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WATER QUALITY OF THE RIVER GANGA DURING MASS RITUALISTIC BATHING ON ARDH KUMBH IN PRAYAGRAJ, INDIA

AJIT KUMAR VIDYARTHI*, VIVEK RANA, GARIMA DUBLISH AND MRINAL KANTI BISWAS

Central Pollution Control Board, Parivesh Bhawan, East Arjun Nagar, Shahdara, Delhi, India

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ABSTRACT

Ardh Kumbh Mela (hereafter mentioned as Kumbh Mela), a religious Hindu festival, was celebrated in India from January to March 2019 which comprises ritualistic mass bathing at the confluence of the rivers Ganga, Yamuna, and Sarasvati in Prayagraj in the Uttar Pradesh state of India. The water quality of the river Ganga at Prayagraj was assessed with respect to bathing water standards. The properties (pH, dissolved oxygen, biochemical oxygen demand, and fecal coliform) of river water were evaluated during, before and after six auspicious bathing occasions at three locations: (i) Sangam; (ii) Kuresar Ghat, upstream of Sangam; and (iii) Deeha Ghat, downstream of Sangam. This study revealed that the river water was found non-complying on some bathing occasions with respect to pH, BOD, and FC. However, the DO content of the river was meeting the stipulated bathing standards at all monitoring locations on all bathing occasions. The high DO content in the river may be attributed to the self-cleansing properties (high photosynthetic activity, low rate of respiration, and low organic degradation) of the river Ganga. However, the impact of bathing on the BOD level of the river was observed as the BOD was higher during morning in comparison to evening on many bathing occasions. The study concluded that the competent authorities must take necessary measures to ensure the river water quality during mass bathing events such as Kumbh Mela.

KEY WORDS : Kumbh Mela, Mass bathing, Prayagraj, River ganga, Water quality

INTRODUCTION

River Ganga is the longest perennial river in India which covers approximately 2525 km with a basin size of 1320 thousand km^2. It originates at Gaumukh (30°362 N; 79°042 E) in the snout of the Gangotri glacier as Bhagirathi river inthe Himalayas at an elevation of 4356 m. In the Himalayas, many small water streams encompass the headwaters of the river Ganga. The six longestheadstreams are Alaknanda, Dhauliganga, Nandakini, Pindar, Mandakini, and Bhagirathi rivers. The river attains the name Ganga at Devprayag, where Alaknanda joins Bhagirathiand enters the Gangetic plains at Haridwar in Uttarakhand state of India (Singh and Singh, 2007). The river Ganga meets the Bay of Bengal after traversing through the five states namely Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal.

The river gets polluted due to both natural sources (such as atmospheric deposition, erosion, and weathering of crustal materials) and anthropogenic activities (such as sewage, industrial effluents, and agricultural run-off) (Pandey and Singh, 2017). Some industrial sectors, such as tanneries in Kanpur, adversely affect the water quality of river Ganga (Khwaja *et al.*, 2001). Apart from these pollution sources, mass bathing activities also affects the water quality of the river.

Kumbh Mela, a religious Hindu social gathering festival in India, is celebrated every twelve years at four river bank pilgrimage sites: (i) Prayagraj (at the confluence of rivers Ganga, Yamuna, and Sarasvati; (ii) Haridwar (on river Ganges); (iii) Nashik (on river Godavari); and (iv) Ujjain (on river Shipra). It is the largest public gathering and collective act of faith, anywhere in the world (Shukla and Gupta, 2015). Apart from Kumbh Mela, Ardh Kumbh

("Half Kumbh") is also celebrated after six years from the Kumbh Mela. The Kumbh Mela at Prayagraj was held in the year 2013, however, the Ardh Kumbh was celebrated in the year 2019. During these festivals, pilgrims take a ritual dip into the river water according to the Hindu mythology. Srivastava *et al.* (1996) and Dwivedi *et al.* (2020) reported that water quality of river Ganga deteriorated at Prayagraj due to mass ritualistic bathing.

The objective of the present study was to assess the suitability of the water of river Ganga for bathing during Ardh Kumbh festival held in 2019 at the Prayagraj city of Uttar Pradesh state in India.

MATERIALS AND METHODS

Description of the Study Area

Prayagraj (25°272 N, 81°512 E) is a city located in the Uttar Pradesh state of India which is named after the word "Prayaga" which means "a confluence of rivers". In Prayagraj, three major rivers of the country namely the Ganga, the Yamuna, and the Sarasvati (mythically believed to be meeting the two rivers invisibly) meet and the confluence point is popularly known as the 'Sangam'. From January to March 2019, Ardh Kumbh Mela (hereafter mentioned as Kumbh Mela) at Prayagraj was held for 55 days in which approximately 120 million Hindu pilgrims participated to take a holy dip at the Sangam. For the present study, three locations were selected on the river Ganga: (i) Before confluence with the river Yamuna at Kuresar Ghat; (ii) At the confluence of the rivers Ganga and Yamuna, i.e. the Sangam (where bathing activities took place), and (iii) After the confluence with the river Yamuna at Deeha ghat. The study area has a humid sub-tropical climate with hot and dry summers, cool and dry winters, and humid monsoon season. It receives annual average precipitation of 1027 mm with the highest rainfall in the month of August.

Sample Collection and Analysis

During Kumbh Mela, there were six auspicious bathing occasions (Makar Sakranti, Paush Poornima, Mauni Amawasya, Basant Panchami, Maghi Poornima and Mahashivratri) that were organized at Sangam during January to March 2019. Ardh Kumbh Mela 2019 was attended by 130.2 million pilgrims against 88.3 million during Maha Kumbh 2013 reported by Dwivedi *et al.* (2020). In total, 76 sampling surveys were conducted to collect the water samples.

To evaluate the suitability of river water for bathing, the water quality of river Ganga with respect topH, DO, BOD, and FC was evaluated at U/s of Sangam near Kuresar Ghat, at Sangam (during morning and evening) and Deeha Ghat on six bathing occasions.The pH of water samples was analyzed on-site. Samples for DO, BOD, and FC were collected using the grab sampling technique. After collection, samples were transferred to the laboratory in an ice-box to ensure data representativeness. After reaching the laboratory, the water samples were analyzed using standard procedures (APHA, 2017).

RESULTS AND DISCUSSION

pH in the River Water

As per the bathing standards, the pH of the river water must be between 6.5 and 8.5. In river water, the pH is driven by several physical and biogeochemical processes such as plant respiration, photosynthesis, dissolved minerals, and composition of anthropogenic waste received by the river (Mitra *et al.,* 2018). In the present study, the pH at Kuresar Ghat variedbetween 8.13 and 8.64 and the water quality failed to meet the bathing water standards during Makar Sakranti. At Sangam, during the morning, pH varied from 8.09 to 8.83 and exceeded the standards on pre-Makar Sakranti, post-Makar Sakranti, post-Mauni Amawasya and from pre to post Basant Panchami. At Sangam, during the evening, pH varied from 8.09 to 8.72 and did not meet the standards on six occasions, i.e., Makar Sakranti, post-Makar Sakranti, pre-Paush Poornima, Mauni Amawasya, post-Mauni Amawasya, and Basant Panchami. At Deeha Ghat, located 18-20 km downstream of Sangam, the pH varied as 7.8-8.58 and exceeded the standards on only one bathing occasion namely Makar Sakranti.

DO in the River Water

DO content in a river drives key processes for the sustenance of aquatic life as its concentration and regulatory elements in water governs the eutrophy, ecosystem health, and biogeochemical responses (Jaiswal and Pandey, 2019). Low DO content in the river (also known as hypoxic conditions) leads to (i) elimination of sensitive fish and invertebrate species; (ii) modify biogeochemical pathways; (iii)

decrease nutrient retention by river sediments (Caraco *et al.,* 2000). The reduction in DO is mainly attributed to (i) the discharge of organic pollutants such as sewage which reduces the DO in the river due to decomposition by microorganisms; (ii) influx of plant-limiting nutrients such as N and P, which develops eutrophication of surface water and anoxic conditions in bottom waters; and (iii) variations in physical mixing or isolation of bottom water (Naubi *et al.,* 2016). In the present study, at Kuresar Ghat, the DO varied from 8.2 to 13 mg/L and the water quality met the bathing standards on all the occasions. At Sangam, the DO varied as 8.5-12 mg/L and 8.4-13 mg/L during morning and evening, respectively, and met the standards on all locations. At Deeha Ghat, downstream of Sangam, the DO was higher than 5 mg/L on all bathing occasions. The high DO content in the river at all the monitoring locations may be attributed to the self-cleansing properties (high photosynthetic activity, low rate of respiration, and low organic degradation) of the river Ganga.

BOD in the River Water

The BOD indicates the biodegradable fraction of the organic load in the river water (Matta *et al.,* 2017). In the river, the BOD typically increases due to the discharge of sewage and industrial effluents and is directly proportional to the urbanization at the bank of the river (Sharma *et al.,* 2016). The BOD at Kuresar Ghat varied from 2.5 to 8.6 mg/L and exceeded the bathing standards on all occasions except pre-Makar Sakranti and Basant Panchami. At Sangam, during the morning, BOD ranged as 2.1-7.7 mg/L which met the standards only on pre-Makar Sakranti, pre-Basant Panchami and Basant Panchami. However, during the evening, at Sangam, the BOD ranged between 2.6 and 7.5 mg/L and the water quality w.r.t. BOD failed to meet the bathing standards on all occasions except Basant Panchami. The impact of bathing on the BOD level of the river was observed as the BOD was higher during morning in comparison to evening on many bathing occasions. At Deeha Ghat, the BOD ranged as 2.5-4.7 mg/L and failed to meet the standards on Makar Sakranti, pre-Mauni Amawasya, Basant Panchami, and post-Basant Panchami.

Fecal Coliform in the River Water

The fecal coliform levels in the river can be attributed to direct discharge of untreated sewage, fecal bacteria remaining in the treated wastewater, and open defecation on the banks of the river (Singh and Saxena, 2018). The fecal coliform level at Kuresar Ghat exceeded the bathing standards on pre-Makar Sakranti, pre-Basant-Panchami, and Basant Panchami. At Sangam, the FC reached up to 13000 MPN/100 mL and failed to meet the standards on Makar Sakranti, post-Mauni Amawasya, Maghi Poornima, pre-Maha Shivratri to post-Maha Shivratri. However, at Sangam, the FC level in the evening reached up to 23000 MPN/100 mL and exceeded the bathing norms on six occasions namely Makar Sakranti, pre-Mauni Amawasya, Mauni Amawasya, pre-Maghi Poornima, Makar Sakranti, and post-Makar Sakranti. Also, the FC was found exceeding the bathing norms on the occasions of Maha Shivratri and post-Maha Shivratri in the morning as well as evening at Sangam. At Deeha Ghat, FC value reached up to 7800 MPN/100 mL and failed to meet the bathing standards on post-Makar Sakranti, Mauni Amawasya, post-Mauni Amawasya, post-Maghi Poornima, Maha Shivratri, and post-Maha Shivratri. Srivastava *et al.* (1996) indicated elevated levels of fecal coliform during Maha Kumbh Mela at Prayagraj in 1989. During Ardhkumbh Mela at Haridwar, in 2004, the water of the river Ganga was found unfit for drinking and bathing due to an increase in the FC count (Kulshrestha and Sharma, 2006).

CONCLUSION

This study revealed that the river water was found non-complying on some bathing occasions with respect to pH, biochemical oxygen demand, and fecal coliform. However, the dissolved oxygen content of the river was meeting the stipulated bathing standards at all monitoring locations on all bathing occasions. The high dissolved oxygen content in the river may be attributed to the self-cleansing properties (high photosynthetic activity, low rate of respiration and low organic degradation) of the river Ganga. However, the impact of bathing on the BOD level of the river was observed as the BOD was higher during morning in comparison to evening on many bathing occasions. The study concluded that the competent authorities must take necessary measures to ensure that the river water quality must meet the standards during mass bathing events such as Kumbh Mela.

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