC) and total thermo tolerant coliform counts. The efficiency of removal of E. coli through RBF was found to be 99% in the studies carried out near river banks in North India (Vash, 2010; Singh, 2010; Bartak, 2014). Therefore this technique should be adopted during mass bathing festival in any water body or river in future in order to reduce the impact of pathogens on human health.

4. CONCLUSIONS

The present study assesses the impact of mass bathing and human activity on river water quality during MAHA PUSHKAR period. The study showed that except pH and turbidity all other physico-chemical parameters of river water samples collected at various ghats are within BIS drinking water limits. The impact of mass bathing has been observed especially in terms biological and microbial parameters and all these parameters were above the permissible limits for mass bathing. The exponential increase in E. coli count is found during Pushkar relative to pre Pushkar period. This confirms the presence of high fecal coliform in the selected reaches of river Godavari in East Godavari District. Therefore suitable precautionary measures are to be taken during mass bathing to avoid health disorders. River Bank Filtration (RBF) is potential technique for pumping river water for mass bathing through showers for children and elder people.

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REFERENCES

APHA, Standard methods for the examination of the water and waste water. American Public Health Association, New York, 1995.

Arora N.K and Tewari S, Analysis of water quality parameters of River Ganga during Maha Kumbha, Haridwar, India. J. Environ. Biol, 34, 2012, 799-803.

Bartak Rico, Declan Page, Cornelius Sandhu, Thomas Grischek, Bharti Saini, Indu Mehrotra, Chakresh Jain K and Narayan Ghosh C, Application of risk-based assessment and management to riverbank filtration sites in India, J. Water & Health, 2014, 174-189.

Bhatnagar A and Sangawan P, Impact of mass bathing on water quality, Int. J. Env. Res., 3, 2009, 247-252.

Bureau of Indian Standards (BIS), Drinking Water-Specification IS 10500:2012, Second Revision, Government of India, New Delhi, 2012.

Bureau of Indian Standards (BIS), Tolerance Limits for Inland Surface Waters Subject to Pollution, IS: 2296-1982, Government of India, New Delhi, 1982.

Dash R.R, Bhanu Prakash E.V.P, Kumar P, Mehrotra I, Sandhu C, Grischeck T, River Bank Filtration in Haridwar, India: Removal of Turbidity, Organics and Bacteria, Hydrogeol. J, 18 (4), 2010, 973-983.

Gangwar K.K and Joshi B.D, A preliminary study on solid waste generation at Har Ki Pauri, Haridwar, around the Ardh - Kumbh period of sacred bathing in the river Ganga in 2004, Environmentalist, 28, 2008, 297-300.

Gupta G.S, Gupta L.N, Parihar S.P and Parihar J.S, Mass bathing assessment of river Mandakini water quality, during Deepawali fair event at Chitrakoot, Int. J. Surface and Groundwater Management, 1(2), 2014, 96-103.

Kaur B.J, George M.P and Mishra S, Water quality assessment of river Yamuna in Delhi stretch during Idol immersion, Int. J. Environ. Sci, 3 (6), 2013, 2122–2130.

Kavita Parmar and Vineeta Parmar, Evaluation of water quality index for drinking purposes of river Subernarekha in Singhbhum District, Int. J. Environ. Sci, 1 (1), 2010, 77-81.

Kulshrestha H and Sharma S, Impact of mass bathing during Ardh Kumbh on water quality status of river Ganga, J. Environ., Biol, 27 (2), 2016, 437-440.

Kumarasamy P, Vignesh S, James R.A, Muthukumar K and Rajendran, Enumeration and identification of pathogenic pollution indicators in Cauvery River, South India. Res. J. Microbiol, 4 (12), 2009, 540-549.

Manisha D.G, Abhay B.F and Pravin U.M, Effect of idol immersion on water quality and Tilapia fish in Futala, Gandhisagar and Ambazari lakes of Nagpur, India, Springer Plus, 3 (669), 2014, 1-8.

Nirmaladevi D, Shrinithivihahshini, Rajendhiran Viji, Mariyaselvam, Sheelamary, Rengaraj Chithradevi, Duraisamy Mahamuni and Dharmaraj Ramesh, Global J. Sci. Frontier Res.: H Environ. & Earth Sci, 14 (3), 2014, 71-80.

Pandey M, Dixit V.K, Katiyar G.P, Nath G, Sundram S.M, Chandra N, Shomvansi AK, Kar S, Upadhay and Ganga, V.K, Water pollution and Occurrence of Enteric disease in Varanasi City, Indian J. Comm. Med, 30 (4), 2005, 115-120.

Parashar N.B, Kaushik P and Pandey S, Physicochemical and Microbiological studies of Ganga canal at Hardwar, during Kumbh Period-1998, Him. J. Env. Zool, 17 (2), 2003, 167-171.

Praveen Mathur, Saurabh Agrawal and Mudita Nag, Assessment of physico-chemical characteristics and Suggested Restoration Measures for Pushkar Lake, Ajmeer Rajasthan (India), Proc. of Taal 2007: The 12th World Lake Conf, 2007, 1518-1529.

Reddy V and Kumar V, Effects of Ganesh-idol immersion on some water quality parameters of Hussainsagar Lake, Curr. Sci, 2001, 81–11.

Saini P, Sharma V, Joshi B. D, A Random survey report about rise in water borne diseases in Haridwar city during Kanwar mela-2008, J. Environ. Bio-Sci, 23 (2), 2009, 215–219.

Sandhu C and Grischek T, Riverbank filtration in India: using ecosystem services to safeguard human health, Water Sci. and Tech, 6, 2012, 783–790.

Saurabh Shukla and Smriti Gupta, Assessment of few impacts of mass bathing on river water quality at Prayag during Maha kumbha mela-2013, Allahabad, Int. J. Res. Eng. and Tech, 4 (10), 2015, 313-319.

Sayan Bhattacharya, Arpita Bera, Abhishek Dutta and Uday Chand Ghosh., Effects of idol immersion on the water quality parameters of Indian water bodies, Environmental health perspectives Int. Letters of Chem., Phy. and Astro, 39, 2014, 234-263.

Semwal N and Akolkar P, Water quality assessment of sacred Himalyan rivers of Uttaranchal, Curr. Sci, 91, 2006, 486-496.

Shivi Bhasin, Arvind Shukla N and Sharad Shrivastava, Observations on physicochemical and microbiological parameters of Kshipra river with special reference to water quality, Int. J. Curr. Microbiol. App. Sci, 8 (2), 2015, 125-138.

Shivi Bhasin, Arvind N, Shukla and Sharad Shrivastava, Observation on *Pseudomonas aeruginosa* in Kshipra River with Relation to Anthropogenic Activities, Int. J. Curr. Microbiol and Applied Sci, 4 (4), 2015, 672-684.

Shivi Bhasin, Arvind Shukla N and Sharad Shrivastava, Impact of mass bathing on water quality of river Kshipra at Triveni Ujjain, M.P., India, Int. J. Adv. Life Sci, 8 (1), 2015, 36-45.

Singh P, Kumar P, Mehrotra I and Grischeck T, Impact of river bank filtration on treatment of polluted river water, J. Environ. Manag, 91 (5), 2010, 1055-1062.

Tiwari T.N and Mishra M, Pollution in Indian rivers: Ganga at Varanasi, Life. Sci. Adv., 3, 1986, 130-137.

Ujjain N.C and Azhar A.M, Impact of Ganesh Idol Immersion Activities on the Water Quality of Tapi River, Surat (Gujarat), India, Res. J. Bio., 1 (1), 2011, 11-15.

Verma A.K, Saksena D.N, Assessment of water quality and pollution status of Kalpi (Morar) River, Gwalior, Madhya Pradesh: with special reference to conservation and Management plan, Asian J. Exp. Biol. Sci, 1 (2), 2010, 419-429.

Vijay Sharma, Sudhanshu Kaushik, Pankaj Saini and Joshi B.D, Assessment of health, hygiene and socioeconomic status in Haridwar city during Kanwar mela, Academ. Arena, 5 (10), 2013, 39-43.

Vijay Sharma, Sushil Bhadula and Josh B.D, Impact of Mass Bathing on water quality of Ganga River during Maha Kumbh, Nat Sci, 10 (6), 2010, 1-5.