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Determination of Water Quality Index (WQI) During Mass Bathing in Different Ghats of River Ganga in Howrah and North 24 Parganas District, West Bengal, India

Sayanti Kar¹, Indrajit Ghosh², Amitava Ghosh³, Pritam Aitch⁴, Gupinath Bhandari⁵

^{1, 4, 5} Department of Civil Engineering, Jadavpur University, Kolkata 700032, West Bengal, India

^{1, 2} Department of Environmental Science, Asutosh College, Kolkata 700026, West Bengal, India

³ Department of Botany, Asutosh College, Kolkata 700026, West Bengal, India

Abstract: The present study was carried out to assess the impact of mass bathing on water quality of Ganga River during the festival Mahalaya, 2016. For Hindus, the festival Mahalaya was considered to honour the soul of departed ancestors by taking a dip in Holy River. An examination of river water from river Hooghly, West Bengal, India was carried out at Mahalaya Festival to estimate the impact of mass bathing during new moon day (called as Amavasya in India) in terms of the Water Quality Index (WQI). WQI provides a single number that helps to express overall water quality based on water quality parameters. The sampling was done from the three selected popular ghats in Howrah and North 24 Parganas District, West Bengal during the event of mass bathing, pre-mass bathing and post-mass bathing. The value of WQI was found in between 56.87-78.24 for each case in all three ghats. WQI value showed very poor water quality in the most popular Dakhineswar ghat during mass bathing.

Keywords: Ganga, Mahalaya, Mass bathing, Water quality, WQI.

I. INTRODUCTION

River Ganga is considered one of the most sacred rivers in Hinduism. Millions of devotees take a dip during different occasions. Mass Bathing, an old age ritual in India is one of the main causes for increasing organic loads of the river. The reasons identified for the deterioration of water quality of river are due to domestic, industrial effluents direct discharge into river and various human activities along the banks of the river [1]. The study of impact of mass bathing in different parts of India shows the least used ghats for bathing remains least disturbed [2]. Offering goods like flower, milk, rice, ghee, oil, bananas leaves, fruits, polythene, water bottle etc. as well as the use of soaps, shampoo and detergents are responsible for water pollution [3]. The level of changes of DO, BOD, COD due to mass bathing in Amavasya have been observed [4, 5]. During the festive occasion of Guru Poornima, the amount of DO is decreased at Har-Ki-Pauri and similar results are observed by other researchers in Nkoro River [6]. Polluted river is responsible for the spreading of different diseases and record says in developing countries 1.8 million children die every year as a result of waterborne diseases [7]. A significant level of microbial parameters like fecal coliform (FC) and total coliform (TC) was found after mass bathing. Other than domestic discharges religious activities are identified one of the major sources of river pollution. The improvement of river quality may be achieved by creating public awareness [8].

In Hinduism festival like Mahalaya an event to worship the ancestors of family mass bathing with offerings like ghee, flowers and other religious items take place in different ghats of the river Ganga as it is the most sacred river of India to perform such deities. A prime tributary of the river Ganga is Hooghly River where such activities were assessed in the light of its effect on the water quality, by recording organic matter, physico-chemical and biological characteristics. Examinations and assessment were conducted in different ghats of Howrah and North 24 Parganas. The Water Quality Index (WQI) provides a single number that helps to express overall water quality based on water quality parameters [9]. The aim of the research is to evaluate how river water quality is affected during mass bathing in the occasion of Mahalaya in river Ganga in Howrah and 24 Parganas District.

II. STUDY AREA

River Ganga rises in the Himalayan Mountains from the Gangotri glacier and is flowing about 2,525 km generally eastward through a vast plain to the Bay of Bengal. The water samples were collected from three different ghats in Howrah and North 24 Parganas Districts which are two important districts in West Bengal. On the basis of gathering with a large number of pilgrims, three ghats

e.g., Belur Math Ghat (Howrah), Bally Pathak Ghat (Howrah) and Dakhineswar Ghat (North 24 Parganas) were selected for sampling.

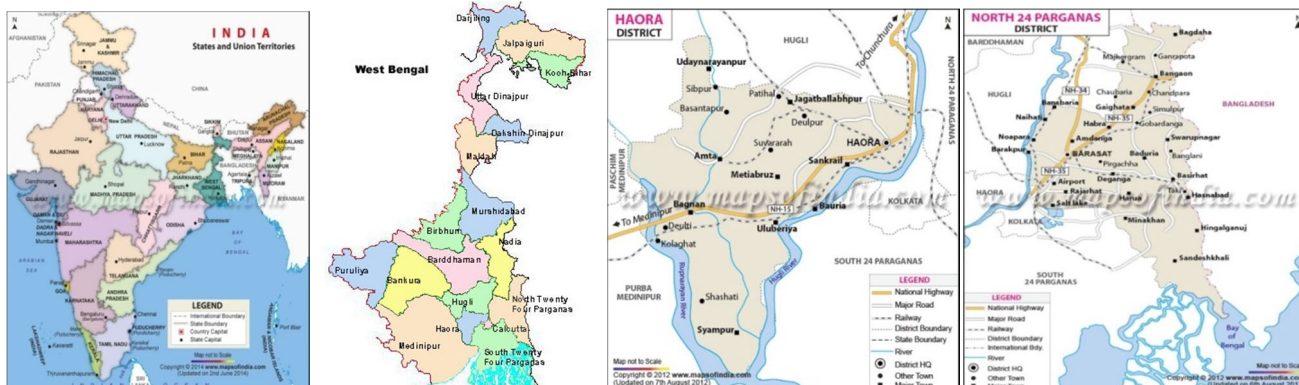


Image 1: Map of India ,West Bengal ,Block Map of Howrah District ,Block Map of North 24 Parganas District

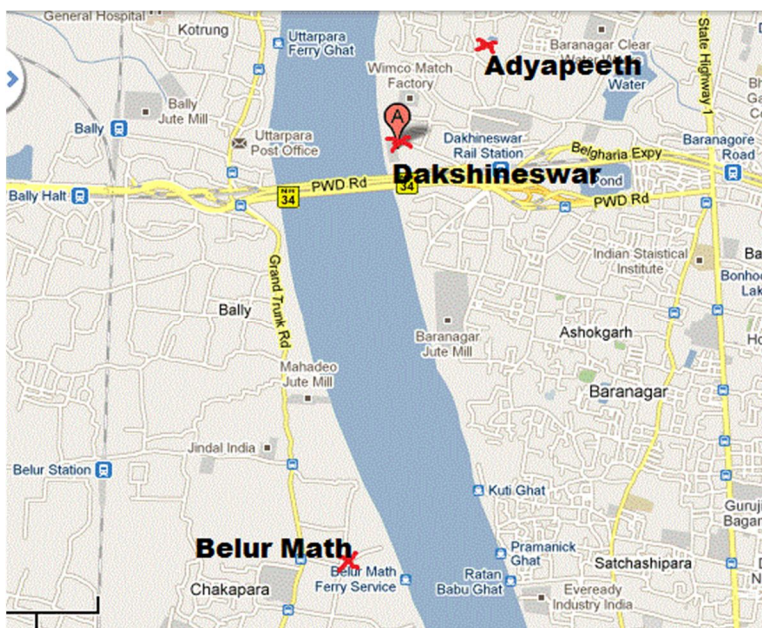


Image 2: Sampling Sites

Samples were collected by different headings as before the occasion, during the occasion and after of the mass bathing at different sampling time from areas of three selected ghats [Table-1].

Table: 1. Sampling Details

Occasion	Sampling Date	Sampling Time	Sampling Area
Pre Mass Bathing	29.09.2016	4.00 pm	Dakhineswar Ghat
		4.30 pm	BallyPathak Ghat
		5.00 pm	Belur Math Ghat
During Mass Bathing	30.09.2016	7.00 am	Dakhineswar Ghat
		7.30 am	BallyPathak Ghat
		8.00 am	Belur Math Ghat
Post Mass Bathing	01.10.2016	4.00 pm	Dakhineswar Ghat
		4.30 pm	BallyPathak Ghat
		5.00 pm	Belur Math Ghat

III. MATERIALS AND METHODS

Water samples were collected from three different ghats in River Hooghly in Howrah and North 24 Parganas District during the occasion of *Mahalaya*, 2016. Considering the occasion of mass bathing water samples were collected from each ghat three times [Table 1]. The samples were collected in polyethylene containers of 2.5 liters and were analyzed for physico-chemical parameters like pH, conductivity, BOD, COD, Hardness, Alkalinity, Chloride, DO, Total Suspended Solid and Total Dissolved Solid by following APHA and Trivedi *et. al.* [10,11].

A. Water Quality Index (WQI) Calculation

To calculate water quality index ten different parameters were chosen. The WQI has been calculated by using the standards of drinking water quality recommended by the Indian Council of Medical Research (ICMR) [12], World Health Organization (WHO) [7], and Bureau of Indian Standards (BIS) [13] for these above mentioned three ghats [Table 2]. A comparative account of WQI of the selected area was made. A rating scale from zero to hundred in WQI provides the information regarding quality of water. Higher the value of WQI indicates lower the quality and lower the value indicates better the quality of water. Brown *et al.*, 1972 gave the status and grading of water quality in respect to WQI (Table3) [14]. A comparison of WQI with different water quality standards helps to understand the actual scenario [15].

Ten water parameters were considered for calculation of water quality index

$$\text{Water Quality Index (WQI)} = \sum W_n q_n$$

$$\text{Where } q_n \text{ (water quality rating)} = 100 \times (V_a - V_i) / (V_s - V_i),$$

When V_a = actual value present in the water sample

V_i = ideal value (0 for all parameters except pH and DO which are 7.0 and 14.6 mg L⁻¹ respectively).

V_s = standard value.

If quality rating $q_n = 0$ means complete absence of pollutants,

While $0 < q_n < 100$ implies that, the pollutants are within the prescribed standard.

$$W_n = K / S_n$$

$$\text{Where } K \text{ (constant)} = 1/V_{s1} + 1/V_{s2} + 1/V_{s3} + 1/V_{s4} + \dots + 1/V_{sn}$$

S_n = 'n' number of standard values.

Table: 2. Standards for Drinking Water Quality by Recommended Agency

Parameters	Standard Value	Recommended Agency
pH	6.5-8.5	BIS
Conductivity(mS cm ⁻¹)	300	ICMR
BOD (mg/L)	5	ICMR
COD (mg/L)	10	WHO
Hardness(mg CaCO ₃ /L)	200	BIS
Alkalinity(mg CaCO ₃ /L)	120	ICMR
Chloride (mg/L)	250	BIS
DO (mg/L)	5	ICMR/BIS
TSS (mg/L)	500	WHO
TDS (mg/L)	500	ICMR/BIS

Table: 3. Water Quality Index, status and grading of water quality, Water Quality Index Level

Water Quality Index Level	Water Quality Status	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very poor water quality	D
Above 100	Unsuitable for drinking and fish culture	E

IV. RESULTS AND DISCUSSION

Table: 4. Assessment of WQI in Dakhineswar Ghat during Pre Mass Bathing

SL.No.	Parameters	Observed Value	Standard value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.30	8.5	0.184	20.0	3.67
2	Conductivity(mS cm-1)	387	300	0.005	129.0	0.67
3	BOD (mg/L)	3.37	5	0.312	67.4	21.03
4	COD (mg/L)	8.25	10	0.156	82.5	12.87
5	Hardness (mg CaCO ₃ / L)	136.44	200	0.008	68.2	0.53
6	Alkalinity (mg CaCO ₃ / L)	135	120	0.013	112.5	1.46
7	Chloride(mg/L)	25	250	0.006	10.0	0.06
8	DO(mg/L)	4.69	5	0.312	103.2	32.21
9	TSS(mg/L)	10	500	0.003	2.0	0.01
10	TDS(mg/L)	254.65	500	0.003	50.9	0.16
					Σqn=645.8	ΣWnqn=72.67
				ΣWn=1.002		

Table: 5. Assessment of WQI in Dakhineswar Ghat during Mass Bathing

SL.No.	Parameters	Observed Value	Standard value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.6	8.5	0.184	40.0	7.34
2	Conductivity(mS cm-1)	445	300	0.005	148.3	0.77
3	BOD (mg/L)	3.13	5	0.312	62.6	19.53
4	COD (mg/L)	9	10	0.156	90.0	14.04
5	Hardness(mg CaCO ₃ / L)	143.53	200	0.008	71.8	0.56
6	Alkalinity (mg CaCO ₃ / L)	142	120	0.013	118.3	1.54
7	Chloride(mg/L)	30	250	0.006	12.0	0.07
8	DO(mg/L)	4.08	5	0.312	109.6	34.19
9	TSS(mg/L)	14	500	0.003	2.8	0.01
10	TDS(mg/L)	292.81	500	0.003	58.6	0.18
					Σqn=714.0	ΣWnqn=78.24
				ΣWn=1.002		

Table: 6. Assessment of WQI in Dakhineswar Ghat during Post Mass Bathing

SL.No.	Parameters	Observed Value	Standard value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.1	8.5	0.184	6.7	1.22
2	Conductivity(mS cm-1)	425	300	0.005	141.7	0.74
3	BOD (mg/L)	3.11	5	0.312	62.2	19.41
4	COD (mg/L)	8.5	10	0.156	85.0	13.26
5	Hardness (mg CaCO ₃ / L)	139.98	200	0.008	70.0	0.55
6	Alkalinity (mg CaCO ₃ / L)	136	120	0.013	113.3	1.47
7	Chloride(mg/L)	28	250	0.006	11.2	0.07
8	DO(mg/L)	4.45	5	0.312	105.7	32.99
9	TSS(mg/L)	12	500	0.003	2.4	0.01
10	TDS(mg/L)	279.65	500	0.003	55.9	0.17
					Σqn=654.1	ΣWnqn=69.89
				ΣWn=1.002		

Table: 7. Assessment of WQI in Belur Math Ghat during Pre Mass Bathing

SL.No.	Parameters	Observed Value	Standard value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.60	8.5	0.184	40.0	7.34
2	Conductivity(mS cm-1)	403	300	0.005	134.3	0.70
3	BOD (mg/L)	1.35	5	0.312	27.0	8.42
4	COD (mg/L)	3.75	10	0.156	37.5	5.85
5	Hardness (mg CaCO ₃ /L)	139.99	200	0.008	70.0	0.55
6	Alkalinity (mg CaCO ₃ /L)	145	120	0.013	120.8	1.57
7	Chloride(mg/L)	27	250	0.006	10.8	0.07
8	DO(mg/L)	4.12	5	0.312	109.2	34.06
9	TSS(mg/L)	11	500	0.003	2.2	0.01
10	TDS(mg/L)	265.17	500	0.003	53.0	0.17
				ΣWn=1.002	Σqn=604.9	ΣWnqn=58.73

Table: 8. Assessment of WQI in Belur Math Ghat during Mass Bathing

SL.No.	Parameters	Observed Value	Standard value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.7	8.5	0.184	46.7	8.56
2	Conductivity(mS cm-1)	395	300	0.005	131.7	0.68
3	BOD (mg/L)	2.89	5	0.312	57.8	18.03
4	COD (mg/L)	5.52	10	0.156	55.2	8.61
5	Hardness (mg CaCO ₃ /L)	139.98	200	0.008	70.0	0.55
6	Alkalinity (mg CaCO ₃ /L)	147	120	0.013	122.5	1.59
7	Chloride(mg/L)	23	250	0.006	9.2	0.06
8	DO(mg/L)	4.69	5	0.312	103.2	32.21
9	TSS(mg/L)	12	500	0.003	2.4	0.01
10	TDS(mg/L)	259.91	500	0.003	52.0	0.16
				ΣWn=1.002	Σqn=650.6	ΣWnqn=70.47

Table: 9. Assessment of WQI in Belur Math Ghat Post Mass Bathing

SL.No.	Parameters	Observed Value	Standard value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.5	8.5	0.184	33.3	6.12
2	Conductivity(mS cm-1)	369	300	0.005	123.0	0.64
3	BOD (mg/L)	1.76	5	0.312	35.2	10.98
4	COD (mg/L)	4.65	10	0.156	46.5	7.25
5	Hardness (mg CaCO ₃ /L)	127.59	200	0.008	63.8	0.50
6	Alkalinity (mg CaCO ₃ /L)	140	120	0.013	116.7	1.52
7	Chloride(mg/L)	21	250	0.006	8.4	0.05
8	DO(mg/L)	4.65	5	0.312	103.6	32.34
9	TSS(mg/L)	9	500	0.003	1.8	0.01
10	TDS(mg/L)	242.80	500	0.003	48.6	0.15
				ΣWn=1.002	Σqn=580.9	ΣWnqn=59.55

Table: 10. Assessment of WQI in Bally Pathak Ghat Pre Mass Bathing

SL.No.	Parameters	Observed Value	Standard value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.1	8.5	0.184	6.7	1.22
2	Conductivity(mS cm-1)	362	300	0.005	120.7	0.63
3	BOD (mg/L)	2.42	5	0.312	48.4	15.10
4	COD (mg/L)	4.98	10	0.156	49.8	7.77
5	Hardness (mg CaCO ₃ / L)	139.9	200	0.008	70.0	0.55
6	Alkalinity (mg CaCO ₃ / L)	25	120	0.013	20.8	0.27
7	Chloride(mg/L)	148	250	0.006	59.2	0.37
8	DO(mg/L)	5.12	5	0.312	98.8	30.81
9	TSS(mg/L)	9	500	0.003	1.8	0.01
10	TDS(mg/L)	238.20	500	0.003	47.6	0.15
				ΣWn=1.002	Σqn=523.7	ΣWnqn=56.87

Table: 11. Assessment of WQI in Bally Pathak Ghat during Mass Bathing

SL.No.	Parameters	Observed Value	Standard value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.8	8.5	0.184	53.3	9.79
2	Conductivity(mS cm-1)	567	300	0.005	189.0	0.98
3	BOD (mg/L)	1.25	5	0.312	25.0	7.80
4	COD (mg/L)	3.3	10	0.156	33.0	5.15
5	Hardness (mg CaCO ₃ / L)	171.88	200	0.008	85.9	0.67
6	Alkalinity (mg CaCO ₃ / L)	32	120	0.013	26.7	0.35
7	Chloride(mg/L)	153	250	0.006	61.2	0.38
8	DO(mg/L)	4.19	5	0.312	108.4	33.83
9	TSS(mg/L)	11	500	0.003	2.2	0.01
10	TDS(mg/L)	373.09	500	0.003	74.6	0.23
				ΣWn=1.002	Σqn=659.4	ΣWnqn=59.19

Table: 12. Assessment of WQI in Bally Pathak Ghat during Mass Bathing

SL.No.	Parameters	Observed Value	Standard value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.1	8.5	0.184	6.7	1.22
2	Conductivity(mS cm-1)	362	300	0.005	120.7	0.63
3	BOD (mg/L)	2.42	5	0.312	48.4	15.10
4	COD (mg/L)	4.98	10	0.156	49.8	7.77
5	Hardness (mg CaCO ₃ / L)	139.9	200	0.008	70.0	0.55
6	Alkalinity (mg CaCO ₃ / L)	25	120	0.013	20.8	0.27
7	Chloride(mg/L)	148	250	0.006	59.2	0.37
8	DO(mg/L)	5.12	5	0.312	98.8	30.81
9	TSS(mg/L)	9	500	0.003	1.8	0.01
10	TDS(mg/L)	238.20	500	0.003	47.6	0.15
				ΣWn=1.002	Σqn=523.7	ΣWnqn=56.87

Table: 13. Comparison between WQI in three different Ghats during Pre Mass Bathing, Mass bathing, Post Mass Bathing

Ghat	Pre Mass Bathing	During Mass Bathing	Post Mass Bathing
Dakhineswar Ghat	72.67	78.24	69.89
Belur Math Ghat	58.73	70.47	59.55
BallyPathak Ghat	56.87	59.19	56.87

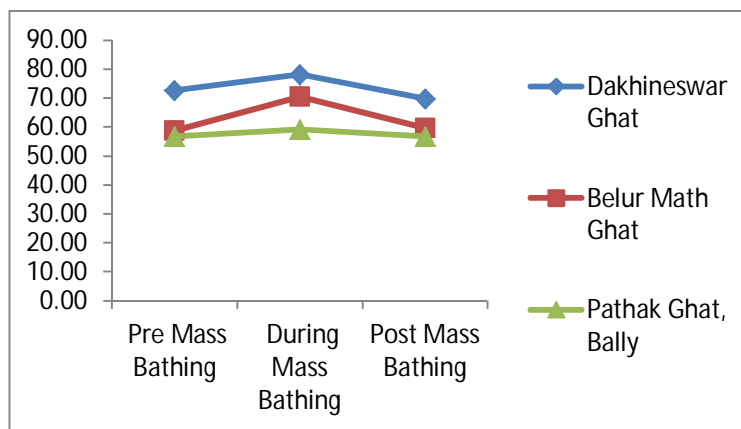


Fig. 1: Graphical representation of Comparison between WQI in three different Ghats during Pre Mass Bathing, Mass bathing, Post Mass Bathing

Table: 14. Water quality status and grading during Pre Mass Bathing, Mass bathing, Post Mass Bathing

Ghat		Water Quality Status	Grading
Dakhineswar Ghat	Pre Mass Bathing	Poor water quality	C
		Poor water quality	C
		Poor water quality	C
Dakhineswar Ghat	During Mass Bathing	Very poor water quality	D
		Poor water quality	C
		Poor water quality	C
Dakhineswar Ghat	Post Mass Bathing	Poor water quality	C
		Poor water quality	C
		Poor water quality	C

V. CONCLUSION

During royal bathing in river Ganga in the *Mahalaya* festival, the monitoring of few physico-chemical parameters had been done. The study involved the assessment on the basis of WQI showed mass bathing makes the water unfit for drinking and bathing purposes. Previous finding showed that mass bathing tends to disturb riverine ecology of Ganga by decreasing DO and increasing BOD, hardness and TDS [2]. Pilgrim related activities were already identified reasons for water quality degradation[16]. Similar results obtained for this case. Comparing with standards (Table 2) poor water quality is reported for each three ghats before, after and during mass bathing. The result for Dakhineswar ghat where the gathering of pilgrims were the highest, reported very poor

water quality during the occasion. Interestingly a study on colonies in Haridwar city shows people with higher financial status of life style generates roughly twice as much solid garbage as people from slum areas [17].

VI. ACKNOWLEDGMENT

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