



Water Quality Analysis of River Ganga and Yamuna during Mass Bathing, Allahabad, India

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Abstract:

The present study was carried out to analyze water quality of river Ganga and Yamuna during Mass bathing at Allahabad. Water samples were collected from eight selected bathing sites of the Ganga and Yamuna. The physico-chemical parameter such as Alkalinity, Biological oxygen demand, Chloride, Calcium hardness, Electric conductivity, Magnesium hardness, pH, Temperature, Turbidity and Total hardness were increased whereas decline in the level of Dissolve oxygen was observed at selected sites of Ganga and Yamuna. All parameters were highly affected at Daraganj and Ramghat. These sites were used frequently for the pilgrims and hence found highest affected zones. At all sites water samples were observed poor and showing that the Ganga has moderately polluted as compared to the Yamuna. The present study indicated an increase in water pollution levels of the Ganga and Yamuna.

Keywords: River Ganga and Yamuna, Mass bathing, Water quality

1.0 Introduction:

Water is one of the mainly essential of all natural resources known on earth. It is important to all living organisms, most ecological systems, human health, food production and economic development (Postel *et al.*, 1996). The water is used for various purposes such as drinking without treatment, bathing, non-contact recreational uses, public water supplies, industrial, agricultural, aquaculture and wildlife propagation, navigation and waste receiving etc. (Sundararajan and Anand, 2011), But the clarity does not remain constant and varies from place to place in nature. Today pollution is one of the biggest problems of water quality degradation in the Ganga and its tributaries increasing from year to year due to the increase pollutant loads particularly from commercial and domestic sources, sewage discharge and industrial effluent (Matta *et al.*, 2014). The water is contaminated due to population explosion, urbanization, industrialization and agricultural pollution cause major alteration of water pollution. It is estimated that the Global annual risk of

contracting infections disease from eating raw vegetables irrigated with untreated wastewater is in the range of 5-15% (Fattal *et al.*, 2004). The Ganga basin accounts for a little more than one-fourth (26.3%) of the country's total geographical area and is the biggest basin in India, covering the entire states of Uttarakhand (CPCB, 2013). The Ganga has great ritual importance among pilgrims and tourists in India. The Ganga is a division and parcel of everyday life in the city and thousands of people bath daily in the Ganga, but the heaviness on the Ganga is increasing enormously due to ever increasing population, industrial and urban growth in the basin. The Canal is being polluted due to mass bathing, washing, disposal of sewage, industrial waste and these human activities are deteriorating its water quality (Seth *et al.*, 2013).

Triveni Sangam at Prayag (Allahabad) has two physical Ganga, Yamuna and the unseen or mythical Saraswati. Kumbh Mela is a mass Hindu pilgrimage of loyalty in which Hindus gather to immerse in a

holy. It world’s prevalent religious gathering, with over 80 million people estimated in 2013. It is held every third year at one of the four places by turning round: Haridwar, Allahabad (Prayag), Nasik and Ujjain. Thus the Kumbh Mela is held at each of these four places every twelfth year. Ardh (‘half’) Kumbh Mela is held at only two places, Haridwar and Allahabad, Every six years. The Mahakumbh Mela is a spiritual incident of epic proportions which takes neither place every 12 years in the city of Allahabad in northern India. It’s a pilgrimage of faith, salvation and hope for millions of Indian’s and vast numbers gather in observance of one of India most famous religious events. Allahabad, the prehistoric holy city of Prayag (the holiest of the holy) is to be found at the confluence of the Ganga and Yamuna and is considered the most sacred position for the mela. To bathe in, to drink its holy water, to have one’s ashes scattered over its surface; these are the greatest wishes of every devout Hindu. According to an ancient Sanskrit verse, the people who ‘participate’ in the Kumbh Mela and ‘bathe’ become free from temporal and get spiritual salvation (Murthi *et al.*, 1991). Above declare literature indicates that the current time in India nearly all of the rivers are in

front of pollution troubles mostly due to anthropogenic activities. A water feature of river Ganga and Yamuna is demeaning day by day due to various human actions. In order to minimize the contamination, firstly we have to analyze the substances current in the water, which are causing this contamination of river Ganga and Yamuna.

2.0 Materials and Method:

2.1 Site description:

The study area was located in Allahabad city in the southeastern part of U.P (98m above the mean sea level). Allahabad district cover an area of 5246 sq.km. Population of Allahabad district as per the census 2011 was 5959798. The sampling station has been referred as Ganga (S1-Rasoolabad, S2-Mahaveerpuri, S3-Phaphamau, S4-Daraganj and S5-Ramghat) and Yamuna (S6-Old Bridge, S7-New Bridge and S8-Saraswati ghat).

2.2 Sample collection

Water sample from the sampling station were collected on main bathing dates during the Mass bathing period and parameter was analyzed by the standard method.

2.3 Physico-chemical parameters

Table 1: The various methods for determination of all parameters are listed below

| Parameter | Instrument /Standard Methods(APHA, 1998) |
|--|---|
| PHYSICAL PARAMETER | Water analyzer |
| Electrical conductivity (µS/cm), Temperature (°C) | EC meter, Thermometer |
| Chemical parameter | pH meter and turbidity analyzer |
| pH, Turbidity (NTU) | pH meter, Nephlo- turbidity meter |
| Dissolve oxygen, Biological oxygen demand, Chloride, Total hardness, Calcium /Magnesium hardness, Alkalinity in mg/l | Volumetric analyzer Wrinkler’s method , Argentrometric method, EDTA tritrimetric , By difference (Total hardness-Ca), Titration method |

Out of these parameters; Temperatures, pH, were analyzed in the field and DO were determined without delay upon persistent to the laboratory and Conductivity, Turbidity, BOD, Chloride, Hardness, Alkalinity were determined in the research laboratory by using given method of (APHA, 1998).

3.0 Results and Discussion:

Conductivity of River Ganga and Yamuna ranged from 0.30-0.75 µs/cm at various sampling sites. The lowest EC value was observed 0.30 µs/cm at Daraganj site and highest EC value was 0.75 µs/cm at the New Bridge site (Fig3.1) during main bathing dates for the reason that domestic sewage as well as industrial effluents is direct release in the Yamuna. On the other hand, the leaching of chemical

fertilizers spread on agricultural lands by rain water also causes high water conductivity (Sawidis, 1997). The value of Temperature ranges involving 10.0-25.2°C. The minimum value for water temperature was recorded 10.0°C at New Bridge site. Despite the fact that the maximum value of water temperature was recorded 25.2°C at Phaphamau site. Temperature impacts both the chemical and biological characteristics of surface water.

Temperature is known to manipulate the pH, Alkalinity and DO concern in the water (Kumar *et al.*, 2010). Present study result of Temperature was presented in Fig 3.3.

pH is measured an essential chemical parameter that determines the appropriateness of water for a range of purposes. Its limitation of water major for the biotic communities for the reason that most of the aquatic organisms are modified to a standard pH. The pH values were recorded between 7.71- 8.80. The minimum pH value was noted 7.71 at Saraswati Ghat site at the same time as maximum pH value was noted 8.80 at Daraganj site durin the main bathing day. The upper pH could be due to bicarbonate and carbonates of calcium and magnesium. Recent studies reported the pH of the Ganga river at Haridwar was slightly alkaline ranged from 7.06-8.35(Joshi *et al.*, 2009). Result of pH is presented in Fig 3.2. Alkalinity is the quantitative ability of a water sample to neutralize a strong acid to a designated pH. Alkalinity of the Ganga and Yamuna water during Mahakumbh ranged between 145-225 mg/l. The highest value 225 mg/l of the alkalinity was found at Old Bridge and Saraswati Ghat site, while the lowest value 145 mg/l was found at Daraganj and Ramghat site. Alkalinity serves as a pH reservoir for inorganic carbon. It is usually taken as an index of productive potential of the water (Manahan, 1994).

Turbidity of water is an essential parameters, which manipulate the light break through inside water and thus affects the aquatic life (Verma and Saksena, 2010).The reading of Turbidity ranged between 13.79-51.04NTU. The minimum and maximum Turbidity was found 13.79 NTU and 51.04 NTU at Saraswati Ghat during main bathing dates in Fig 3.4. Excessive Turbidity in water can cause problem for water purification process such as flocculation and filtration which may increase treatment costs. High turbid waters are associated with microbial contamination (DWAf, 1998). Again turbidity causes decrease in photosynthesis process since Turbidity precludes deep penetration of light, of water (Muoghalu and Omocho, 2000). Chlorides are important in detecting the contamination of ground water by waste water. In general, high evapotranspiration tends to increase the Chlorides and salinity at the root zone of irrigated plants, making it difficult for crops to take up the water due

to osmotic pressure differences between the water outside the plants and within the plant cells (Hariharan, 2007). Chloride of the Ganga and Yamuna water during Mahakumbh ranged between 101-288.26 mg/l. The highest value of the chlorides was found 288.26 mg/l at Phaphamau site, while the lowest value was found 101 mg/l at Daraganj site because it was due to receiving both industrial and domestic waste, the higher concentration of Chloride observed for Kanhan and Pench by (Khadse *et al.*, 2008). Result of Chloride was presented in Fig 3.7.

Dissolved oxygen is the most essential parameter in water quality assessment. Its presence is essential to maintain a variety of forms of life in the water and the effect of waste discharge in a water body are largely determined by the oxygen balance of the system. It can be rapidly removed from wastewaters by the discharge of the oxygen demanding waste. Inorganic reducing agents such as H₂S, ammonia, nitrite, ferrous iron and certain oxidizable material also tend to decrease dissolved oxygen in the water (Shrivastava *et al.*, 2011). In the present study the overall lowest and highest value of DO was observed 6.4-11.6 mg/l and maximum DO 11.6 mg/l was found at Mahaveerpuri site, while the minimum DO 6.4 mg/l was found at New Bridge site. Result of DO was presented in Fig 3.5. Lower temperature is known to favor greater dissolution of oxygen in water. DO in good quality streams is usually more than 6 ppm to promote proper growth of fish and other aquatic organisms (Miller, 1994). Biochemical oxygen demand ranged between 1.2-7.6 mg/l the higher DO in the surface water due to the depth of mixing of air with water temperature. The minimum BOD 1.2mg/l was found at Old Bridge and New Bridge site, while the maximum BOD 7.6ml/l was originate at Daraganj and Ramghat site for the reason that the higher BOD in water due to direct release of influence into the water bodies. Result of BOD was presented in Fig 3.6. Higher values of BOD and lower values of DO point out more amount of organic matter present in sewage for the reason that the mass bathing certainly degrade the quality of water.

The hardness of water is not a pollution indicator parameter, but indicator of water quality, mainly in terms of Ca²⁺ and Mg²⁺ bicarbonate, sulphate, chloride, and nitrates. Water with less than 75mg⁻¹ of CaCO₃ is considered soft and above 75mg⁻¹ of

CaCO₃ as hard (Singh and Choudhary, 2013). It is an important criterion for determining the usability of water for domestic, drinking and many industrial supplies (Mitharwal *et al.*, 2009). Total hardness of the Ganga and Yamuna water during Mahakumbh ranged between 190-336 mg/l, the highest value of the hardness was found 336mg/l at Saraswati Ghat site, while the lowest value was found 190mg/l at

Phaphamau site in Figure 8. Mg hardness ranged between 14-220mg/l. The highest Mg value 220mg/l was found at the Old Bridge site, while the lowest value of Mg hardness 14mg/l was found at Phaphamau site. Ca hardness ranged between 90-184mg/l. The lowest value 90mg/l was found at Daraganj site, while the highest value 184mg/l was found at Ramghat site.

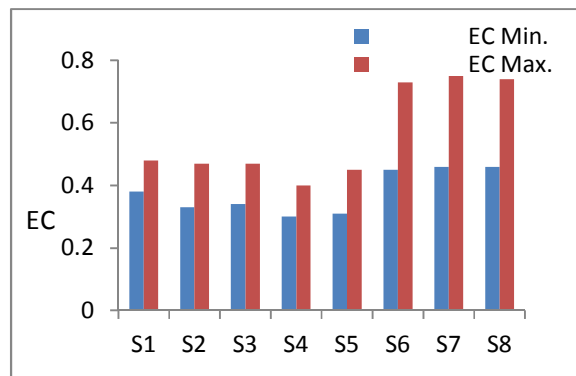


Fig. 3.1: Variations in EC (°C) at Selected sites

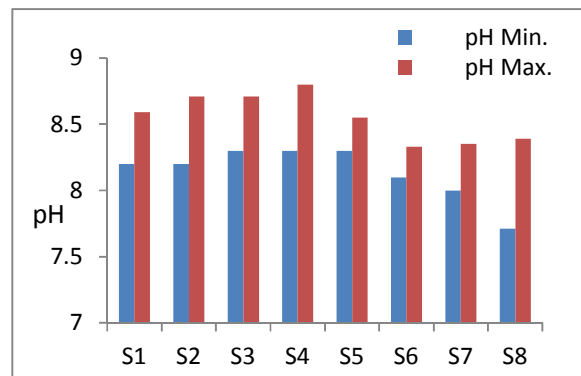


Fig. 3.2: Variations in pH at Selected Sites

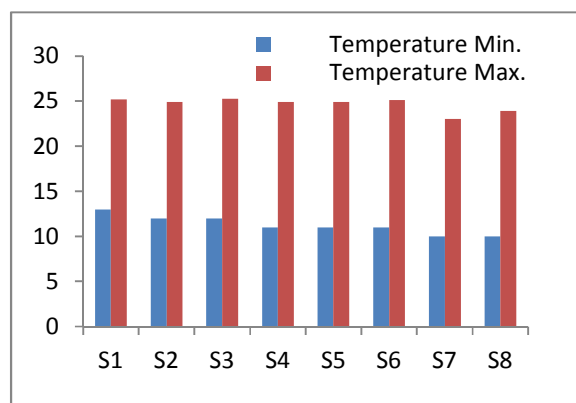


Fig. 3.3: Variations in Temperature (°C) at Selected sites

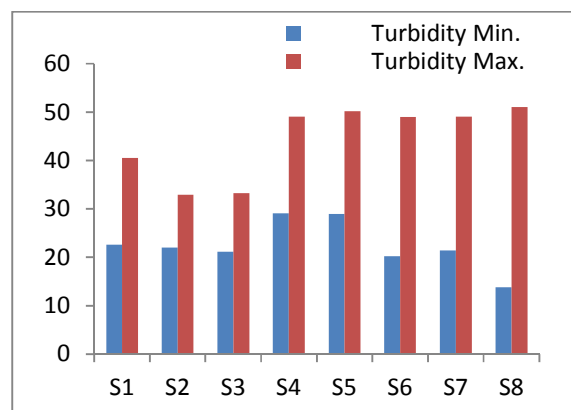


Fig. 3.4: Variations in Turbidity (NTU) at Selected Sites

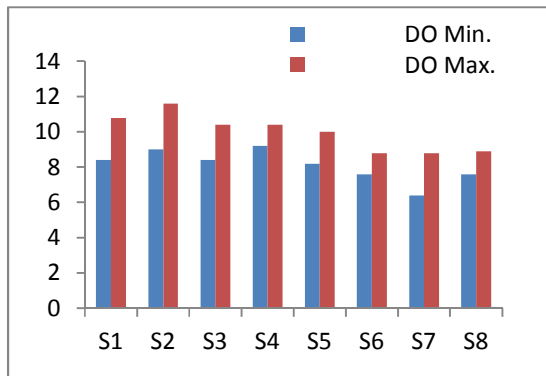


Fig. 3.5: Variations in Dissolve oxygen (mg/l) at selected sites

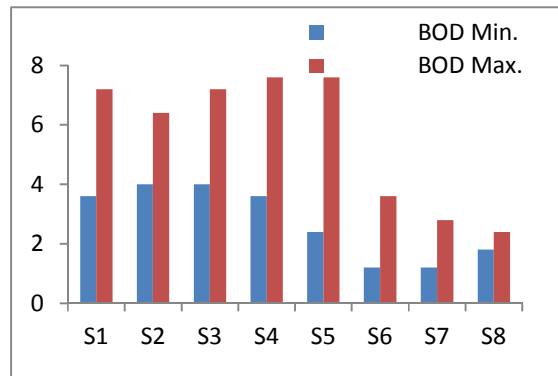


Fig. 3.6: Variations in B.O.D (mg/l) at selected Sites

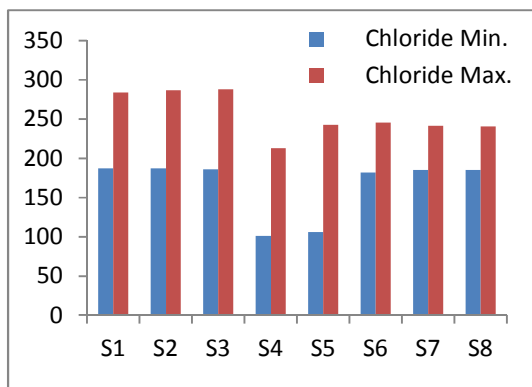


Fig. 3.7: Variations in Chloride (mg/l) at selected sites

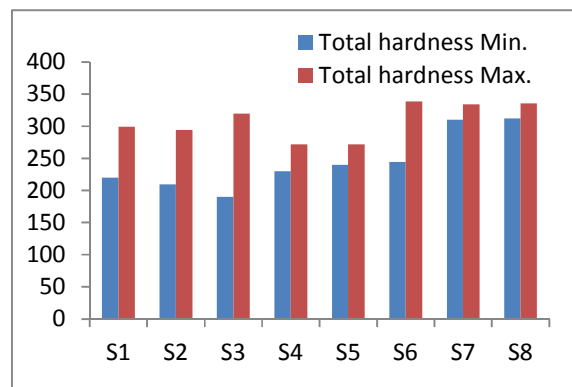


Fig. 3.8: Variations in Total hardness(mg/l) at selected sites

Table 2: Parameters of River Ganga and Yamuna during Mass Bathing Period

| Parameter | EC | | Temperature | | pH | | Alkalinity | | Turbidity | | Chloride | | DO | | BOD | | Total hardness | | Ca hardness | | Mg hardness | |
|-------------|------|------|-------------|-------|---------|------|------------|------|-----------|-------|----------|--------|-------|------|--------|------|----------------|------|-------------|------|-------------|------|
| | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| S-1 | 0.38 | 0.48 | 13 | 25.2 | 8.20 | 8.59 | 169 | 198 | 22.6 | 40.6 | 187.44 | 284 | 8.4 | 10.8 | 3.6 | 7.2 | 220 | 299 | 132 | 156 | 64 | 162 |
| S-2 | 0.33 | 0.47 | 12 | 24.9 | 8.20 | 8.71 | 171 | 191 | 22 | 32.9 | 187.44 | 286.80 | 9 | 11.6 | 4 | 6.4 | 210 | 294 | 138 | 170 | 44 | 156 |
| S-3 | 0.34 | 0.47 | 12 | 25.25 | 8.30 | 8.71 | 176 | 187 | 21.1 | 33.2 | 186.02 | 288.26 | 8.4 | 10.4 | 4 | 7.2 | 190 | 320 | 100 | 182 | 14 | 198 |
| S-4 | 0.30 | 0.40 | 11 | 24.9 | 8.30 | 8.80 | 145 | 162 | 29.1 | 49.07 | 101 | 213 | 9.2 | 10.4 | 3.6 | 7.6 | 230 | 272 | 90 | 180 | 72 | 160 |
| S-5 | 0.31 | 0.45 | 11 | 24.9 | 8.30 | 8.55 | 145 | 163 | 29.0 | 50.19 | 105.9 | 242.8 | 8.2 | 10 | 2.4 | 7.6 | 240 | 272 | 98 | 184 | 62 | 160 |
| S-6 | 0.45 | 0.73 | 11 | 25.1 | 8.10 | 8.33 | 183 | 225 | 20.19 | 48.98 | 182.19 | 245.66 | 7.6 | 8.8 | 1.2 | 3.6 | 244 | 339 | 110 | 144 | 100 | 220 |
| S-7 | 0.46 | 0.75 | 10 | 23 | 8.0 | 8.35 | 200 | 221 | 21.45 | 49.1 | 185.19 | 241.5 | 6.4 | 8.8 | 1.2 | 2.8 | 310 | 334 | 114 | 130 | 196 | 210 |
| S-8 | 0.46 | 0.74 | 10 | 23.9 | 7.71 | 8.39 | 200 | 225 | 13.79 | 51.04 | 185.19 | 241 | 7.6 | 8.9 | 1.8 | 2.4 | 312 | 336 | 110 | 132 | 196 | 215 |
| BIS LIMITS | - | | - | | 6.5-8.5 | | - | | - | | 250mg/l | | 5mg/l | | 30mg/l | | 300mg/l | | - | | - | |
| CPCB Limits | - | | - | | 6.5-8.5 | | 600mg/l | | 10NTU | | 250mg/l | | | | | | 600mg/l | | 200mg/l | | 100mg/l | |

4.0 Conclusion:

From the study of river Ganga and Yamuna at Allahabad, it was the result that the water quality of Ganga and Yamuna is contaminated. The water quality was found mainly due to mass bathing and direct discharge of sewage water domestic waste water of the city was a major factor that is responsible for the contamination of the Ganga and Yamuna. At sampling S4-Daraganj and S5-Ramghat the water quality is highly polluted low DO and high BOD, alkalinity during mass bathing. S-4 Daraganj and S5- Ramghat is using highly gathering point of pilgrim in Mahakumbh period and using of organic matter and direct discharge of organic effluents and direct discharge of domestic waste. Temperature, Turbidity, Chloride, Total hardness, it presents the pollution group due to human origin including untreated and partially treated discharge. The focusing point of the study is that River Ganga and Yamuna at Allahabad city is contaminated due to the addition of pilgrim in Mahakumbh, Hence the users of River Ganga and Yamuna are badly affected due to the use of such contaminated.

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